Surgical Decision Making in Geriatrics

A Comprehensive Multidisciplinary Approach

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Editor
Rifat Latifi
Department of Surgery
New York Medical College
School of Medicine and
Westchester Medical Center Health Network
Valhalla, NY
USA

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Prologue: COVID-19 Pandemic and the Elderly, Disparity

When we conceived this book, none of us could imagine that before the book goes to the print, the world would be in chaos from a disease that would affect all of us, but particularly will be deadly for the elderly and disparity population. None of us thought that the entire world would change as it did. Over the past six months, not just the world has changed and with that the hospitals and practice surgery have also changed. For months we did not perform any elective surgery; we only performed emergency surgery. Everyone has a mask on, everyone who works in the hospitals and patient alike. But as bad as it was, we learned a lot during these past months, and chances are we will continue to learn more about the disease that has spread throughout the world and that affects every organ.

With each day passing we learned new things. Who is dying, but even more importantly, why patients are dying? How do we protect each other, ourselves, our families, our patients, and hospital staff? It is very difficult to keep up with new information. One paragraph written today on your paper on COVID-19 or information you read is challenged next day by new data or by lack of data. The first report on deaths from COVID-19 that came from China was alarming with death rates of 11.1–14.6% of those infected. However, as New York become the hottest zone in the world, the study from New York City reported higher mortality rates. We have learned that elderly, obese patients, those with hypertension, lung diseases, chronic kidney disease, malignancy, myocardial infarction, cerebral infraction, and arrhythmia, had worse outcomes. Those who died from COVID-19 had significantly increased white blood cell (WBC) count and decreased lymphocyte and platelet counts. On rounds in the ICU now we talk about biomarkers of inflammation, interleukins 6 (IL-6) and 10 (IL-10), serum ferritin, and neutrophil-to-lymphocyte ratio (NLR). One thing that we knew, but it became even more apparent from this pandemic, is the disparity and inequality of healthcare. It has become evident that blacks, Native Americans, and patients from Hispanic communities are dying at a much higher rate. In other words, poor people and elderly in nursing homes are dying in disturbing numbers worldwide, particularly in Europe and USA. Vascular complications of COVID-19 (thrombosis both of venous and arterial tree) are severe including causing major abdominal catastrophes (Figures). In order to prevent these complications, patients are placed on anticoagulants, which in critically ill patients can cause major bleeding such as bleeding from ulcers or other intestinal bleeding. Stopping anticoagulants causes stroke, entering this way in a vicious cycle, that often ends fatally.

Due to severely depressed mental status in severely ill COVID-19 patients, often neither stroke nor abdominal catastrophe is recognized in a timely manner and may have severe consequences. As we were only performing emergency and cancer surgery, there is a fear that many patients stayed at home and did not seek help. Are patients with gallbladder disease, major hernias, reflux disease, and cardiovascular problems dying at home because they are afraid of calling 911 and go to the hospital? Is this the new post-COVID-19 surgical world order where we will continue to operate only when things get bad? Is this new surgical world order of healthcare: only emergency surgery. Hope not. Will today's "elective" surgery become emergency one day, or perhaps patients will select to suffer or simply die at home? What will the outcomes of all "emergency surgery only" patients be? More questions than answers.

Valhalla, NY, USA Rifat Latifi

Preface: The Last Sunset and Dying Alone

The Last Sunset

The times have changed. What was considered old a few decades ago now is not old at all. In fact, despite the fact that World Health Organization has defined the elderly as those above 65 years of age, there are significant changes in demographics of world population, and we researchers of the subject are struggling with definitions. Should the elderly be defined chronologically (e.g., those above the age of 85) or based on frailty index and physiology? So, I have to admit that even the title of this book, *Surgical Decision Making in Geriatrics,* is unclear and may raise an eyebrow of those who are totally functional but have passed their 70s long ago. A good number of faculty in my department are there already. Moreover, it is not uncommon for us surgeons to perform complex surgeries in patients in their 80s and 90s.

As we age, our bodies and our minds change, our needs change, our goals and objectives change. Aging is beautiful though. Recently, a well-known surgeon said while receiving a lifetime achievement award, “I am very happy to be with you, but frankly nowadays, I am very happy be anywhere.” It is a beautiful thing to be able to walk without major help, to feed yourself, to love and be loved, to put clothes on and bathe and take care of your own hygiene, to go out to dinner with family, friends, or your spouse or partner, to watch your own grandkids or other kids grow. Simply talking to friends is a beautiful thing. Going to the movies or the park is a wonder. It is all simple stuff maybe – stuff that we take for granted when we are young.

When my paternal grandfather died at age 54, the kids in our village of Kllodernice, Kosova, told my uncle that “an o*ld man has died*,” not knowing that he was the son of the dead man. I never met my grandfather, but everyone has told me that I look like him. When I celebrated my 54th birthday in Tucson, AZ, thousands of miles from the village I grew up, I was relieved that at least I had passed that mark. My grandfather died at home – probably from tuberculosis or lung cancer or both. And he knew that he was dying, like many patients do. I was told that the night before his death, he finished praying and looked at the sunset, saying “This was the last sunset I will see.” He died early in the morning before the next sunrise. There was no doctor at the bedside, no nurse, no intravenous fluid, no test, no surgery, no nursing home, no rehab center. The nearest place to get a chest x-ray was days away by horse carriage. He died surrounded by 9 out of 10 of his kids, his brothers, his cousins, and his friends. The entire village and many people from surrounding villages came to his funeral to pay their respects.

By the time my grandmother died, I had just finished medical school and was attending her at home. She was in her 90s and died surrounded by near 100 kids (10 of whom she birthed and raised), grandkids, sons and daughters-in-law, cousins, and friends. I saw her take the last breath. It was a peaceful death. It was a beautiful death and it took place in her own large bedroom.

Many decades later, my father was 90 years old living in Prishtina, Kosova. One day, my daughter Kalterina, who at the time was living in Prishtina, called to tell me that my father was not doing well, and the surgeon would like to take him to the operating room for a left ruptured iliac artery aneurism.

I had to make a difficult decision. I was told that he has been anuric for almost 9 hours. Because he was 90 years old, the prospect of him making it out of hospital functional was very grim. He had lived a full life and was functional till the last day of his life. Now it was time for the end. I told the vascular surgeon not to operate but instead to find him a quiet room and control his pain while his family gathered to say goodbye.

Three hours later, he died peacefully after waving goodbye to all around him. He died surrounded by my two sisters and their husbands, my brother, his grandkids, cousins, friends, and many others. He was a soldier in three wars, fought the bad guys of the time, nearly died a few times, but lived to be old. This was a beautiful death.

My mother passed has few years earlier. She was 82 years old. She died at home, but she had doctors at her bedside, providing care in the last 3 days of her life. When she died, I was in a surgical mission in Tagbilaran, Philippines, caring for others. She died peacefully, I was told, at her home being cared by my two sisters, their husbands, and many grandkids. I went to her funeral in Prishtine, but for me, my mother died in Philippines, not in Prishtine.

Lonely Death

My grandparents died at their homes, not a bustling and noisy hospital ward or intensive care unit. They grew old and truly enjoyed their lives. They spent their years with plenty of family and social interaction, enjoying seeing kids and grandkids and friends. They enjoyed life as it is meant to be. This is how we are supposed to live and die – independent and with dignity, fully aware of our age and life and participating actively in life.

But, unfortunately, this is not the case all the time. With the modernization of our lives, the family fabric and family supporting infrastructure has changed dramatically. Kids move out, parents live alone, and they grow old alone. And they die alone.

One of the most difficult things that I had to do as trauma and general surgeon in Tucson, AZ, was watch patients die alone without family around. Sometimes their family was living on the other side of the country and the patient was alone in Tucson, trying to avoid the harsh winters of the East Coast. Often, when finally, I would get a hold of someone on the phone to give the bad news or the good news, the conversation was strange. Almost non-human. The kids often would not even know that their parents were in Tucson. They may not have seen them for years.

Once, I performed a complex abdominal wall reconstruction on an elderly, pleasant woman, a known medical illustrator, for disruption of the abdominal wall from a seatbelt injury. She survived two surgeries and was doing great but her son, a priest, insisted on us stopping everything and extubating her. "She suffered enough," was what he kept saying, but it felt like he was in a rush to return to his church in Connecticut. I did not agree with his opinion and his decision and refused to extubate her prematurely. At his insistence, while I was out of town, one of my partners extubated her. To everyone's surprise, she lived and recovered and went to rehab. I asked her to be an illustrator of my book on abdominal wall reconstruction. She replied softly "I will give it the best shot." I never forgot her and often wonder if she eventually died alone.

About 2 years ago, my youngest daughter Lulejeta and her dance team Pulse from Katonah, New York, were performing at the nursing home in our town. The nursing home is a beautiful complex of many buildings on the hill overseeing the reservoir, and I pass by it daily. I went to see the show and support my daughter. Watching the interaction of support staff with the residents and seeing how the staff were treating the patients like they were in kindergarten, I became acutely depressed and told my wife I had to leave. It was depressing to see how these old people were being treated like kids. Old people are not kids. I made my wife promise me that if and when I grow old, no one will take me to a nursing home. No one; I will not go. Recently, my friend's mother was in the IC for few days; an old lady with serious problems. She was visibly upset when nurses were calling her mother "honey," "sweetheart," "baby." As a patient is Mr. and Ms. or Mss., and not honey or baby or sweetheart.

Do We Have to Die from Surgery?

So much has changed since my grandfather died. We live longer but we also require more resources, more medical care, and more extensive surgical care. We have the most sophisticated medical and surgical advances to postpone death and have the ability to perform the most complex surgical procedures to sustain life. As surgeons, we can operate in any cavity, any organ, any part of the body. We can repair, remove, or replace an organ. That is not a question anymore.

The fundamental question that we, as surgeons, and for that matter healthcare providers, must ask ourselves is, what is the mission and the goal of the treatment that we are proposing to our elderly patient? My personal answer to this is: restore the function, relieve the suffering, and improve the quality of life. We must also ask at what cost? This book will explore this fundamental question. One of my dearest friends, Tom, underwent radical cystectomy and prostatectomy with creation of a neobladder. I had significant reservations and suggested much less radical surgery. He had significant complications postoperatively. And once he recovered the pathology report came back. “Suspicious for invasion…” The recommended treatment was chemoradiation therapy. I pleaded with him not to undergo either one. He did. He did not survive. At his funeral, his grandson read from Ecclesiastes: “There is time for everything, and a season for every activity under the heavens: A time to be born and a time to die….” The truth is that we should not offer therapies with significant complications for any kind of suspicions to frail 76-year-old men. We should not.

About this Book

While there are other books in the field of geriatric surgery, this is a unique book that deals with surgical decision-making and other elements in caring for the elderly. Just like the majority of healthcare institutions around the country and the world, the fastest growing population that we care for at Westchester Medical Center Health Network, Valhalla, New York, is the geriatric population. More than 35% of all surgical procedures performed occurs in this population.

As it is evident from all chapters in this book, the fastest growing segment of the US population is over 65 years of age. Similar growths are seen and projected to continue globally. This demographic shift in the population has serious implications in many aspects of life, but from the surgery standpoint, the elderly will undergo increasingly frequent major surgeries and other interventional procedures to maintain quality of life and physical and social independence. At the same time, the cost of health services will increase and the elderly will become the major consumers of healthcare and hospital resources. Deciding what surgical approach to take for an elderly patient is not an easy task. Should we perform definitive surgery in the elderly at the time of presentation or should we try a minimalistic approach initially and give time for the patient to recuperate and then perform the definitive surgery? This book will explore surgical decision-making in this population, particularly, in all aspect of surgery. The hardest decision that we surgeons have to make is whether everyone who has a potential surgical problem actually needs surgery? Does an 80-year-old lady with serious comorbidities and massive hernia for about 20 years need an operation? The answer is complex and must be searched for with care.

The idea for this book was born during the preparation for the Third Retreat of Department of Surgery at Westchester Medical Center and New York Medical College which took place in October 2018, where the focus was a multidisciplinary team approach to caring for the elderly patient where every aspect of geriatric surgery was discussed by each surgical specialist and those who are part of the geriatric healthcare team including emergency medicine, cardiology, anesthesia, and others. I want to thank all the authors for their time and devotion first to their patients and to this book. I hope that this book will serve those who make difficult decisions for their geriatric patients. To my team of research fellows, coordinators, and research scientists and to the Springer editorial team: thank you. Publishing these books truly takes more than a village. This time, it took an entire county – Westchester County.

Valhalla, NY, USA Rifat Latifi, MD, FACS
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Contents

Contributors

Husham Abdelrahman, MD Department of Surgery, Trauma Surgery, Hamad General Hospital, Doha, Qatar

Kaveh Alizadeh, MD, MSc, FACS Westchester Medical Center, Valhalla, NY, USA

Patrice L. Anderson, MD Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

Gabriela Andries, MD Cardiology Division, Department of Medicine, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Clara Angeles, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Wilbert S. Aronow, MD, FACC, FAHA Cardiology Division, Department of Medicine, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Mohammad Asim, PhD Department of Surgery, Trauma Surgery, Hamad General Hospital, Doha, Qatar

Ammar Athar, MD Cardiology Division, Department of Medicine, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Sateesh C. Babu, MD Section of Vascular Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Samuel Barasch, MD Department of Pathology, Westchester Medical Center, New York Medical College, Valhalla, NY, USA

Saleha Batool, MD Department of Hematology and Oncology, New York Medical College and Westchester Medical Center, Valhalla, NY, USA

Ira Bedzow, MA, PhD Biomedical Ethics and Humanities Program, New York Medical College, Valhalla, NY, USA

Aspen Center for Social Values, Aspen, Colorado (CO), USA

Roberto Bergamaschi, MD, PhD, FRCS, FASCRS, FACS Department of Surgery, Westchester Medical Center and New York Medical College, School of Medicine, Valhalla, NY, USA

Vincent Finbarr Blood, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Christian A. Bowers, MD Department of Neurosurgery, Westchester Medical Center, New York Medical College, Valhalla, NY, USA

Susan Boyle, MSN APN AGNP Department of Emergency Medicine, Morristown Medical Center, Morristown, NJ, USA

Francis X. Carroll, MD, FACS, FCCP Division of Thoracic Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

Maria Castaldi, MD, FACS Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Department of Surgery, New York Medical College, School of Medicine, WMCHealthcare Network, Valhalla, NY, USA

Vasu Chirumamilla, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

James K. Choi, MD Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

Muhammad S. Choudhury, MD, FACS Department of Urology, New York Medical College, Valhalla, NY, USA

Jorge Con, MD, FACS Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

Miles Dale, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Gizelka David-West, MD, FACOG Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, New York Medical College/Westchester Medical Center, Valhalla, NY, USA

Kartik Dhaduk, MD Cardiology Division, Department of Medicine, Westchester Medical Center and New York, Valhalla, NY, USA

Department of Medicine, New York Medical College and Westchester Medical Center, Valhalla, NY, USA

Thomas Diflo, MD, FACS Department of Surgery, New York Medical College, Westchester Medical Center, Valhalla, NY, USA

Xiang Da Dong, MD, FACS Surgical Oncology, Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Ayman El-Menyar, MD, FRCP Department of Surgery, Trauma Surgery, Hamad General Hospital, Doha, Qatar

Clinical Medicine, Weill Cornell Medical College, Doha, Qatar

Jason Elyaguov, MD Department of Urology, New York Medical College, Valhalla, NY, USA

Ashraf Elzanie, MD Westchester Medical Center, Valhalla, NY, USA

James M. Feeney, MD, FACS Associate Professor of Surgery, Department of Surgery, Westchester Medical Center, and New York Medical College, School of Medicine, Valhalla, NY, USA

William H. Frishman, MD Cardiology Division, Department of Medicine, Westchester Medical Center and New York, Medical College, Valhalla, NY, USA

Mahir Gachabayov, MD, PhD Department of Surgery, Westchester Medical Center and New York Medical College, School of Medicine, Valhalla, NY, USA

Geena George, MPH Department of Surgery, Clinical Research Unit, Westchester Medical Center, Valhalla, NY, USA

Shekhar Gogna, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Joshua B. Goldberg, MD Department of Surgery, Division of Cradiothoracic Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Nikhil Gopal, MD Department of Urology, New York Medical College, Valhalla, NY, USA

Cara Grimes, MD, FACOG Department of Obstetrics and Gynecology, Advanced Urogynecology and Female Pelvic Medicine and Reconstructive Surgery, New York Medical College/Westchester Medical Center, Valhalla, NY, USA

Ansab Haider, MD Department of General Surgery, Westchester Medical Center, Valhalla, NY, USA

Firas Jafri, MD Department of Medicine, New York Medical College and Westchester Medical Center, Valhalla, NY, USA

Faisal Jehan, MD Department of Surgery, Westchester Medical Center and New York, Medical College, Valhalla, NY, USA

Ashutosh Kaul, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Sarvesh Kaul Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Colgate University, Hamilton, NY, USA

Jaclyn Klimczak, MD Department of Otolaryngology Head and Neck Surgery, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Donna C. Koo New York Medical College, Valhalla, NY, USA

Harry Kopolovich, MD MBA FAAEM FAEMS Department of Emergency Medicine, Richmond University Medical Center, Staten Island, NY, USA

Department of Emergency Medicine, Albert Einstein College of Medicine, Bronx, NY, USA

Danny Lascano, MD Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Igor Laskowski, MD, PhD Section of Vascular Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Rifat Latifi, MD, FACS, FICS Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA

Robert G. Lerner, MD Department of Hematology and Oncology, New York Medical College and Westchester Medical Center, Valhalla, NY, USA

Alessandra Marino, MHS, PA-C Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, New York Medical College/Westchester Medical Center, Valhalla, NY, USA

Romeo Mateo, MD Section of Vascular Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Jaqueline Maxwell, MS, RD, CNSC Clinical Nutrition, Westchester Medical Center, Valhalla, NY, USA

Matthew K. McIntyre, BA School of Medicine, New York Medical College, Valhalla, NY, USA

Ivan T. Miller, MD, FACEP Department of Emergency Medicine, Westchester Medical Center, Valhalla, NY, USA

Department of Emergency Medicine, New York Medical College, Valhalla, NY, USA

Augustine L. Moscatello, MD, FACS Department of Otolaryngology/Head and Neck Surgery, New York Medical College, Valhalla, NY, USA

Department of Otolaryngology/Head and Neck Surgery, Westchester Medical Center, Valhalla, NY, USA

Seigo Nishida, MD, PhD, FACS Department of Surgery, Transplant Section, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Julia Pazniokas, MS New York Medical College, Valhalla, NY, USA

John L. Phillips, MD, FACS Department of Urology, New York Medical College, Valhalla, NY, USA

Anthony J. Policastro, MD, FACS Trauma and Critical Care, Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Kartik Prabhakaran, MD, FACS Section of Trauma and Acute Care Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Department of Surgery, New York Medical College, Valhalla, NY, USA

Tana Pradhan, DO, FACOG Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, New York Medical College/Westchester Medical Center, Valhalla, NY, USA

J. K. Rasamny, MD Department of Otolaryngology, Head and Neck Surgery, ENT Faculty Practice, Ardsley, NY, USA

Aditya Safaya, MD Section of Vascular Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

David J. Samson, MS Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

Anar Shah, MD MBA Geriatric Emergency Department, Morristown Medical Center, Morristown, NJ, USA

Department of Emergency Medicine, Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA

Abbas Smiley, MD, PhD Department of Surgery, Westchester Medical Center and New York Medical College, School of Medicine, Valhalla, NY, USA

Sarah C. Smith, MD Division of Cardiothoracic Anesthesia, Department of Anesthesiology, Westchester Medical Center, New York Medical College, Valhalla, NY, USA

Anitha Srinivasan, MD, MPH, FACS Metropolitan Hospital Breast Health Center, Department of Surgery, New York Medical College, School of Medicine, Valhalla, NY, USA

Metropolitan Hospital, New York, NY, USA

Noam Stadlan, MD Department of Neurosurgery, NorthShore University Healthcare System, Evanston, IL, USA

Division of Neurosurgery, Pritzker School of Medicine at the University of Chicago, Evanston, IL, USA

Brianna Theriault, PhD New York Medical College, Valhalla, NY, USA

Stephanie Twomey, PA-C Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, New York Medical College/Westchester Medical Center, Valhalla, NY, USA

Gregory Veillette, MD, FACS Section of Hepatobiliary and Pancreatic Surgery, Department of Surgery, Westchester Medical Center, and New York Medical College, School of Medicine, Valhalla, NY, USA

Tracey L. Weigel, MD, FACS, FACCP Division of Thoracic Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

Dan E. Wiener, MD, FACEP Department of Emergency Medicine, Morristown Medical Center, Morristown, NJ, USA

Department of Emergency Medicine, Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA

Part I

General Considerations for the Geriatric Surgical Patient

1 Decision-Making in Geriatric Surgery: More Surgery or Less Surgery?

Rifat Latifi, Shekhar Gogna, and Geena George

Introduction

The NIH report on aging predicts as the world population ages, the elderly will be the fastest-growing subset of the population, as fertility rates have fallen to low levels in most parts of the world and life expectancy is increasing. When the global population reached 7 billion in 2012, 562 million (8.0%) were aged 65 and over. Post World War II baby boomers in the United States and Europe recently joining the older ranks and with the accelerated growth of older populations in Asia and Latin America, the next 10 years will witness an increase of about 236 million people aged 65 and older throughout the world. Thereafter, from 2025 to 2050, the older population is projected to be twice the size to 1.6 billion globally, whereas the total population will grow by just 34 percent over the same period [1–3].

Only in the United States it is expected that by the year 2050, there will be over 80 million adults older than 65 years, representing more than one-fifth of the population. As the longevity of geriatric population will increase, it will have more independent and active lifestyles. Hence, the burden of surgical disease and injuries in this population is expected to increase. Importantly, this population accounts for 23% of all trauma admissions, and trauma is the fifth leading cause of death in the elderly [4]. Because of the high prevalence of multiple comorbidities in the elderly, there is an increased likelihood of death or severe disability following trauma. Up to one-third of all patients presenting with an Injury Severity Score (ISS) greater than 15 can be expected to have in-hospital mortality. Furthermore, elderly patients experience higher economic and societal costs, following trauma. Falls are the leading cause of trauma in the elderly. Approximately one-third of geriatric adults are at risk for falls each year. With an average hospital cost of $18,000 per fall and further costs associated with long-term nursing care following trauma, the economic implications of all trauma to the elderly are astonishing (the United States, 2012). Looking forward, the social and economic implications of the expected increase in geriatric trauma cannot be overlooked, and clinicians must continue to strive toward a more standardized and evidence-based approach to the diagnosis and treatment of these patients. (See Chap. 10).

With dramatic changes in our population, there is a growing need for surgeons, surgery

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: rifat.latifi@wmchealth.org

S. Gogna
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

G. George
Department of Surgery, Clinical Research Unit, Westchester Medical Center, Valhalla, NY, USA

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residents, medical students, and nurses across all disciplines (medicine, anesthesia, gynecology, orthopedics, etc.). They will need to learn the basic surgical and other major decision-making in managing our oldest population. While there are other books in the field, this is a unique book that will deal with surgical decision-making and other elements in caring for the elderly. During perioperative period, the elderly often require a different level of care than younger patients. Many geriatric patients have multiple chronic illnesses other than the one for which surgery is required and therefore are prone to developing postoperative complications, functional decline, loss of independence, and other untoward outcomes. To provide optimal care for the older surgical patient, a thorough assessment of the individual's health status and a plan of care that identifies and addresses deficits during the perioperative period are essential. While this assessment is possible for elective surgery, many times in emergency situation, there is no time for such preparation, and often the elderly undergo major emergency surgery under suboptimal conditions.

The American College of Surgeons (ACS) has partnered with the American Geriatrics Society (AGS) and in collaboration with John A. Hartford Foundation has developed guidelines for the optimal surgical care of older adults. The first part of these guidelines, the American College of Surgeons National Surgical Quality Improvement Program (NSQIP)/American Geriatrics Society (AGS) Best Practices Guidelines: Optimal Preoperative Assessment of the Geriatric Surgical Patient, was published in 2012. This resource defined nine assessment categories: cognitive/behavioral disorders, cardiac evaluation, pulmonary evaluation, functional/performance status, frailty, nutritional status, medication management, patient counseling, and preoperative testing [3].

Surgical Decision-Making in the Elderly

How we surgeons make decisions under what can be inauspicious conditions is still a matter of debate and not well understood overall even though millions of surgical procedures are performed daily worldwide [5]. It is not easy to decide what surgical approaches to take in the elderly when there are multiple other options available. The surgical diseases once approached radically are now commonly treated with the "minimalistic approach." So the question to be answered is: Should we perform "more surgery" (that is taking care of the problem entirely in one sitting, as soon as clinically and physiologically possible) or perform a "less invasive" procedure and come fight another day? There is no simple answer for this question yet. For example, would you consider performing cholecystectomy to remove the infected gallbladder versus tube cholecystostomy in the elderly?

Intraoperative surgical decision-making (SDM) in the elderly should not be different from the SDM in the younger patient. However, one has to not only keep in mind the ability to execute the procedure itself but to remember the long-term goals of the surgical procedure, the implications on the physiology, and overall outcomes of the patient.

For the most part, SDM has been described as "intuition" or "gut-level" responses. Many factors affect the decision-making process of the surgeons before and during operations. These factors are the physiology of the patient, the balance and implications of doing or not doing a procedure, the goals of surgical care, and the patients' and their families' wishes. To name a few, other factors that affect SDM are the physiologic state of the surgeon, the harmony of teamwork, and the surgeon's ability to adapt quickly to a changing environment. The favorable outcomes in the postoperative elderly are obtained by incorporating evidence-based medicine (EBM), SDM, and the joint decision-making with the patient and family (Fig. 1.1). Yet, the question remains: How to perform an evaluation of the surgical decision and gain a better understanding of a seemingly gut-level process, which helps surgeons combat the external factors experienced before and during surgery?

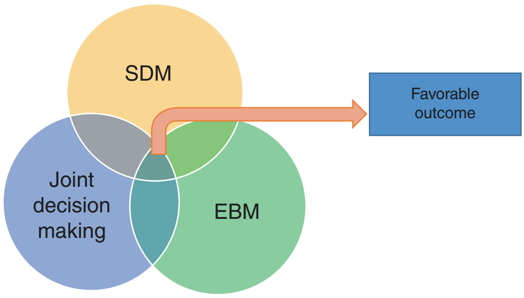

Fig. 1.1 The favorable outcome in elderly is achieved by amalgamating SDM, EBM, and joint decision-making. SDM Surgical decision-making, EBM Evidence based medicine

Surgical Decisions in Emergency Surgery in the Elderly: The Tale of Four Common Clinical Problems

Complex surgical procedures, particularly in the elderly, carry significant risks and potential complications. These complications can occur despite the most conscientious preoperative preparations. Unforeseen surprising events may occur during the operation (less likely), immediately in the postoperative period (most likely), and after a long time after the surgery itself. The complications, such as cognitive decline, and simply "giving up" are often thought to be due to anesthesia (see Chap. 7), delirium, or a slew of other factors. Aging promotes the physiological changes in the protoplasm and functioning of the heart, lungs, kidneys, and liver. So, deciding to operate in the elderly is not an easy one and requires the surgeon, patient, and family to understand the gravity of the procedure. Despite enormous significance and implications that SDM has on surgical outcomes, this topic and particularly its role in the elderly have received minimal attention in the literature. Only in recent years, both scientific and public media [3, 6] have taken up reporting surgical outcomes of the geriatric population. Subsequently, there are only a few studies that investigate how these decisions are made, although the decision-making process (DMP) is of great importance both for training and patient safety purposes [5]. According to the paper from, American Association for the Surgery of Trauma (AAST), most common emergency surgery in elderly occurs in the following clinical conditions: hepatobiliary, hernia, colorectal cancer, bowel obstruction [7]. In this chapter we will further dissect the role of SDM in these four clinical problems.

Acute Cholecystitis

Hepatobiliary emergency surgery is common among the elderly. While much progress has been made in this clinical discipline, there is a wide difference on how acute cholecystitis is managed from country to country, institution to institution, or even among individual surgeons within the same group. The question is: How do we surgeons decide which procedure to perform on an elderly patient with acute cholecystitis as compared to the non-elderly? Is there a difference in SDM? Let's assume that you have seen an 89-year-old patient, living independently who undergoes TEVAR and has known gallstones. He has a remote history of laparotomy for the perforated gastric ulcer but otherwise is in good shape. Postoperatively the patient develops acute cholecystitis. What would you do? One surgeon may perform cholecystectomy, perhaps even an open one, and the other one will perform a percutaneous tube cholecystostomy (PTC). Either approach has become an "acceptable" treatment. So it comes to a surgeon's SDM. I think we should take the gallbladder out. Remove the infected gallbladder and be done with it. Although I would start with laparoscopic approach with a very low threshold to convert into an open cholecystectomy.

Percutaneous tube cholecystostomy (PTC) could also be an acceptable treatment. Although it was intended for acute acalculous cholecystitis (AAC) [8] and not for those who have stones, nowadays it is has become a common practice. What is wrong with PCT? Well for starters, it commits the patient to many more procedures, morbidity, and eventually an operation that usually is not an easier one. While recent studies on the use of cholecystostomy tube for AAC reported that drainage can be achieved in up to 90%, PCT has a high rate of tube dysfunction requiring frequent re-intervention, such as tube exchange or replacement at an average of 2 per patient (range 1–10) [9, 10]. In another study of 288 patients with ACC, undergoing PCT, PCT dysfunction occurred in 132 patients (46%), with 80 patients (28%) requiring re-intervention, while 7% developed procedure-related complications [11]. Interval cholecystectomy reduced the risk of recurrent biliary events from 21% to 7% ($p = 0.002$). Cholecystectomy was performed laparoscopically in 45% of patients receiving an interval operation vs. 22% of those undergoing urgent surgery for PCT failure/dysfunction or recurrent biliary event ($p = 0.03$).

While the use of PCT in AAC is "more" acceptable, however, there is a new trend of the use of PTC in acute calculous cholecystitis. It is very commonly seen that a sick patient, with a gallbladder full of stones and subsequent sepsis, undergoes PTC drainage. Sometime ago an elderly gentleman on his way to Tucson felt sick on the plane. He was removed from the flight and underwent emergent PTC in one of the local hospitals in Dallas. He eventually improved after weeks in the ICU and came to see me. His gallbladder was filled with 54 stones. The question that I discussed with residents that day was: Is this what we do nowadays? (Fig. 1.2).

Recent data in elderly patients with grade II acute cholecystitis demonstrated the worst outcomes that were seen in those who underwent cholecystectomy tube placement. The in-hospital mortality was similar between the two groups

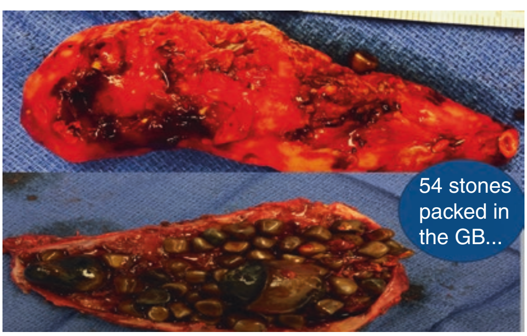

Fig. 1.2 Post-PTC cholecystectomy specimen showing 54 stones in gentleman with acute calculous cholecystitis

(24.0% in the cholecystostomy group vs. 22.6% in the control group; OR 1.08, 95% CI 0.86–1.35). However, the odds of 30-day mortality were significantly higher in patients who underwent PCT placement compared to those who did not (38.9% PCT group vs. in those versus 32.7% in no PCT group). Similarly, 90-day mortality was 46.7% in PCT group versus 39.6% in no PCT group. Also, the authors report that the 2-year survival rates in patients in PCT group were significantly shorter compared to those who did not (35% vs 41%, $p < 0.0059$) [12].

Recently, I performed an open cholecystectomy in a patient with a severely contracted gallbladder that was treated with a cholecystostomy tube. This tube was making her life miserable. While I did not see her previously, I am pretty sure that there was no good indication for draining the gallbladder. What needed to be done correctly actually happened months later. She did very well postoperatively and is back at work. Just the fact that you wait for a later day to perform a cholecystectomy will not make the procedure any better or easier. It may even make the situation worse. I remember a case from a few years ago when a surgeon performed a cholecystectomy 4 months after the PCT placement. The fibrosis that set in caused severe contraction of the gallbladder (GB), and major injury to the common bile duct (CBD) ensued. The good thing was that it was recognized intraoperatively (due to inadvertent injury to the right hepatic artery) causing the surgeon to convert to an open procedure and prompt hepaticojejunostomy. Most of the time, inflamed gallbladders are easier to remove surgically compared to a fibrotic, contracted GB.

In acute gallstone cholecystitis, patients should have a cholecystectomy. If there are no gallstones and the patient improves, then there is no reason to perform a cholecystectomy. This decision is assuming that the tube cholangiogram demonstrates patent cystic duct along with clinical signs of improvement. This can be done either laparoscopically or with the open technique. In sick patients with difficult gallbladders, partial or subtotal cholecystectomy is a viable and safe procedure [13].

A recent paper has proposed to discard the term partial cholecystectomy and substitute it with “fenestrated” and “reconstituting” types based on how you deal with the cystic duct and or the lower end of the gallbladder [14]. I agree with the concept of subtotal cholecystectomy, as long as great care is given to remove any stones in the remnant of the gallbladder, as the patient may return with symptoms of cholecystitis in the future. The patient must understand what type of procedure was done, so in the case of recurrence of symptoms, the patients knew what to expect. I have performed a completion cholecystectomy in a patient, and one has to remind the patient what the other surgeon did, but particularly why they did a subtotal cholecystectomy. In elderly critically ill patients, this is a very good option to remove the gallbladder while not risking major injury to the common bile duct.

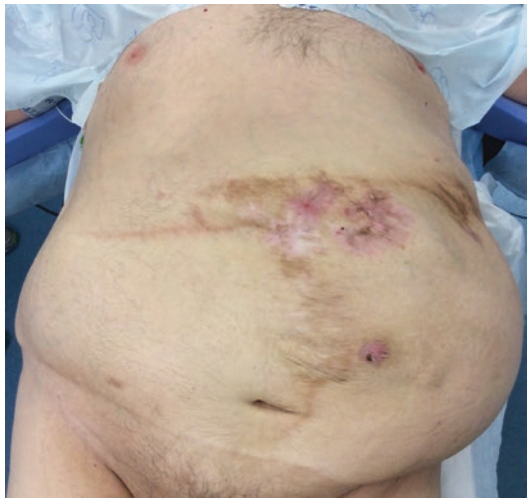

Fig. 1.3 An elderly gentleman with chronic small bowel obstruction with concomitant large “reducible” hernia and associated with loss of abdominal wall domain

Bowel Obstruction: Operate Early or Wait?

Another very common surgical dilemma in current surgical practice is partial or complete small bowel obstruction (SBO). While the second scenario (complete bowel obstruction) is less controversial, in partial recurrent SBO, SDM tends to be more difficult. The SDM gets even more complex when there is a concomitant large “reducible” hernia and often with loss of abdominal wall domain (Fig. 1.3). Add morbid obesity and things become even more complicated. It is not uncommon that these patients are in and out of the hospital being managed with nil per Os (NPO) for weeks, nasogastric tube (NGT) decompression, and Foley catheter and severe deconditioning ensues. Malnutrition, already present at admission, gets worse because the patients are “too old to have an operation” or “still do not have peritonitis” or because “let’s give conservative” approach a few more days. Eventually these patients deteriorate and develop complete bowel obstruction, requiring an emergency surgery or even a damage control approach (Fig. 1.4), with intestinal diversion. They will have to return to the operating room, have another hernia, or may require major abdominal wall reconstruction under suboptimal conditions (Fig. 1.5). Hence, the vicious cycle goes on, and should be stopped.

Fig. 1.4 An elderly patient undergoing damage control surgery for bowel ischemia due to failure of “conservative approach”

While many have adopted the use of gastrografin as a first line of “treatment challenge,” this tactic may work only in those who have an early episode of partial SBO, mostly due to electrolyte imbalance and not true adhesive SBO. Use of water-soluble contrast medium (gastrografin) does not decrease the need for operative intervention nor the duration of hospital stay in uncomplicated acute adhesive small bowel obstruction.

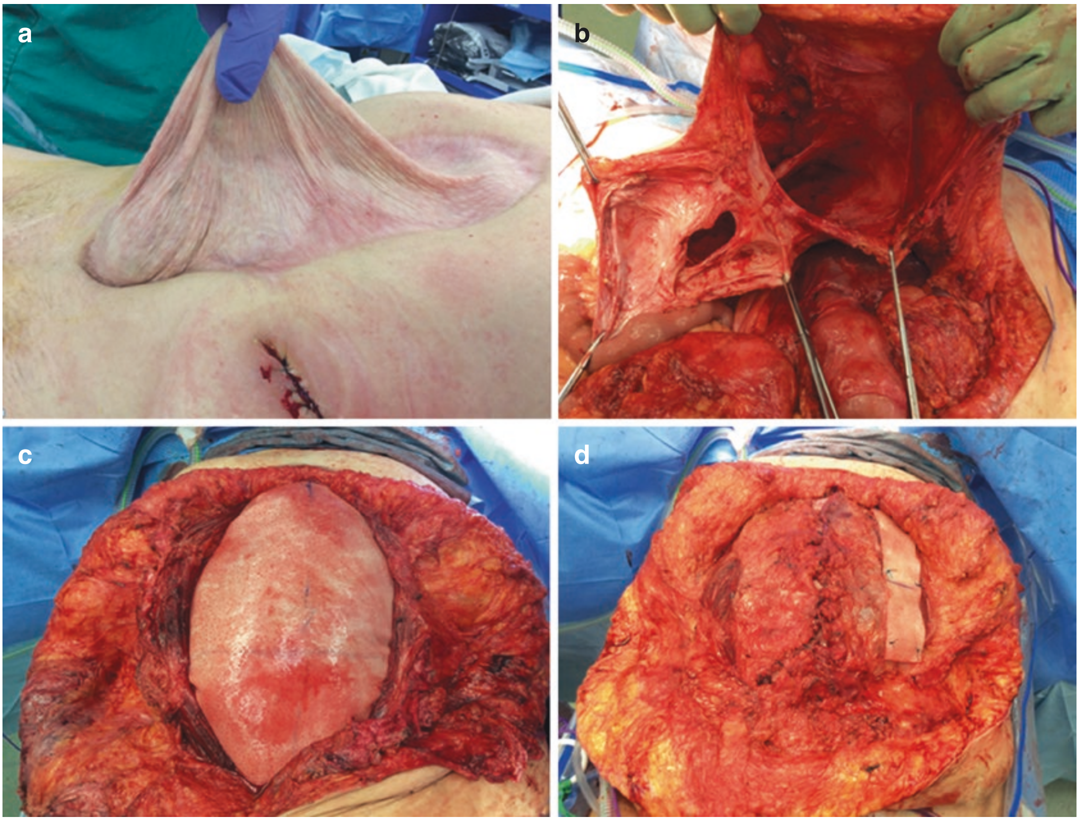

Fig. 1.5 (**a**) Patient being operated for complex abdominal wall hernia with loss of domain; (**b**) complex anatomy due to fibrosis and high burden of hernia sacs; (**c**, **d**) surgical decision-making to determine type of complex abdominal wall reconstruction

A multicenter, randomized, clinical trial (Adhesive Small Bowel Obstruction Study) and systematic review evaluated the association between oral gastrografin and the need for operative intervention. In this trial, the rate of operative intervention in gastrografin vs. saline solution arms was 24% and 20%, and the bowel resection rate was 8% and 4%, respectively. Moreover, age was the only identified potential risk factor for the failure of nonoperative management. The evidence thus suggests that gastrografin challenge is of no benefit in patients with adhesive small bowel obstruction [15].

On the other side, studies have concluded that the use of water-soluble contrast medium as a predictive test for nonoperative resolution of adhesive small bowel obstruction may reduce the need for operation and appears to shorten the hospital stay for those who do not require surgery [16].

What Are the Data on Small Bowel Obstruction in Geriatrics?

Small bowel obstruction (SBO) is one of the most frequent emergencies in general surgery, commonly affecting elderly patients. Morbidity and mortality from small bowel obstruction in the elderly are high [17]. Up to 50% of emergency laparotomies are due to small bowel obstruction, and 10–12% of these are seen in the elderly [18, 19]. The elderly have higher mortality with emergency [20]. These measures translate into the fact that we should not deprive major surgery in this group of patients as not offering the surgery would probably lead to worse outcomes. Although recent advances in diagnostic modalities have made it easier to diagnose the SBO, nonetheless the surgical treatments need better prioritizing, and one should be cognizant that the elderly may have a major catastrophe in the abdomen, without demonstrating signs of peritonitis, normal lactate, and simply just looking sick.

Recently, I operated on a cachectic 82-year-old lady with visible loops of intestines under thinned out skin in the lower abdomen that had gangrene of more than 80 cm of the small bowel, but preoperatively she was sitting up in her bed with no complaints whatsoever. So, just because they do not demonstrate the usual clinical signs and symptoms or biochemical indicators of small bowel obstruction does not mean that the elderly do not need an operation. The real art and science of being a surgeon lie in determining when and which operation will enhance the outcomes. To achieve that level of surgical decision-making takes time and years of practice, and, more importantly, it requires a sincere and honest interest in surgical discipline.

Diverticulitis

Diverticular disease (DD) of the colon accounts for more than 300,000 hospitalizations and nearly $2.4 billion in direct healthcare costs each year in the United States [21, 22]. The prevalence of diverticulitis is age-dependent. It is estimated to be approximately 5% in those under the age of 40, with this prevalence increasing to 65% in those above 65 years of age [23].

Patients with contained perforation (Hinchey Stages I and II) are managed with intravenously administered antibiotics with or without percutaneous drainage of the abscess, depending on abscess size. Those with free perforation resulting in either purulent or fecal peritonitis (Hinchey Stages III and IV) require surgery [24].

The standard of care for patients with acute diverticulitis who fail conservative treatment has also changed over time. Since the 1980s, a two-stage procedure, sigmoid resection plus colostomy followed by colostomy takedown, has become widely accepted as the surgical standard of care for acute diverticulitis. Over the past 2 decades, however, a significant amount of research and opinion has advocated for a shift in the surgical approach to patients with acute diverticulitis. The use of a Hartmann's procedure for patients with the mild or moderate disease has been questioned, with the idea that many (if not most) patients are better served by a single-stage procedure (resection, primary anastomosis). In a systematic review, the morbidity and mortality of primary anastomosis were found to be similar to that of a Hartmann's procedure for patients with even the most severe acute disease [25]. In another study based on ACS-NSQIP database, 1314 patients showed that partial colectomy with end colostomy and closure of distal segment (Hartman's procedure), colectomy with primary anastomosis (PA), and colectomy with PA with proximal diversion (PAPD) had similar outcomes. Resection and PA can be performed safely in acute diverticulitis with no difference in postoperative morbidity or 30-day mortality when compared with the Hartmann's procedure [26]. One of the most controversial aspects of diverticulitis in recent years is the role of laparoscopic lavage (LL), particularly in Hinchey III diverticulitis. There are mixed results; in the SCANDIV trial, patients with the suspected perforated diverticular disease were randomized to undergo either LL or colonic resection. The LL does not reduce serious complication rates, and patients had higher reoperation rates [27]. Another trial from Belgium showed similar results. The primary outcome was a composite endpoint of major morbidity and mortality within 12 months. Recruitment terminated early after an interim analysis of results demonstrated poorer outcomes in the LL group [28].

A contrast-enhanced CT scan is typically the examination of choice for patients with suspected diverticulitis [29]. Clinical examination and CT scan in conjunction should be used to decide the subsequent treatment. A large abscess found on initial CT scan may prompt early percutaneous catheter drainage (PCD), and the drainage serves as the bridge to surgery because most surgeons regard PCD as a temporary procedure and not a definitive treatment [30]. Failure to respond within 48–72 hours is an indication to proceed to surgery. Interestingly, the severity of diverticulitis at the time of the first CT scan predicts not only an increased risk of failure of medical therapy on index admission but also a high risk of secondary complications after initial nonoperative management [31].

When we consider the type of surgical approach in the elderly, a recent Cochrane analysis from 2017 comparing laparoscopic versus open resection for sigmoid diverticulitis showed that there is no evidence to support or refute the safety and effectiveness of laparoscopic surgery versus open surgical resection for treatment of patients with acute diverticular disease [32].

Appendicitis

Only 5–10% of all cases of appendicitis are diagnosed in patients older than 65 years, but they have mortality rates 5–8 times higher than younger patients [33, 34]. The classic triad of appendicitis, anorexia, fever, and right lower quadrant pain, is seen only in 20% of the elderly at presentation [35]. They present later in the course of their illness, with 85% presenting after 24 hours of pain. This delay in diagnosis leads to higher rates of perforation, i.e., 72% in the elderly as opposed to 20–30% in younger populations [36, 37]. Early surgical consultation should be obtained even in the absence of clear radiographic signs of acute appendicitis.

Several randomized controlled trials (RCTs) and meta-analyses have suggested that nonoperative management (NOM) for acute appendicitis is a viable alternative to the long-standing practice of immediately proceeding with an appendectomy on the diagnosis. Limitations of the current studies assessing NOM for acute appendicitis include (1) selection bias, (2) influence of comorbidity on decision-making for operation, and (3) exclusion of potential high-risk patients [38, 39]. The use of NOM in the elderly is not established to date.

The other important issue about surgical treatment is to use interval appendectomy (IA) in the elderly as an alternative. However, recent evidence has shed doubt on the necessity of this procedure. The IA should not be performed on a routine basis. However, neoplasia must be actively ruled out, particularly in the older age group [40]. Appendectomy in elderly patients has a low rate of complications similar to younger patients and should be offered early [41]. Laparoscopic appendectomy can be safely performed in the elderly with acute appendicitis or with a complicated one [42].

Complex Hernia Repair in the Elderly

Although a separate chapter is dedicated to this topic (see Chap. 16), we believe that the patient with a large complex incisional hernia should be repaired, unless they are at prohibitive risk for perioperative complication.

Intraoperative Surgical Decision-Making

The question is: How do we surgeons make intraoperative decisions under what can be inauspicious conditions? Some describe these decisions as “intuition,” “gut-level,” or “gray hair effect.” On whatever factor the decision is made, we surgeons have difficulty in describing exactly how we came to the specific decision and why we did what we did during surgery. Many factors affect our decision-making before and during operations. This is probably more important during the surgery itself. These factors are the physiologic state of the surgeon, the harmony of teamwork, external factors at work such as scheduling, and the surgeon’s ability to adapt quickly to a changing environment, to name only a few. So, perhaps while we may understand how we made the decision, the question remains: How to perform an evaluation of the surgical decision and gain a better understanding of a seemingly gut-level process, which helps surgeons combat the external factors experienced before and during surgery?

When a patient is dying from bleeding that we cannot control when irreversible metabolic shock does not respond to anything that we do, when new problems emerge unexpectedly, and when things go alarmingly wrong in such dire moments during a carefully planned operation, how do we decide what to do next? Many surgeons make such decisions based on "a gut feeling" or "intuition" or the "gray hair effect," among other techniques. In this chapter, we review theoretical as well as objective data that we as surgeons use to make intraoperative decisions. Most of the many theories and hypotheses in the literature have been created by individuals who are not surgeons. But, our collective firsthand experience as surgeons points to a combination of factors contributing to our intraoperative decision-making process, including education, clinical expertise, mentoring, and the creativity and excellence that come with long practice and with surgical strict discipline.

Concomitant Medical Problems Should Not Stop Surgical Care

A 78-year-old male, who is an active farmer, presented with stable metastatic melanoma to the ribs and lungs after undergoing immunotherapy for a few years and subsequently developed myelofibrosis and splenomegaly requiring almost monthly blood transfusions. The risk of getting injured at the farm due to frequent drop in his hemoglobin was concerning. The patient told me in the office, "I do not feel good when my hemoglobin goes under 6.5," and one could almost see the outline of enlarged spleen on his left abdomen.

After careful planning, including blood transfusion and selective splenic artery embolization, I performed an open splenectomy (Fig. 1.6). I started with a long midline incision and extended to the left subcostal incision. A month later the patient reported, "I baled 20 bales of hay." Much of planning went into the DMP. The decision came down to: If we do not take his spleen, he will bleed to death (should he hurt himself) and continue to suffer. Neither one was a good option.

Lesson: Otherwise healthy-looking people with the surgical problem and medical issues should be operated. His frailty score was 0. The only issue was malignancy which was not part of the modified frailty index (mFi).

Fig. 1.6 Massive splenomegaly in an elderly gentleman due to secondary myelofibrosis after chemotherapy for metastatic melanoma

Final Thoughts: The Art of an Exploratory Laparotomy?

In the days before the CT scan and other modern imaging technologies, physical examination was truly a clinical art, and an exploratory laparotomy was commonly practiced to make the definitive diagnosis. Recently, in a very difficult situation, a colleague of mine asked me to see a patient that was caring in the ICU for the last few months and who now has taken a wrong turn, septic but without a clear source, requiring vasopressors to maintain blood pressure, intubated, pale-looking, and critically ill. The *succus* was coming out of the incisional wound VAC. The team has asked many questions: Is there a dead gut? Is there just a small hole in the bowel, the so called enetero-atmospheric fistula, or this is a reflection of some real catastrophe? Should the surgical team go back to the operating room and make the diagnosis and decide which direction should go? The patient in is his 70s, on continuous venovenous hemodialysis (CVVH). One can make an argument to do nothing. I saw the patient briefly, I discussed with the family, and I suggested to them and my colleagues: you have two options – do nothing and terminate the surgical care, or go back and make the diagnosis, which will give you a clear direction of care. If this was my decision to make, I would go back to the OR, I told them. If there is something small like the dead gallbladder, take it out, but if the small bowel is dead, then this will help you and the family to stop the care. The family agreed to do just that. The team and the family did all they could. Intraoperatively, the entire small and large bowel was leathery looking, with no life into them. Two spontaneous fistulas were being drained by the incisional VAC. The patient was brought back to the ICU, and he passed early the next morning with the family at bedside, grateful that they and the team of surgeons and nurses were so helpful in the decision-making process and had done everything possible.

Conclusions

Surgical decision-making has implications for surgeons, patients, and their family members. The SDM is not merely a "gut feeling"; it is the amalgamation of the vast experience, learned evidence-based concepts, and their practical application over the years. The elderly do present with atypical signs and symptoms of pathology, and high index of suspicion with early decision-making is the key. The geriatric population will be the major shareholders in the healthcare industry; the composite synthesis of SDM, current evidence-based medicine, and joint decision-making among multidisciplinary teams, patients, and their families will enhance the outcomes.

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2 Is There Room for Common Sense in Surgical Decision-Making?

Ira Bedzow and Noam Stadlan

Introduction

The topic of this chapter arose from a conversation that one of the authors (IB) had with the editor of this book. In the conversation, the editor expressed the difficulty for physicians to be, at times, critical of some of the choices that they make regarding which medical intervention they either suggested or acquiesced to implement. After discussing the influences of hospital policies, healthcare law, insurance, clinical specialization, and patient autonomy on medical and surgical decision-making, the editor of this book asked, or rather exclaimed: "Is there room for common sense?" While this author (IB) appreciated the sentiment and understood the source of frustration while discussing the issue, he later had trouble communicating the difficulty of the issue and its importance in written form. Of course, what influences decision-making and how shared decision-making should occur between patients and physicians have produced a large body of literature. Yet, descriptions of the internal components, processes of thinking, and external pressures that affect what options are possible and plausible do not seem to convey accurately the meaning of the exclamation. The editor's point of "common sense" conveys that there must be something intangible or non-reductionistic that separates decisions that follow certain protocols and those that are correct for the situation at hand, even when they seem to diverge from the literature regarding the processes of thinking and the expected norms proposed for general cases.

We understand the question, "Is there room for common sense in surgical decision-making?" to mean something very specific. In this instance, "common sense" does not mean something akin to "folk wisdom" or an unreflective knowledge that has no basis in specialized training or deliberation. Such a definition would hardly fit the needs of shared decision-making or providing care in a healthcare setting, which necessitates specialization, training, and an ability to recognize and account for changing circumstances and the needs of various stakeholders over time. Nor does this connotation fit with the question presented in the title of this chapter. Rather, for the sake of this chapter, we take the term "common sense" to mean something akin to "prudence" or "practical reasoning." Prudence, or practical rea-

I. Bedzow (✉)
Biomedical Ethics and Humanities Program, New York Medical College, Valhalla, NY, USA

Aspen Center for Social Values, Aspen, Colorado (CO), USA
e-mail: ira_bedzow@nymc.edu

N. Stadlan
Department of Neurosurgery, NorthShore University Healthcare System, Evanston, IL, USA

Division of Neurosurgery, Pritzker School of Medicine at the University of Chicago, Evanston, IL, USA

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son, is the intellectual skill of knowing what one wants to achieve in a given situation as well as knowing the means through which one can achieve it. It is typically gained through experience, which implies it is gained over time and practice. Yet the individual skills that give rise to prudence are not simply mechanical; they serve as a foundation to allow the prudent individual to consider more than what may narrowly be in primary focus and to act on more than the skills that their training hones.

The relationship between "common sense" and "prudence" is evident in common parlance, even if the philosophical understandings of the two terms are distinct and even contradictory at times. The reason for choosing to define "common sense" as prudence is because it is a faculty that elucidates the editor's question in two very important ways. First, prudence and its influence on decision-making are very difficult to describe operationally; it, therefore, is very difficult to explain how to utilize it when considering the various factors and influences on decision-making. Second, prudence is very difficult to inculcate explicitly; it, therefore, seems as if there is no explicit room for it in medical training. In this chapter, we will give a description of prudence and explain how it can direct decision-making effectively through a case example. We will then conclude with a brief vision for how it can be incorporated as part of medical training.

Prudence

Prudence is traditionally conceived of as the mother of all the virtues, which gives it a moral or spiritual connotation, since virtue ethics and moral theology have historically been the only fields to speak of virtue. However, prudence has a very practical meaning at its root, and, as stated above, it should be defined as the ability to discern what one wants to achieve in a given situation as well as knowing the means through which one can achieve it. In this sense, prudence as a virtue aligns with the view of virtue as a capability without a specific moral or religious connotation. Nevertheless, when prudence is applied to clinical or surgical decision-making, the goals of professional care necessarily entail professional or ethical values. As such, prudential decision-making would not simply be technical know-how; it would encompass the professional and personal values of the various stakeholders who are affected by the decision. Moreover, those professional and personal values of the various stakeholders are what provides the foundation for prudence to arise over and above one's technical skills, since they form part of the motivation to achieve one's goals when the simple rote of acting competently does not fulfill what one wants to accomplish.

Prudence emerges from the utilization of the various components of decision-making in such a way that the total can be greater than the sum of its parts. Those components can be categorized broadly as recognizing reasons and responding to reasons, though these two broader categories include subcategories in themselves.

Reasons can be explanatory or normative. In other words, reasons can describe a situation, or they can impose expectations on what should be done in a situation given the goals and values of which the normative reasons are a consequence. Explanatory reasons describe a given state of affairs. As one of the authors (IB) defines elsewhere, explanatory reasons are facts that describe relationships between other facts in the world. Their existence as facts does not depend on whether they are perceived and understood by a person, yet the person must perceive and understand them in order to employ them as reasons. Normative reasons, on the other hand, consist of facts that describe relationships between other facts in the world in such a way that the person who recognizes that fact may be motivated to respond in a particular way because of them. Normative reasons create duties for the person to act even if he or she does not recognize them as such, yet they only become motivation for acting when the person recognizes them as applying to him or her. Again, their existence as facts does not depend on whether they are perceived and understood by a person, yet the person must perceive and understand them in order to be motivated by them as reasons for acting [1].

For example, suppose that *the reason* why a person has pain shooting down his leg is due to *the fact* that he has a compressed nerve in his spine. This *fact* is an *explanatory reason*. It describes a state of affairs that gives rise to the person's situation. Yet it does not obligate or motivate anyone to do anything. Now, assume *the fact* that the person wants to relieve his back pain. This may motivate the person to act so as to relieve his pain, but it does not obligate or motivate anyone to assist him in doing so.

Now consider a member of the medical profession who is dedicated to curing and alleviating suffering of patients; the fact of his membership and the dedication that the profession demands is a *normative fact* (consisting of professional values) – i.e., that the person is dedicated to curing and alleviating suffering – that may impose an *obligation* on him or her to consider the additional facts that the person has back pain/a compressed nerve and that he or she has the ability to alleviate the person's pain. Anyone who does not have the ability to relieve that pain would not have an obligation to do so, since all three facts are part of the normative reason to treat. (While "ought" implies "can," "cannot" implies "ought not" or the lack of an obligation). Yet, even if a medical professional does have the ability, the *normative fact* may nevertheless still not impose an *obligation* if the person does not become the medical professional's patient. This is a legal fact that serves as an additional component to create a normative reason in this case.

Recognizing the *fact* that the person is in pain and the *fact* that one is a member of the medical profession, as well as the other facts of the situation that entail an obligation to treat, will *motivate* the person to engage in a patient-physician relationship and seek to treat the person, if he or she is able to do so. In order words, the *explanatory and normative facts* of the case which obligate medical professionals in general become the source of *motivation* for the particular physician who recognizes them as *reasons* to act for the sake of the patient. Yet how the physician acts to best alleviate that pain depends on more than simply recognizing that he or she is motivated to do so; it also depends on many specific details of the case, including the different treatment alternatives that could be applied, the probabilities of success for each of the different alternatives, the particularities of the unique patient that may influence which alternative is best, as well as the resources at the disposal of the physician. Moreover, all of these factors are not static, and all of them can influence how the physician determines the best way to respond to the reason to treat. The prudent physician must continually re-evaluate his or her recognition of the state of affairs (explanatory facts) of the case so that he or she can respond in the most optimal way to the normative reason that motivates him or her to treat the patient.

Recognizing reasons for action includes the following components: attention, perception, and orientation. By attention, we mean the active self-urging to sustain focus. The importance of attention relates to the fact that clinicians in general, and surgeons in particular, must continually assess the situation in which they are acting. Surgery entails many complex and interconnected systems, both physiologically and within the dynamics of the clinical team. If one does not attend to the situation at hand, one may miss many of the cues needed for prudential decision-making. As a person becomes more skilled at maintaining attention, he or she can use less cognitive energy to attend to the same area of focus, thereby becoming more able to attend to a larger scope. This broadens the person's receptivity to recognize more explanatory facts so that they can be incorporated into better responses. For example, an inexperienced surgeon may focus entirely on a particular compressed nerve and miss other physiological aberrations which a more experienced surgeon might be able to perceive because of his or her greater and broader attention span. The more experienced surgeon's attention would also allow him or her to be better prepared for unexpected changes, either in the patient or in the broader situational environment.

By perception, we do not mean simply recognition of what objectively occurs. This is because any given situation may allow for multiple descriptions which bear competing or even conflicting claims. Moreover, emphasizing different details will highlight different considerations for how to relate to a particular scenario. Perception is the ability to understand nuanced differences between one situation and another and between the needs of one person and another. It is a skill of recognizing the particular while maintaining a grasp of commonalities. For example, consider two patients with a compressed nerve. It may be possible that a physician perceives that one patient is suitable for surgery, while the other is more suitable for physical therapy. It may also be the case that one physician recommends surgery, while another recommends physical therapy for the same patient. When perception is conceived in this way, it is heavily tied to orientation. Orientation is the lens through which perception is interpreted. It provides the epistemological frame that helps a person see different claims and prioritize which perspectival interpretation is most appropriate for the goals of care. It is tied not only to the facts that one perceives but also with what one may expect to see and with one's experience responding to similar situations in the past. In this way, prudence provides a person with the ability to understand how framing and other biases may influence perception by making salient certain factors while dismissing others. This is because prudence incorporates more than simply scientific knowledge or technical skill; it is tied to a social or professional orientation that provides a framework through which one can prioritize conflicting values so that one's decision aligns with one's overall goal.

After a prudential person has evaluated the situation and recognized the various reasons for acting, responding to reasons in action includes assessing the various ways to respond and choosing the alternative that best fits the goals of the situation and one's own ability to implement the chosen alternative. In assessing the various ways to respond, the prudential person does more than simply apply moral maxims or decision-making rules to the situation at hand. Prudential decision-making includes and carries over the experience of previous decisions that the person has made and continuously compares the current case with previous cases through use of analogical reasoning. Analogical reasoning is different than deductive reasoning. In deductive reasoning, the governing rule is given first, and the person derives particularities from the rule. When it comes to clinical decision-making, those rules consist of "best practices," hospital policies, or professional codes. In analogical reasoning, the reasoning itself helps a person to identify the principle for action and its relevance to the situation, since the person compares the situation at hand to similar experiences, accounting for both the similarities encountered and the differences that must be addressed. Through analogical reasoning, a person will not simply apply "best practices" because that is what is recommended. He or she will recognize that best practice recommendations apply in general to most cases but may not apply to every case, given the circumstances of the case. There may be other factors that override the applicability of a standard practice. For example, consider the guideline that one does not transfuse a patient who appears to be hemodynamically stable if the patient's hemoglobin level is more than 7. If that patient has compression of their spinal cord or other areas of tissue at risk if oxygen levels fall, a prudent physician may transfuse an apparently stable patient even if the patient has a hemoglobin level greater than 7. It is for this reason that experience is such an integral part of acquiring the virtue of prudence. Experience not only refines one's intellectual skills, but it also provides a bank of information so that decisions have a deeper source of knowledge that can inform them.

While previous examples have been more technical in nature, in medicine especially, where every situation necessitates communicating and responding to explanatory and normative facts that are social and value-laden, prudence demands honing interpersonal skills as much as deliberative and physical skills. Therefore, choosing the best alternative includes knowledge of what one is able to accomplish, given dispositional and situational considerations. Dispositional considerations include a person's tendency to act in certain ways, such as whether one is introverted or extroverted or whether one communicates better face-to-face or in written form, as well as his or her emotional and motivational affect. These latter dispositional traits influence more than just what one can accomplish; they also influence how one recognizes reasons as well. For example, Walter Mischel and Yuichi Shoda have argued that features of current situations as well as how those situations compare to previous experiences activate cognitive and affective reactions, which influence how one categorizes and reacts to current cases. Moreover, previous experience need not be actual. How a person has thought, planned, fantasized, and imagined a situation, as well as the emotional states that they invoke, also influence recognition and response to reasons in a current case. “Thus,” they write, “what constitutes a situation in part depends on the perceiver’s constructs and subjective maps, that is, on the acquired meaning of situational features for that person, rather than being defined exclusively by the observing scientist” [2]. Thus, it is not only actual experience which can be utilized to develop prudence. Even vicarious experience gained through reviewing other professionals’ cases, as well as imagining how one may act in a hypothetical case, can serve to develop prudence. Because prudence incorporates lessons from experience as well as hones skills of perception and deliberation, a prudent person may respond to a situation by seeing commonalities between the current case and previous cases, whereas a novice or an outside observer may not.

In a given situation, the prudent person will thus choose a particular response and choose to perform it in a particular way, accounting for what the situation demands and the person’s abilities, social role, and disposition. Prudence can thus be described as the combination of a ready disposition to respond to situations in a certain way and an intellectual ability to discern the best way to respond *for that person*. Factors that influence how a prudent person responds to a situation include not only what one would want to do generally but also the various stakeholders and what would be most persuasive to them in a given situation, what consequences the person foresees for himself or herself as well as for the other stakeholders, the systemic or organizational limitations or support the person might encounter when implementing his or her decision, and whether interpersonal relationships which the choice affects seem to support or disallow the desired choice.

The emergent quality of prudence appears in understanding that acting efficaciously entails more than sensory perception, intellectual cognition, and affective states, it also demands that these components of reasoning work in tandem and in relation to each other. A person cannot simply deliberate on a given situation and each potentially appropriate response as if he or she were an outside observer, since what he or she affirms as reasons to act are based on his or her relationship to the situation, i.e., his or her perception and receptivity to see alternative interpretations and responses, his or her goals, responsibilities, and capabilities. Moreover, in many interpersonal situations, there will be reasons to act in contradictory ways. Prudence allows a person to prioritize the values that different reasons engender to apprehend which reason has the greatest normative force.

Case Example

The following case example comes from the experience of one of the authors of this chapter (NS). The vast majority of spinal surgery consists of removing structures such as herniated discs which are compressing neural structures such as nerves or the spinal cord. The surgeon dissects and removes tissue until he or she identifies the neural structure that is being compressed. Since the removal of tissue is done with cutting instruments, one of the most challenging parts of the surgery is accurately identifying where the neural structures are and where they are not. Obviously much greater care needs to be taken near the neural structures. The method to understand where the neural structures are located is to use specific parts of the vertebrae (bone) as landmarks. The neural structures are almost always found in a specific relation to the landmark, but unusual anatomic variations occur.

During the dissection, on the way to identifying landmarks, a relative novice may pay more attention to every detail, not having the experience to know, or, perhaps, more accurately, to know with confidence, where the safe areas are and where unanticipated damage may be inflicted on a nerve. On the other hand, the experienced surgeon, confident of where he or she is, and having done the procedure numerous times, may need to expend less cognitive energy to attend to the details that he or she considers routine and also to dissections in areas where he or she is confident no danger lies. The input of vision and touch have to be mapped to the surgeon's mind's view and understanding of where the instruments are located in relation to the crucial parts of the patient's anatomy. The perception is then filtered through the surgeon's orientation. The experienced surgeon may be better oriented to understand the visual and tactile data, and the result is (hopefully) a more accurate map in the surgeon's mind of where the instruments are and where the important structures lie.

The spinal nerves are almost always found in a specific relationship to a part of the vertebra called the pedicle. The medial part of the pedicle marks the lateral borders of the thecal sac. In the lumbar spine, this sac contains the spinal nerves that are exiting from the spinal cord. Nerves exit from the sac at every level of the spine, similar to branches from a tree. In the lower (lumbar) spine, the nerve gracefully passes the pedicle and turns laterally to exit the spinal canal directly under (inferior to) the pedicle. Therefore, the thecal sac can only be present medial to the pedicles, and the nerves exiting are usually only directly under the pedicle. This means that the space directly above the pedicle, where herniated discs are most likely to occur, is free of nerves and therefore a safe place to dissect. The boundaries of the safe area are usually bordered by an imaginary line extending superiorly from the medial border of the pedicle and extending upward until the nerve above (exiting under the pedicle above) is encountered. The nerve root above is the superior border of the safe zone and is also the lateral border of the safe zone, because the nerve root angles inferiorly as it travels laterally. Therefore, identifying the pedicle provides the surgeon with confidence of where the nerves are and are not and where a safe dissection can be done and cannot be done.

However, anatomic variants are known to occur, the most frequent one known as a conjoined nerve root. In this case, the more proximal (higher up) nerve root extends much lower than usual, sometimes over the disc space, and sometimes it can be mistaken for a disc that is out of place. Mistakenly incising the nerve, thinking that it is the disc, can result in severe nerve damage and significant unnecessary pain, weakness, and/or numbness. Dealing with the aberrant nerve requires not only attention to the anatomy but perceiving it in the context of the known information regarding conjoined nerve roots and then dealing with it in an acceptable fashion. A knowledgeable surgeon will have a significant advantage over one who either lacks the knowledge or experience to properly identify landmarks and account for unanticipated variations.

While the most frequent goal of surgery is to remove the pressure from the nerve by removing the piece of disc that is compressing the nerve, sometimes that goal may also incorporate an additional decision to fuse vertebrae together. A fusion is done if the joint is causing significant pain or if there is concern that the vertebrae will move too much in relationship to each other, perhaps causing compression of nerves or becoming painful in the future. Fusion sometimes is the primary way to achieve the goal of the surgery, and it is also sometimes contemplated as something to be done in order to keep the patient from needing an additional surgery. In other words, sometimes there is a choice of doing a larger surgery initially or a smaller surgery initially. The expectation is that the pain and risk of an initial larger surgery will have the benefit of decreasing or eliminating the need for surgery in the future. With the smaller surgery, the benefit of less pain and less risk is offset by a larger risk of requiring another surgery in the future. Frequently there is no surgical consensus, and the patient's hierarchy of values has the most influence in which surgery is chosen.

As an example, elderly patients frequently develop pain from lumbar stenosis. This is where the gradual growth of arthritic joints and disc bulging result in compression of the adjacent nerve roots. Patients can develop severe pain with walking, frequently somewhat alleviated with leaning over shopping carts or walkers. While surgery is the most successful treatment, sometimes non-surgical treatment can be beneficial. Many patients, in addition to having compression of the nerve roots (lumbar stenosis), also have slippage of the vertebrae (spondylolisthesis). The slippage is not dangerous in and of itself. However, surgery to enlarge the spinal canal and relieve the stenosis can destabilize an already somewhat unstable segment. To complicate matters further, patients frequently have not only the classic buttock and leg pain of stenosis but also back pain. That back pain sometimes can be caused by the stenosis but can also be caused by slippage of the vertebrae and the resultant stress on the joints. Frequently there is uncertainty as to whether one, the other, or both are the source of the back pain.

There are two major surgical options for such a situation: decompression (removing the offending joints, ligament, and disc and relieving the pressure on the nerves) only and decompression with a fusion. Decompression has the advantage of being a smaller procedure and can reliably relieve the buttock and leg pain. It may relieve the back pain as well, but it may not. It also may lead to the need for another surgery in the future due to further slippage of the vertebrae. The other option is to decompress the stenosis and also place devices and/or bone graft to fuse the vertebrae together. This has the benefit of not only relieving the buttock and leg pain but having the best chance of relieving the back pain as well. In addition, it is the procedure that carries the smallest chance of requiring another surgery.

When surgery is contemplated for these patients, there can be a number of goals. Usually the primary goal is relief of the stenosis symptoms – the debilitating buttock and leg pain. However, if the back pain is severe, the patient may want to make relief of the back pain another primary goal. The patient also could want to have the smallest surgery possible or may prioritize the likelihood of never having to undergo another surgery. All of these are reasonable goals that serve as potential reasons to provide different alternative responses, each of varying degrees of priority. The prudent surgeon not only has as much data on outcomes as possible to discuss with the patient but works with the patient to decide on the goals of surgery. Only then can the best surgery for the patient be planned.

One of the more common methods of accomplishing a fusion is to remove most of the disc and place a plastic support in the space along with bone graft and chemicals designed to "trick" the body into growing a bony bridge from one vertebra to the other across the disc space. This is termed posterior lumbar interbody fusion (PLIF). In order to implant the device, the surgeon needs to retract (gently move) the nerves out of the way in order to have space to place the device. Retracting nerve roots in the lumbar spine is a very common maneuver. However, too much retraction can result in damage to the nerve. Not enough retraction can mean having to place a smaller and perhaps inadequate device.

Returning to our example above, a conjoined nerve root sometimes cannot be easily retracted, and therefore there can be technical difficulty in finding enough space to place the PLIF device. In this situation the surgeon needs to assess the risk of nerve damage with the amount of retraction needed to place the device, his or her technical skill in performing the required dissections/mobilization, whether achieving the fusion is part of the integral goal of surgery, and what other options he or she may have to fuse or stabilize the spine (there would be options of making the surgery larger, placing screws or other types of devices, etc.). Other factors that may have an effect include previous experience (both successful and unsuccessful), training, whether aborting this part of the procedure would affect the surgeon's self-esteem or image to the or staff or peers, concerns that the procedure may not be as described in the informed consent, or that the surgery does not comply with the patient's stated values. Other issues that may come into play would be time and convenience. A long dissection or using alternate methods of fusion could be time consuming and affect the rest of the schedule for the day.

The prudent surgeon, having identified the problem and potential solutions, attempts to find the solution that provides maximal benefit to the patient in the context of what the patient wants to accomplish while at the same time minimizing risk. In some situations, that might mean an extended dissection to allow safe retraction and placement of the device that the surgeon and patient agreed was the best option. In other situations, it may mean aborting that part of the procedure and explaining to the patient the rationale for the change in plan. Some surgeons by their nature are more likely to accept more risk on behalf of the patient in order to accomplish the goal, while others by nature are more risk-averse. Prudent surgeons should recognize their tendencies and do their best to make sure that they are doing their best for the patient, not just for themselves.

How Can Prudence Be Taught

Once one recognizes that prudence is a capability that consists of various skills of recognizing and responding to reasons, then training to hone those skills becomes easier to implement. Of course, experience will always be essential to develop practical skills, whether they be intellectual or physical skills, yet certain exercises can focus on the various components of prudence independently and holistically to make the acquisition of prudence more effective so that it need not take as much experience to acquire it. The analogy would be to how coaches give guided training to an athlete to build his or her technique and strength rather than simply having the athlete improve through playing without any guidance or practice drills. In a similar way, guiding younger surgeons to perceive complications differently and verbalize the ramifications of the different descriptions would expand their ability to frame circumstances – and thus decisions – differently when they are acting on their own. Similarly, thinking through many and various ways to approach a complication and examining the benefits and detriments of each alternative – and not just describing what occurred and what should occur – would expand surgeon's capabilities of evaluating different responses to reasons. While personal experience will always be the ideal practice to hone one's skills, relying on the vicarious experience through engaging others in analysis of case studies and observation can allow people to see options that they may not have seen before and to assess different components of how decisions are made and in which ways one can best respond to reasons.

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3 Emergency Medicine Management of the Elderly

Ivan T. Miller, Susan Boyle, Harry Kopolovich, Anar Shah, and Dan E. Wiener

Introduction: A Brief History of Emergency Medicine

Emergency medicine is a clinical field that consists of the knowledge required for the unscheduled diagnosis and management of acute illness including injury. It is positioned at the intersection of prehospital and inhospital care and represents a critical entry point for the management and disposition of patients in our healthcare system. Emergency medicine, as a field evolved in the 1960s during a time in which a rising number of patients sought immediate unscheduled care for emergency conditions. Emergency departments of this era were staffed by community physicians of varying expertise, and, eventually, the need for specialized training became evident. In 1979, the American Board of Medical Specialties recognized emergency medicine as a distinct medical specialty in the United States. Today, emergency medicine is a thriving academic specialty that welcomes over 2000 new residents each year. Fellowships and subspecialty training in emergency medicine span critical care, toxicology, pediatrics, sports medicine, disaster, prehospital medicine, and ultrasound, among others. The emergency department is a key partner for surgical specialties, as many patients requiring surgical interventions will receive assessments and stabilization in the ED, including some who will be referred from the ED to the outpatient setting for definitive surgical management.

According to the United States Census Bureau, the population age 65 and over increased

I. T. Miller (✉)
Department of Emergency Medicine, Westchester Medical Center, Valhalla, NY, USA

Department of Emergency Medicine, New York Medical College, Valhalla, NY, USA
e-mail: Ivan.Miller@wmchealth.org

S. Boyle
Department of Emergency Medicine, Morristown Medical Center, Morristown, NJ, USA

H. Kopolovich
Department of Emergency Medicine, Richmond University Medical Center, Staten Island, NY, USA

Department of Emergency Medicine, Albert Einstein College of Medicine, Bronx, NY, USA

A. Shah
Geriatric Emergency Department, Morristown Medical Center, Morristown, NJ, USA

Department of Emergency Medicine, Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA

D. E. Wiener
Department of Emergency Medicine, Morristown Medical Center, Morristown, NJ, USA

Department of Emergency Medicine, Sidney Kimmel Medical College, Thomas Jefferson University, Philadelphia, PA, USA

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from 37.2 million in 2006 to 49.2 million in 2016. The Administration on Aging, a division of the US Department of Health and Human Services, projects this group to almost double to 98 million by 2060. In 2015, 7.1 million people age 65 and over had at least one overnight hospitalization during the year. In 2016, older Americans spent over 13% of their total expenditures on health [1]. The number of patients over the age 65 presenting to emergency departments (EDs) has been steadily increasing. The 2009 National Hospital Ambulatory Care Survey showed 52,200 ED visits per year for every 100,000 patients over age 65 [2]. For this age group, the ED visit rate per 100,000 was consistently higher than that for other age groups for the 10 years between 2006 to 2015, and rising overall, reaching 56,803 in 2015 [3] (Fig. 3.1). In 2016, there were 145,591,000 ED visits in the United States, with those age 65 years and over representing 23,108,000 or 15.9%.

According to the Census Bureau's projections, the elderly populations will more than double between 2017 and the year 2050, to 80 million. By that year, as many as 1 in 5 Americans could be elderly. Most of this growth will have occurred between 2010 and 2030 when the "baby boom" generation enters their elderly years. During that period, the number of elderly will grow by an average of 2.8 percent annually.

Geriatric Emergency Medicine: An Overview

As the geriatric population has continued to increase in size, hospitals around the world have designed models of care that make the ED friendlier for geriatric patients. Numerous studies and scholarly articles focusing on the emergency care of the elderly have been published. Multiple papers have been published exploring many aspects of geriatric emergency medicine from predictors of emergency department use through triage, disposition, and beyond.

Emergency medicine triage is the process of rapidly sorting patients by clinical priority. It is typically performed by a nurse following an algorithm that includes vital signs, chief complaint, brief history of present illness, past medical history, and medications. The emergency severity index (ESI) has become standard in US emer-

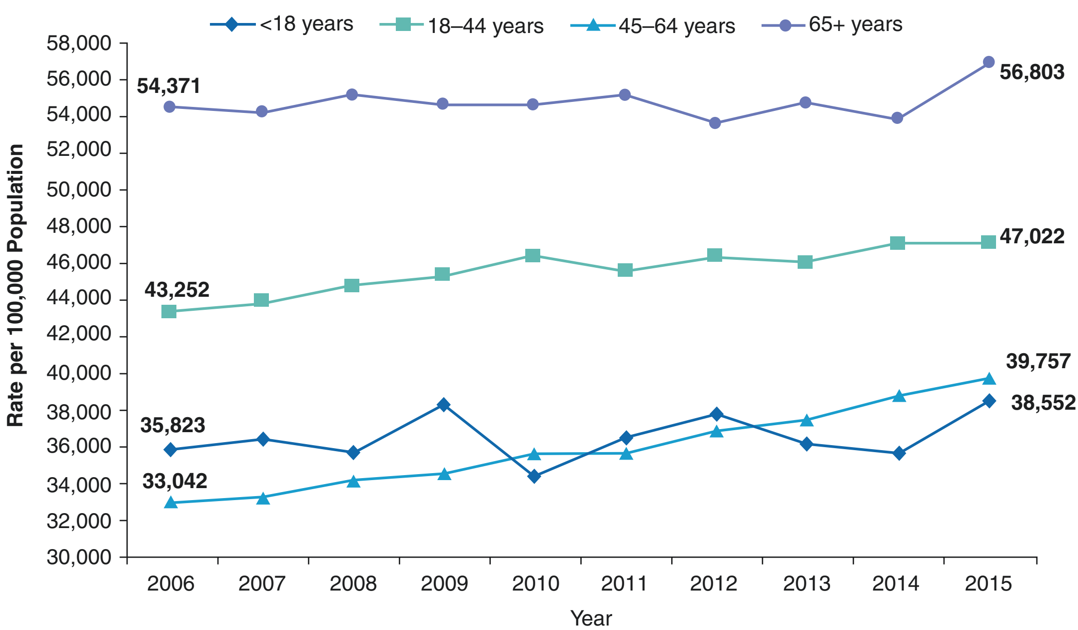

Fig. 3.1 Rate of ED visits, per 100,000 population by age group, 2006–2015. (From Sun et al. [3])

gency department triage since the American College of Emergency Medicine and the Emergency Nurse Association endorsed it in 2003 and 2010 [4]. Studies of its use in the geriatric population are mixed. On the one hand, the ESI score did predict likelihood of hospitalization, length of stay and 1 year outcomes [5]. On the other, ESI score identified fewer than half of elderly patients receiving an immediate lifesaving intervention [6]. This finding is not surprising considering the difficulty some elderly patients have in describing their chief complaint. Given the increased prevalence of acute surgical and medical emergencies in the elderly population, triage protocols that place this population in the waiting room may be high risk. Various efforts to reduce undertriage have been studied. Across the spectrum of outcome studies, ESI level 3 has been recognized as the most heterogeneous. In many crowded emergency departments, ESI level 3 patients may wait hours prior to being seen by a provider. One approach that has been implemented as a QI project at a geriatric emergency department is to forbid ESI level 3 in elder patients. This approach forces a triage nurse to choose level 2 which requires immediate placement in a treatment room or level 4 which is reserved for patients who do not need a workup. Without the option of ESI level 3, the choice is either immediate bed placement or minimal workup. This change would likely reduce undertriage at the expense of overtriage. Outcome studies are needed to assess this age-based alteration to the standard ESI-based triage protocols.

Frailty

Frailty is a phenomenon estimated to occur in approximately 25% of those over the age of 65 and in over 50% of those over the age of 85, but it is not an inevitable consequence of normal aging [7]. There is no one single definition of frailty, but most geriatricians describe it as a syndrome that combines a cumulative loss of physiologic reserve and function with an increased vulnerability to stressors [7, 8]. The consequence of this decline is the characteristic presentation of frailty: weakness, fatigue, reduced mobility and loss of muscle mass, poor balance and gait instability, susceptibility to urinary tract infections, anorexia, weight loss, and some loss of cognitive function, with increased susceptibility to extrinsic stressors. Frailty is now recognized as a risk factor for poor outcomes in healthcare and especially postsurgical interventions. A meta-analysis showed that frailty is associated with higher postoperative inhospital and 1-year mortality, longer length of hospital stay, and increased need for residential post-acute care [8]. While there is widespread agreement on the negative effect that frailty has on outcomes, there remains a lack of consensus on an exact causal mechanism or method of measurement.

Pathophysiology of Frailty

While normal aging is thought to arise from an accumulation of molecular and cellular damage, despite the efforts of a complex repair and maintenance network, frail patients have an increased presence of inflammatory markers and epigenetic changes. A range of inflammatory cytokines have been independently associated with frailty including interleukin-6 (IL-6), C-reactive protein (CRP), tumor necrosis factor-α (TNFα), and CXC chemokine ligand-10 (CXCL-10), a potent pro-inflammatory mediator [7]. Advanced glycation end products (AGEs) may also cause widespread cellular damage through the upregulation of inflammation. This leads to an abnormal, low-grade inflammatory response that is hyperresponsive to stimuli and that persists for prolonged periods following removal of the initial inflammatory stimulus.

Frailty Models

There are two principal overlapping and statistically convergent models of frailty: the frailty phenotype by Fried and the cumulative deficit model, which was proposed by Rockwood [7]. Fried's model is based on five criteria: weakened grip strength, self-reported exhaustion, slow gait speed, unintentional weight loss, and low physical activity, where people with three out of the five factors are classed as frail and those with two of the factors are classed as pre-frail. The cumulative deficit model proposes that it is a cumulative accumulation of deficits (symptoms, signs, and laboratory tests) that eventually tips the balance. It uses a frailty index based on the presence or absence of 92 parameters, the higher the number of deficits, the greater the frailty.

Measurements of Frailty

A variety of tools have been used to detect and measure frailty including measurement of gait speed, the timed up and go test (TUG), hand grip strength, pulmonary function tests, and many questionnaires, but the gold standard is the comprehensive geriatric assessment, usually conducted by a multidisciplinary team.

Frailty is a risk factor for death and disability following a range of surgical treatments including hip fracture, aortic valve replacement and likely plays a pivotal role in the older patient's potential for recovery [9, 10, 11]. While national guidelines recommend a preoperative evaluation of frailty and other risk factors, the lack of consensus surrounding frailty assessment tools is a major reason why frailty is often not measured in clinical practice.

In a meta-analysis of a wide range of surgical interventions, frailty was associated with a higher inhospital mortality rate, a higher 1-year mortality rate, a longer hospital stay, and a higher rate of discharge to post-acute residential nursing care [8]. Similar data exists in emergency department measures of frailty. In Dresden et al. the clinical frailty score (CFS) correlated with admission or transfer to a skilled nursing facility (SNF) [12]. The implications for emergency medicine are that frailty must be considered along with other risk factors and comorbidities. Another attempt to measure premorbid risk is the Identification of Seniors at Risk (ISAR) score, which is a six question self-reported screening tool [13]. ISAR has been evaluated in multiple studies in emergency medicine and in other surgical contexts. The results are mixed. Tavares et al. found that ISAR could predict return to the ED within 30 and 180 days but not admission during the repeat visit [14]**.** Suffoletto at al found that ISAR was not able to predict seniors who would die or return to the emergency department within 30 days of discharge [15]. A meta-analysis of 10 studies using ISAR (8860 patients) concluded that ISAR is not suitable "alone for identifying seniors at risk for adverse outcomes in the ED" [16].

Delirium and Dementia

One dimension of frailty that has been studied in more detail is dementia, especially in its early phases [17, 18]. Dementia may prevent a patient from providing an accurate history which is crucial to guiding the emergency department workup. The absence of a reliable history along with the increased prevalence of multiple morbid conditions leads to increasing use of radiological imaging in the emergency department with advancing patient age [19]. Especially without collateral information about baseline status, delirium, and dementia may be difficult to distinguish in the emergency department setting [20, 21]. Efforts to screen for both conditions have been combined in tools such as the 4AT and 6-CIT. O'Sullivan et al. found that 6-CIT and 4AT accurately exclude delirium and dementia in older ED attendees. 6-CIT does not require collateral history but has lower positive predictive value (PPV) for delirium [22]. Much of the literature on screening for dementia and delirium has been produced by clinicians who provide geriatric assessment upon clinical consultation to the ED. In a meta-analysis, Carpenter et al. found variable diagnostic accuracy of screening tests for dementia. In their assessment, the AMT-4 appeared to be the most accurate positive predictor of dementia, and the Brief Alzheimer's Screen is the best negative predictor of dementia [23].

Delirium or acute encephalopathy is a neuropsychiatric disorder with an acute onset and a fluctuating course, characterized by disturbances in consciousness, memory, cognition, perception, and behavior [24]. It occurs in hyperactive, hypo-active, or mixed forms, is more common in those with preexisting dementia, and is associated with increased mortality, hospital length of stay, functional disability, rates of admission to long-term care institutions, and healthcare costs [24, 25]. Frailty and dementia are risk factors for delirium and acute delirium in the emergency department and are significant predictors for bad outcomes [11]. Delirium results from the interaction of multiple predisposing factors together with precipitating stressors. The most common causes of delirium seen in the emergency department are infection, drugs/medications, CNS disorders, metabolic disturbances, pain, and hypoxia [7]. Guidelines encourage the need to screen all older patients for the presence of delirium, although there is no consensus on the best tool. Many, such as the b-CAM and CAM-ICU, are a variation of the Confusion Assessment Method (CAM) [26]. The CAM diagnostic algorithm is based on the four cardinal features of delirium: (1) acute onset and fluctuating course, (2) inattention, (3) disorganized thinking, and (4) altered level of consciousness. A brief two-part screening tool – the Delirium Triage Screen (DTS) can be used as an initial step to rule out delirium, and those who have a positive DTS are then screened using the bCAM, which has higher specificity. A diagnosis of delirium according to the CAM requires the presence of features 1, 2, and either 3 or 4. Management of delirium focuses on prevention, symptom management, and the need to consider and treat all possible reversible causes.

Similar to the task of evaluating abdominal pain without an accurate history is the challenge presented by nonspecific complaints in general. Every emergency physician learns to approach complaints such as generalized weakness ("weak and dizzy") in elderly patients with caution. Dementia or even delirium may cause an elderly patient with a suggestive history to describe the reason for their visit to the ED in nonspecific terms. Nemec et al. found that in a cohort of patient's median age of 82 who presented to an ED with nonspecific complaints, a serious condition was diagnosed within 30 days in 59%, and the 30-day mortality was 6% [27]. Interestingly, a secondary analysis of this cohort by Liu et al. found that the subgroup with recent falls had similar outcomes to those without falls suggesting to the authors that falls in the elderly might best be considered "under the broader entity of nonspecific complaints [28]."

In the authors' collective experience, tools such as AMT-4, 4AT, 6-CIT, CFS, and ISAR are not commonly deployed in emergency departments at this time. Nevertheless, the emergency physician's perception of frailty, dementia, and other risk factors including delirium and nonspecific complaints found in this body of work should influence the extent of diagnostic workup and choice of disposition. Further study is needed before a standardized scale can be recommended for routine use in the emergency medicine setting. In other words, the older the patient, the more likely they will receive tests in the emergency department due to the pretest probability of significant findings and to the challenges in obtaining an accurate history. In this context, we now turn to the emergency department evaluation of abdominal pain in the elderly.

Abdominal Pain in the Elderly

Abdominal pain is the chief complaint of 3–4% of elderly patients presenting to the ED [29]. Of these patients, 51% will be admitted [30], 24–34% will require surgery [31, 32] and mortality rates are reported as 6–35% [33]. All these rates are significantly higher than those of younger patients [34]. The diagnostic approach to the elderly patient is challenging as their symptoms are less severe, nonspecific, and often atypical. A retrospective review of 131 patients >65 all with culture proven intra-abdominal infections found that geriatric patients presented more frequently without the usual symptoms of abdominal pathology including an absence of abdominal pain, nausea, vomiting, diarrhea, and fever [35]. Symptoms were present for a longer period before presentation [31–33, 35, 36]. Taking an accurate history can be challenging as it is estimated 10–20% of persons older than 65 have significant degrees of memory deficit, disorientation, or decline in intellectual performance [37].

Classic findings on physical examination may be absent as the multisystem changes associated with aging lead to altered physiologic responses. Atrophy of the abdominal wall musculature can diminish rebound and guarding and changes in peripheral nerve function lead to later and subtler presentation of pain [38]. Older patients may not be able to mount a fever and those with an intra-abdominal infection are four times more likely than a younger patient is to present with hypothermia [35]. In one study 30% of patients greater than 80 years old in the ED with an intra-abdominal abnormality requiring surgery developed neither fever nor leukocytosis [39]. In older patients with peritonitis, only 34% manifest guarding or rebound tenderness [40]. Medications commonly taken by elderly patients, including beta-blockers, steroids, NSAIDs, and opiates, make it less likely that they will manifest fever or tachycardia [38]. Many elderly patients present later in the course of their disease as they fear losing independence, hospitalization, and death or may lack health insurance, transportation, or a reliable caregiver for their spouse or pet [41].

A 2005 prospective, multicenter, observational study of 360 patients ≥60 presenting with atraumatic abdominal pain found that patients had the following diagnosis: nonspecific (14.8%), UTI (8.6%), bowel obstruction (8%), gastroenteritis (7.4%), gallbladder disease (5.5%), diverticulitis (6.2%), constipation (5.9%), cancer/mass (5.6%), PUD/GERD (4.5%), pancreatitis (3.9%), and urinary retention(3.6%) [42]. A retrospective review of ED records and operative reports of 117 patients ≥80 years old presenting with acute abdominal pain requiring operation found that cholecystitis, hernia, obstruction, peptic ulcer disease, ischemia, and perforation were the most common diagnosis [39]. A second retrospective cohort study of patients with intra-abdominal infections compared the frequency of diagnosis in those ≤65 with younger patients and found the following incidence of disease [35] (Table 3.1).

In addition to the changing incidence of common diagnosis, the risks for certain diseases such as ruptured AAA mesenteric ischemia, colon cancer, and atypical presentations of MI significantly increase in patient is older than 50 years. Given the challenges of making an accurate and timely diagnosis in an elderly patient presenting with abdominal pain, CT is often the diagnostic modality of choice. CT is performed in 37% to 59% of older patents presenting to the ED with abdominal pain and leads to a diagnosis in 67–75% of cases [19, 34, 42]. Given the challenges of atypical presentations and the significant morbidity and mortality of elderly patients presenting to the ED with abdominal pain, clinicians need to maintain a large differential diagnosis focus on potentially immediate life-threatening conditions.

Table 3.1 Common causes of abdominal pain

Disease	Incidence in those ≤65	Incidence in those ≥65
Appendicitis	28	61
Diverticulitis	28	6
Cholangitis	12	8
Cholecystitis	12	2
Intra-abdominal abscess	9	14

Cooper et al. [35]

Biliary Tract Disease

The incidence of gallstones increases with age and in postmortem studies, gallstones were found in approximately 50% of patients >60 years [43]. The increases in the prevalence of gallstones, lithogenicity of bile, percentage of pigmented stones, and CBD diameter all contribute the greater incidence and severity of biliary disease in elderly patients [44]. The incidence of complications ranges from 7 to 20% overall and rises to 40–60% in patients over age 70. These complications include acute cholecystitis, empyema, perforation, abscess, jaundice, cholangitis, and pancreatitis [45]. Gallstone pancreatitis increases with age accounts for 50% of acute pancreatitis adults >56 years old compared to 31% in those younger <21 years old [46]. A retrospective review of 88 male patients older than age 60 with biliary tract disease reported a mortality rate of 6.7–6.8% [45, 47].

As with other abdominal emergencies, the prevalence of classic signs and symptoms may be absent. In a retrospective review of patients over age 65, pain was in the epigastric area or RUQ in 84% of patients and in the back or flank in 36%, and 5% had no pain. The prevalence of other symptoms was noted to be nausea (57%), emesis (38%), jaundice (8%), and fever (44%) [48]. An elevated WBC was found in 58%–65% of patients, and 13% had no fever, and all tests were normal [47, 48]. Bilirubin and alkaline phosphatase were elevated in 59% of patients, and SGOT and SGPT were elevated in 62% [47]. Evaluation by ultrasound is the test of choice when there is a high index of suspicion of biliary tract disease. However, it may be less helpful than in younger patients given the increased prevalence of acalculous cholecystitis [37].

Appendicitis

Appendicitis in elderly is characterized by atypical and late presentations resulting in higher perforation rates and increases in morbidity and mortality compared to younger patients [49]. Atypical presentations and perforation are attributable to depressed T-cell function and increased vascular sclerosis [50]. The classic presentation of appendicitis (RLQ pain, fever >37.6C, WBC >10,000, nausea, and vomiting) is seen in 10–30% of elderly patients [49–52]. On physical examination findings include RLQ tenderness (91%), fever (71%), rebound tenderness (54%), pain and guarding (40%), Rovsing's sign (16%), abdominal distention (7%), and abdominal mass on palpation (5%) [53]. A study done in 2011 found the sensitivity of CT scanning with contrast in the elderly population to be 100% sensitive with a specificity of 99.1% [54]. While non-contrast CTs have a sensitivity of 92.7% and a specificity of 96.1% [55], ultrasound has a sensitivity of 76% and a specificity of 95% [56].

Elderly patients have increased risks of significant morbidity and mortality, ranging as high as 70% versus approximately 1% in the general population [52]. Perforation rates are 50–70% in the elderly compared to 20–30% in the general population [52, 57]. A study published in 2002 noted a decrease in perforation over the previous 20 years from 72% to 51% which was attributed to the increased use of CT [52]. The overall mortality rate for elderly with appendicitis has been reported to approach 15% [54].

Diverticulitis

Diverticula form as patients age with an incidence of 50% in those over 70 and 66% in those over 80 [37]. Approximately 80% of patients with diverticulosis are asymptomatic [37]. The most common complication of diverticulosis is diverticulitis, which occurs in 10–30% of patients [58, 59]. Uncomplicated diverticulitis is defined as a microperforation that results in peridiverticulitis and/or phlegmon. In complicated diverticulitis, this progresses to free perforation, fistula or abscess formation, sepsis, or obstruction [60].

Diverticulitis is characterized by LLQ pain and tenderness, fever, and leukocytosis. Peritoneal signs may be present if the diverticula have perforated. 30% of the geriatric patients with acute diverticulitis abdominal tenderness is absent on physical examination [37]. CT is the test of choice to confirm diverticulitis as it reliably detects the location and extent of the inflammation [61]. Following recovery from the first episode of simple, uncomplicated diverticulitis surgery is seldom indicated as only 20–30% of patients that will have recurrent episodes.

Rectal bleeding is associated with diverticulosis in up to 30% of patients. The bleeding is painless [58] and can be massive. Angiodysplasia of the right colon must be considered in the differential diagnosis [62]. In an actively bleeding patient, angiography is the test of choice, as it is both specific and sensitive, provided the rate of bleeding is sufficient (0.5–1.0 ml/min.) [61]. Angiography also provides the option to treat with either infusion of vasospastic substances or selective embolization [61]. In patients with slower bleeding rates, nuclear scanning techniques using Technetium-99m sulfur colloid and Technetium-tagged RBCs may be useful [63]. When the bleeding site cannot be identified with these modalities, colonoscopy has been successfully used for electrocoagulation of arteriovenous malformations [64]. Patients may require massive transfusion. This should be done cautiously as elderly patients with systolic or diastolic dysfunction can experience fluid overload.

Peptic Ulcer Disease

Several physiologic changes associated with aging increase the incidence of PUD in elderly. Gastric emptying becomes delayed leading to an increased prevalence of atrophic gastritis and PUD [65, 66]. The incidence of colonization with *Helicobacter pylori* increases, and approximately 50–70% of elderly ulcer patients are *H. pylori* positive. This pathogen has been associated with an increased incidence of PUD [67]. In one study of Medicare patients, 26% tested positive for *H. pylori*, while recent use of NSAIDs was documented in 82% of patients [67]. The odds ratio for bleeding ulcers in elderly patients is 4.9 for NSAIDs and 1.8 in patients with *H. pylori*. When both of these risk factors are present, it increases to 6.1 [68].

The incidence of gastric ulcers increases from 13% to 45% in elderly patients compared to younger patients with a concurrent decrease in the incidence of duodenal ulcers from 84% to 51% [52]. Symptoms of PUD are usually absent or vague and poorly localized. Approximately 30–35% of patients older than 60 with confirmed PUD have no abdominal pain compared to 6.9% of younger patients [69, 70]. These atypical presentations are associated with an increased incidence of complications which occur in 50% of patients older than 70. Complications include hemorrhage, perforation, penetration, and obstruction [71]. When hemorrhage occurs in the elderly, they have more severe bleeding and require more transfusions [72]. Endoscopy may be considered to evaluate for the indicators that predict recurrent bleeding and identify findings that may require endoscopic intervention [71]. Perforations in the elderly may be difficult to diagnose because of lack of symptoms, lack of physical signs, and lack of history of PUD [71]. The mortality from perforation has been reported as 9% for duodenal ulcers and 13% gastric ulcers [71].

Treatment should include lifestyle changes such as discontinuing NSAIDS, ETOH, tobacco, and caffeine. Medications including antacids, sucralfate, h-2 receptor antagonists, proton-pump inhibitors, misoprostol, and antibiotics for *H. pylori* have been shown to be effective. Proton-pump inhibitor infusion for acute bleeding does not lower mortality but does decrease the incidence of finding a lesion that requires intervention when endoscopy is performed [73]. If endoscopy does not control the bleeding, interventional radiology can attempt angiography with arterial embolization. Surgery presently is reserved for individuals with ulcers that are refractory to medication or are associated with complications [73].

Small Bowel Obstruction

Small bowel obstruction (SBO) can be caused by adhesions from previous surgeries (50–70%), incarcerated hernias (15–30%), and neoplasms (15%). Gallstone ileus is the cause of up to 25% of cases among older adults, in contrast to 2% in younger patients [74]. Patients with SBO present with diffuse abdominal pain, distension, vomiting, and constipation. In the elderly the symptoms of SBO are often subtler than in younger patients [75]. The treatment is conservative consisting of NG decompression, NPO, and IV fluids. Surgery should be considered if the patient does not improve in 24–48 hours [37].

Large Bowel Obstructions

Large bowel obstructions (LBO) occur more frequently in elderly patients than in the general population. The most common causes are malignancy and diverticulosis [37]. Colonic volvulus can also cause obstruction. Sigmoid volvulus is the most common type (75–80%) followed by cecal volvulus [76].

The symptoms of sigmoid volvulus include crampy abdominal pain, vomiting, obstipation, small liquid stools, and abdominal distension [74]. Plain films demonstrate a dilated sigmoid loop and air/fluid levels in 67% of cases [77] but if not present CT is diagnostic [78]. A sigmoid volvulus can often be decompressed with a rectal tube, sigmoidoscopy, or barium enema. Sigmoid or cecal volvulus has a high risk for perforation and should be decompressed urgently [37]. After nonoperative reduction, recurrence rates and mortality rates are as high as 90% and 35%, respectively. Therefore, elective resection is recommended to avoid recurrences [78].

Patients with cecal volvulus present with episodic cramping abdominal pain, nausea, vomiting, and obstipation. Recent surgery, adhesions, congenital bands, chronic, and mental disorders constipation are all risk factors [78, 79]**.** On physical examination, patients will have diffusely distended abdomens, and they can progress to exhibit rebound tenderness if peritonitis or bowel ischemia develops. Complications include bowel ischemia, necrosis, or perforation. There is a 25% incidence of gangrenous bowel at the time of diagnosis [72]**.** The classic finding on plain film is a "coffee bean sign" in the LUQ, but this is present only in 17% of patients [80]. On CT scan a "whirl sign" (twisting of the mesentery around the ileocolic vessels) is pathognomonic for cecal volvulus, CT may also demonstrate signs of bowel obstruction (a massively dilated cecum with associated small bowel dilation) or signs of colonic or small bowel ischemia (mural thickening or mesenteric edema) [81, 82]. The treatment of cecal volvulus requires surgical repair [78].

Colonic pseudo-obstruction or Ogilvie syndrome is a functional obstruction of the GI tract, which occurs more commonly in the elderly debilitated patient, particularly those who are institutionalized or have a prolonged hospital course [80]. Patients present with gradually worsening abdominal distension and abdominal pain (83%), nausea (63%), and emesis (57%) [83]. Passage of stool is absent in 50% of patients [84]. Physical exam findings will include massive abdominal distension [82]. Treatment involves discontinuing narcotics, sedatives and anticholinergics, and making the patient NPO while providing IV hydration and electrolyte replacement. A rectal tube can help decompress an air-filled sigmoid colon [82]. About 75% of patients with Ogilvie syndrome will resolve with conservative therapy within 8 days [84]. If symptoms do not resolve after a few weeks, mechanical obstruction should be considered.

Vascular Problems in Elderly

Both acute mesenteric ischemia (AMI) and abdominal aortic aneurysm (AAA) should be considered in elderly patients presenting with abdominal pain. These vascular emergencies require early identification and treatment. AAA is found in 5% to 10% of men aged 65 to 79 years [85]. Risk factors for AAA include tobacco use, HTN, PVD, and a family history of AAA [86, 87]. The classic triad of ruptured AAA (hypotension, flank pain, pulsatile mass) is present in only 25–50% of patients [40]. Patients may also present with deceased blood flow to the lower extremities manifesting as numbness and coldness [88]. In those patients presenting to the hospital with rupture, the mortality is 80% [85].

AMI most often involves embolism or thrombosis of the superior mesenteric artery. Patients older than 60 with a history of recent myocardial infarction, CHF, arterial emboli, or atrial fibrillation are at increased risk. Classically, patients present with severe, poorly localized pain that is out of proportion to physical findings [89]. One third will have nausea, vomiting, or diarrhea. On physical examination there is abdominal distension, and patients may develop peritoneal signs and shock [40]. Laboratory abnormalities consistent with ischemic bowel include leukocytosis and an elevated lactate, which result in an anion gap metabolic acidosis. Plain films are diagnostic in only 30% of patients (focal edema or pneumatosis intestinalis) [90]. CT angiography should be done as soon as possible in patients with suspected AMI. CTA has a sensitivity of 93% and a specificity of 100% [91]. Survival is dependent on early recognition with mortality rates of 50% when the diagnosis is made within 24 hours increasing to

<70% when there is a delay [92]. The mainstays of therapy are fluid resuscitation, anticoagulation, superior mesenteric artery infusion of vasodilators, and emergency laparotomy [89].

Emergency Management of Elderly Trauma Patient

Customarily, trauma models have mirrored the centers for Medicare services definition of elderly as those aged 65 and above. This definition was validated in the largest trial evaluating the relationship between age and trauma mortality, the MTOS study, which demonstrated that patients older than 65 years of age had elevated mortality across matched Injury Severity Scales (ISS), mechanisms of trauma, and body region injured [93]. However, restricting patients to intensity of initial evaluation based solely on chronological age has severe limitations for the potential improvements in morbidity and mortality of patients. In fact, physiologic changes that impact trauma-associated morbidity and mortality begin to occur at age 40 [94]. Currently, the American College of Surgeons recommends that emergency medical services transport patients older than 55 years of age to a designated trauma center regardless of apparent injury severity [95]. Furthermore, these same trauma activation criteria recommend universal activation of the trauma team of all patients older than 75 who present regardless of the mechanism of injury or physiologic status [96].

The elderly are not just old adults. In fact, age may be an overly simplistic measure to understand outcomes in geriatric patients. A more robust methodology may be the degree of frailty [97]. Frailty is composed of both the loss of physiologic reserve and increased incidence and severity of the comorbid disease. Biologically, this translates to musculoskeletal, neuroendocrine, and immunologic deficits that synergistically contribute to a state of muscular weakness and overall physical impairment [98]. Frailty is an independent predictor of postoperative mortality, complications, and hospital duration [99]. Frail patients not only have short-term worse outcomes but long-term ones as well. For example, frail elderly patients have decreased functional ability 1 year after a fall and increased mortality that persists 3 years after the event [100]. Chronological age is, therefore, one of many other components that must be assessed to determine the correlation between pre-injury state and long-term outcome. As described above, multiple factors with particular attention to frailty interplay to determine complications, consumption of hospital resources, and readmission rates.

Falls

Although the causes of injury in elderly persons are many, falls are the most common mechanism in this population subset. More deaths occur from falls in patients aged 85 or older than deaths from motor vehicle crashes in the 18- to 19-year age group [101]. Coexistent medical conditions that collectively contribute to the pre-injury frailty of the individual result in a myriad of medical complications. These inevitably result in poor outcome and ultimate demise.

Ground level falls tend to prevail in this age group, whereas falls from height are less prevalent. Lack of adequate protective mechanisms exacerbate the injury patterns seen in low-energy falls. Similar height falls tend to cause considerably less injury in younger cohorts likely due to the ability to brace for the impact on an outstretched hand. Older patients with impaired reflexes or slowed cognition are less likely to have such a protective mechanism, often resulting in more severe and combined injuries. Elderly persons are predisposed to fall for a myriad of reasons (Table 3.2).

Table 3.2 Factors predisposing to falls in the elderly person

Impaired sensation and proprioception	Degenerative joint disease
Visual disturbances	Dementia
Unsteady gait and balance	Predisposition to syncope and near-syncope
Neuromuscular disorder	Stroke
Weakness of musculature	Polypharmacy

When evaluating the elderly patient who has fallen, the emergency physician must evaluate not just the injuries that result from the fall but also acute illness that may have caused the injury. The latter may have a far greater ramification on the patient's post-convalescent period than the injury itself. Over 80% of patients evaluated after accidental fall are found to be on medications implicated in contributing to their fall [102]. The presence of four or more medications is directly correlated with increased risk for falls [102].

Initial Evaluation

Expert panels as well as the American College of Surgeons Committee on Trauma (ACS COT) field triage algorithm have recommended transport of the elderly to a trauma center even in the absence of high-energy injuries [103, 104]. Once at the trauma center, an elderly patient with a fall from standing may not meet the criteria for full trauma team activation. However, patients in this age group may have more serious injuries than younger patients with higher-energy mechanisms. Without trauma activation, a patient such as this may have to wait while patients with higher triage acuity are evaluated. Some centers have created an automatic activation for elderly patients. This approach is resource intensive as many of these patients do not have significant injury. One of our trauma centers has established a "level 3" activation which is limited to emergency department staff. A level 3 patient is immediately placed in a treatment area and fully exposed by a smaller team including emergency department physician, nurse, and patient care tech. Decisions about c spine immobilization, analgesia, and imaging are made rapidly, and the full trauma team can be consulted when indicated. Level 3 activation can be helpful for all patients whose mechanism of injury is below the typical threshold for level 1 or 2 activation with an emphasis on older patients at elevated risk for injury for the reasons described above.

Several unique considerations are relevant during the trauma primary and secondary survey of the elderly trauma patient. Physicians should be aware that because of unique physiologic and anatomic changes that occur in this group as well as the complicating role of medications and prosthetic devices, many of the traditional hallmarks of clinical instability may be initially masked. Attention to vital signs is particularly important in the elderly. Although abnormal vital signs certainly warrant additional investigation, normal prehospital or initial vital signs should not impede a thorough investigation. Normal blood pressure in an older patient with a history of chronic hypertension may be abnormal for that patient and an indication of serious injury. Vital sign trends are critical in the elderly trauma patient. The emergency department team should track and trend vital signs, reporting any change during the emergency department course.

The remainder of the physical examination should proceed with emphasis on the disability and exposure portion of the primary survey. Poor nutrition, loss of lean muscle mass, microvascular changes, and blunted hypothalamic function increase the elderly trauma patient's risk for hypothermia and sores [105]. All efforts should be made to quickly clear the cervical spine when applicable and remove the patient from the hard backboard if it has been applied. Several orthopedic and wound management studies have demonstrated that in the elderly, the pathologic process of pressure ulcers begins early in the hospital course [106]. Pressure sores result in increased hospital length of stay, as well as preventable patient morbidity and mortality. Action thus taken in the trauma bay can thus positively impact the patient in these domains.

Computed tomography scanning has been shown to help reduce mortality in the severely injured elderly patient [107]. Maintaining a low threshold for axial imaging is a mainstay of emergency medicine evaluation in this cohort. Even in the absence of high-injury mechanisms, the routine usage of CT scans can result in the earlier detection of injury that would otherwise prove difficult to diagnose. Earlier management can ultimately decrease ultimate resource utilization, more rapid mobilization, and decreased fasting period, both of which are important for the prevention of delirium and other morbidities.

Despite a relatively low-injury rate, the elderly patient has the highest trauma-related mortality of any age group [101]. Elderly patients that have been injured do not have the physiologic reserve of their younger counterparts. They are less tolerant in delays of diagnosis and definitive management of their injuries. Elderly trauma patients have reported inhospital complication rates of 33% compared with 19% for younger patients [108]. Cardiovascular events (23%) and pneumonia (22%) are the most common and most clinically significant delayed complications. Prevention begins in the emergency department through aggressive evaluation coupled with timely and thorough management.

Elderly trauma patients have increased mortality for given ISS, RTS, and GCS as compared to their younger cohorts. However, as with younger patients, shock and occult hypoperfusion reliably predict mortality in the elderly trauma patient [109]. Two retrospective studies demonstrate that an elderly blunt trauma patient with a systolic blood pressure <90 mmHg was associated with mortality rates of 82% to 100% [110]. Unfortunately, preexisting conditions can mask the diagnosis as well as complicate resuscitative efforts. Specifically, heart disease and chronic kidney insufficiency can complicate the resuscitative effort, resulting in volume overload and a worsening of the clinical picture. Further compounding the resuscitative effort is the challenge of assessing the response to resuscitation. A combination of radiologic, laboratory, and clinical parameters may reflect the effectiveness of the resuscitative effort. Initial blood gas and lactic acid should be routinely measured in elderly trauma patients. Both lactic acid and base deficit correlate with systemic hypoperfusion and shock. Initial values sampled upon emergency department presentation correlate with ICU length of stay (LOS), hospital LOS, ISS, and overall mortality [111].

Vital signs can remain remarkably normal in the elderly trauma patient, especially early in their evaluation and management. This is despite the occult shock that can result in precipitous decompensation. Careful attention to stability prior to allowing a patient to leave the resuscitation area is crucial. Explanations for why the vital signs do not respond in a predictable fashion as compared to a younger cohort are multiple. Elderly patients may have significant reductions in coronary blood flow even in the absence of atherosclerotic disease which may cause demand ischemia in the setting of early hemorrhagic shock. Couple this to the exaggerated response that is seen to hypothermia, acidosis, and hypoxia in the elderly. Furthermore, as the myocardium ages, it becomes less responsive to circulating catecholamines because of beta-receptor insensitivity [112].

Under periods of stress, the circulating catecholamines are less able to produce an increase in heart rate and therefore less able to increase cardiac output to effectively compensate for blood loss. Furthermore, the elderly trauma patient has a higher likelihood of being on medications such as beta-blockers and calcium channel blockers that limit their maximal achievable heart rate below what would be expected at a given age. Because of this, emphasis on tachycardia in this cohort may curtail identification of occult shock early in the course of evaluation.

Specific Sites of Injury

In a study of prehospital data of trauma patients over age 70 presenting to the emergency department, the majority of injuries were due to fall (60.7%), followed by motor vehicle accidents (21.5%) with a combination of pedestrian struck by automobiles and penetrating injuries making up the most of the remainder [113]. Low-level falls, such as those from standing corresponds to the largest proportion of injuries in the elderly. Complications resulting from falls are the leading cause of death from injury in men and women over the age of 65. Injuries sustained by the geriatric trauma patient tend to be more significant than their younger counterparts. Specific sites of injuries tend to include head and face, pelvis, and lower extremities [111].

Head injury is a serious contributor to traumatic death in the geriatric population. Elderly patients experience a higher mortality rate as well as poorer overall functional outcomes as a result of their injuries. Traumatic brain injury (TBI) and intracranial hemorrhage (IH) are common injuries in the elderly trauma patient. Age is an independent predictor of mortality and disability in patients who have moderate to severe head trauma [114]. Compared with younger patients with equivalent or lower injury severity, the elderly have longer hospital stays, increased ICU usage, lower rates of functional recovery, and significantly higher mortality [115]. Patients older than 65 years have mortality rates two-to-five times of those younger patients with matched intracranial injuries [116].

Multiple factors contribute to the increase in morbidity and mortality in the elderly head injury patient. Brain weight decreases as a result of aging by10% between the ages of 30–70. As a result of this cerebral atrophy, bridging veins traverse a greater distance and are at a higher likelihood to rupture due to shearing forces. Cerebral atrophy also increases the amount of intracranial free space resulting in subtle symptoms and potentially delaying diagnosis of intracranial hemorrhage. In addition, the prevalence of antiplatelet and anticoagulant agents in this age group is higher, which dramatically increases morbidity associated with the traumatically brain injury [117, 118].

Blunt thoracic trauma is responsible for 25% of all trauma deaths in the United States. Two-thirds of these patients have rib fractures, and up to 35% is affected by pulmonary complications [119]. The elderly patient is more susceptible to rib fractures from a minor injury due to loss of bone density. In addition, Bulger and colleagues study of 277 patients older than 65 years of age who had rib fractures, mortality increased 19% and risk for pneumonia increased 27% for each rib fractured [119]. The elderly patient who has rib fractures is more likely to present with hypotension and has a significantly higher risk for sternal fracture. Aggressive pain management, hemodynamic monitoring, and early resuscitation are of particular importance. Control of fracture-associated pain decreases splinting and atelectasis and may limit subsequent pulmonary sequelae.

Pelvic fractures in the elderly are a distinct clinical entity. In the younger population, a pelvic fracture requires a significant amount of kinetic energy. In the elderly, however, low-energy trauma such as those from falls from standing height is the most common mechanism of injury. This is followed closely by motor vehicle collisions.

Fracture patterns are similar between younger and older trauma patients. The pubic rami are most commonly fractured (56%) followed by the acetabulum (19%) and ischium (11%) [107]. More than 50% of elderly patients with a pelvic fracture have two or more pelvic fractures. The mechanisms and clinical sequelae differ significantly in the elderly. An elderly patient with a pelvic fracture is less likely to suffer more severe vascular and solid organ injuries and yet have higher rates of mortality than younger patients with pelvic fractures. In addition, the elderly have higher rates of hemorrhage, blood and blood product transfusion, need for interventional embolization, and admission to the ICU [120, 121].

Elderly patients undergoing radiography of the cervical spine after trauma are twice as likely as their younger counterparts to have fractures diagnosed in this region. In particular, elderly patients who fall from standing height are at significant risk to injure the region between the occiput and C2 as well as to the spine in general. Given the high incidence of injuries to the atlantoaxial complex in cases of isolated head trauma, a common strategy is to pursue computed tomography of the cervical spine in any situation where an elderly patient is going to be undergoing imaging of the head for trauma.

Due to factors associated with aging such as the development of osteophytes in the cervical spine and other advanced degenerative changes, the elderly are at higher risk for development of spinal cord injuries without concomitant fractures. Specifically, the distinct clinical entities of Brown-Sequard and central cord syndrome must be carefully evaluated clinically in any senior who sustains a fall. Mechanisms for this phenomenon have been attributed to narrowing of the spinal canal, making the spinal cord more susceptible to compression in instances that result in hyperextension such as that which occurs in a fall [122].

ED Analgesia

Inadequate treatment of pain termed oligoanalgesia has become a recognized phenomenon that occurs in acute care settings. Specifically, recent work done by Quattromani and colleagues [123] has demonstrated that the elder trauma patient tends to wait on average 30 minutes longer to analgesic administration, with the average time being 92 minutes from the time of arrival to analgesic to be administered. In this study, there was no difference in morphine equivalence by age group. However, the significant delay in time-to-analgesia was interpreted by the authors of this study as being representative of oligoanalgesia. Their findings were recapitulated in the study by Jones and colleagues, where age was determined to be an independent risk factor for inadequate analgesia in the setting of acute fractures [124].

When treating pain in older adults, it is important to incorporate patient preference and goals of care. Pain treatment in older adults requires balancing the relief of symptoms with the unwanted side effects of medications. Age-related changes in metabolism can cause varying levels of increased sensitivity to opioids in the elderly. This can result in altered mental status and respiratory depression [125]. Cautious management by starting slow and titrating to the desired level of analgesia with frequent reassessment and careful simultaneous attention to patient and vital signs is paramount in the elderly. Opioid medications impair balance and make subsequent falls even more likely.

Antiplatelet/Anticoagulant

The average elder traumatic patient arrives into the emergency department taking four or more prescribed medications. Aspirin and other platelet inhibitors are commonly used for primary and secondary prevention of atherosclerotic disease.

The last decade has seen a dramatic increase in the number of older individuals on dual antiplatelet agents or oral anticoagulants (Table 3.3). Therapeutic indications are multifactorial and are outside the scope of this chapter. However, elderly trauma patients on one or more of these agents require a special mention. Bleeding in these patients is common, and so the liberal use of imaging and in some cases reversal of iatrogenic coagulopathy is indicated.

Table 3.3 Anticoagulants and potential reversal agents

Anticoagulant agent	Mechanism of action	Potential reversal agent
Warfarin	Vitamin K antagonist	FFP, PCC, vitamin K
Dabigatran	Direct thrombin inhibitor	Idarucizumab
Rivaroxaban	Factor XA direct inhibitor	PCC
Apixaban	Factor XA direct inhibitor	PCC
Enoxaparin	Antithrombin III inhibitor	Protamine
Heparin	Antithrombin III inhibitor	Protamine
Aspirin	Antiplatelet agent	Platelets
Clopidogrel	Antiplatelet agent	Platelets

Current trauma guidelines call for the uniform assessment of all patients with particular attention to the international normalized ratio (INR), prothrombin time (PT), and partial thromboplastin time (PTT). Furthermore, guidelines recommend rapid reversal of all abnormalities when indicated. However, normalization of PT or INR, which reflects the effects of warfarin but not the newer oral anticoagulants, does not always correlate with decreased bleeding. However, what has emerged is that traumatic intracranial hemorrhage when present is more profound in those individuals on antiplatelet or anticoagulants [126, 127].

Disposition

Despite the high incidence of falls, very little is known about the long-term outcome of geriatric patients who have fallen, especially if their initial workup is negative. The observed readmission rate of 5% to 10% is higher than the younger trauma patient [128]. Hall and colleagues determined readmissions were strongly associated with 6-month mortality, and home living status at the time of the fall was a predictor of 30-day readmission [129]. This is in direct contrast to other studies that demonstrated that elderly trauma patients discharged to a rehabilitation facility are more likely to be readmitted than those who are discharged to home [130]. From this conflicting set of data, what is clear is that the elderly are a heterogeneous population with a variety of comorbidities and physical limitations. Factors that should be evaluated prior to discharging the elderly trauma patient including a thorough evaluation of predisposing factors to recurrent accidental injury including polypharmacy, home situation, and its associated barriers to mobility, assessment of pain, and social support network.

The Geriatric ED

The introduction of emergency departments specializing in the care of the elderly over the past decade has increased the focus on geriatric-centered safety measures, coordination of both inpatient and outpatient services, and comprehensive care to assist patients and their families, all concurrent with typical emergency care.

Geriatric patients can pose unique challenges to medical and surgical providers. Patients with advanced age are often sicker than the average younger patient. In 2016, 14.7% of patients aged 65 or older were triaged as ESI level 1 (immediate) or level 2 (emergent), highlighting the acuity of elderly patients who present to the ED [131]. Older patients often have health histories that are more complex with aging, with the potential for multiple comorbidities, long medication lists, and nonspecific/vague complaints that lack classic features of emergent pathology. Furthermore, older patients with cognitive impairment may be unable to provide a reliable and complete history. Care of the geriatric patient therefore requires a high index of clinical suspicion and careful coordination with caregivers, family members, friends, and outpatient providers. The Geriatric ED structure supports this by tasking case managers, social workers, patient advocates, and pharmacists to partner with physician and nursing teams to evaluate clinical cases comprehensively with a patient-centered approach. This allows for safer care to be delivered in the acute care setting and can serve to streamline the care of admitted patients, as well as those patients who are discharged to the community or rehabilitation/longtime care centers.

Accreditation of Geriatric Emergency Departments

Geriatric emergency departments were first established in the United States in 2008. In 2014, The American College of Emergency Physicians, The American Geriatrics Society, Emergency Nurses Association, and the Society for Academic Emergency Medicine created a consensus guideline, with recommendations for the accreditation of Geriatric EDs [132]. The Geriatric ED guidelines are similar to recommendations made by the British Geriatrics Society in *The Silver Book: Quality Care for Older People with Urgent or Emergency Care Needs* [133]. ACEP recognized the positive impact that accredited trauma centers has had on trauma care nationally, and in 2018 ACEP launched their own accreditation process for Geriatric EDs. The ACEP Geriatric Emergency Department Accreditation awards Levels I, II, and III certification to departments that meet certain benchmarks (https://www.acep.org/globalassets/sites/geda/documnets/geda-criteria-final_1.17.2019.pdf) [134]. Currently, over 50 departments hold formal accreditation across the United States, with many more to join in the near future.

The goal of geriatric accreditation is to improve adherence to the geriatric guidelines and catalyze adoption of best geriatric-focused practices. The accreditation process provides an opportunity for emergency departments to demonstrate their commitment to these standards and their investment in optimizing the care of the older patient. Accreditation is a means of assuring that GEDs meet a set of standardized, measurable criteria, provide screening for geriatric syndromes, and provide additional resources to support safe discharge and transitions of care.

The geriatric guidelines provide a template and guidance in regards to critical issues that affect this population such as delirium, frailty, cognitive impairment, and falls; however, each GED is challenged to build upon these by producing evidence-based policies, procedures, and protocols, or adapt existing policies to meet the needs of their specific geriatric population.

Critical to the model of the Geriatric ED is a multidisciplinary team inclusive of a Medical Director, Nurse Manager, Emergency Medicine physicians, Staff Nurses, Case Managers, Social Workers, Mid-Level Providers, Occupational/Physical Therapists, and Pharmacists. Successful Geriatric EDs also ensure that these stakeholders receive geriatric-specific education and seamlessly integrate geriatrics into the ongoing quality improvement (QI) programs. Geriatric-focused QI may focus on deaths, return visits to the ED, readmissions, fall prevention, catheter use and preventing associated urinary tract infection, polypharmacy and medication reconciliation, restraints, and delirium assessment, screening for dementia, and other diseases of the elderly such as abdominal aortic aneurysms.

The clinical team can deliver care in a separate ED when available or when the general emergency department treatment areas are made more "geriatric friendly." Geriatric patients can have unique challenges to vision, mobility, behavior, incontinence, and memory; these can be supported with physical modifications and integration of geriatric supplies. The physical part may include features like chairs and stretchers that are more easily reclined/transferred from, with fabrics that are soft and moisture proof. Equipment such as bedside commodes, non-slip fall mats, natural and soft lighting, and enhanced signage can aid the care of these patients by making the clinical environment both safer and more comfortable.

Another key component of the Geriatric ED model is a formalized follow-up and transition of care system that can facilitate communication with family, providers, and long-term care facilities. The overarching goal is to ensure that at the point of entry into the hospital, geriatric patients receive focused care in an environment that attends to their unique needs. This framework of care facilitates formalized assessments by a team that approaches the patient comprehensively, allowing for overall care both inpatient and outpatient to be coordinated, safe, and more patient-centered.

Palliative Care

The World Health Organization (WHO) defines palliative care as "an approach that improves the **quality of life** of patients and their families facing the problem associated with life-threatening illness, through the **prevention and relief of suffering** by means of early identification and impeccable assessment and treatment of pain and other problems, physical, psycho-social and spiritual." [135]. Palliative care is a specialized medical care for people living with a serious illness and focuses on improving the quality of life for both patients and their families (CAPC). It is appropriate for patients of any age and at any stage in a serious illness and can be provided in conjunction with curative treatments. While timely palliative care consultations have been shown to reduce hospital length of stay [136], days in intensive care [137], and improve patient and family satisfaction [138], there are large gaps in the availability and provision of palliative care in the outpatient environment. Elderly patients with life-limiting diseases who present to the emergency department may be the subject of aggressive life-saving measures that are not in alignment with their goals of care, and it is important that measures are taken both to screen patients for unmet palliative care needs, to initiate palliative care earlier in the patient's hospitalization, to provide better symptom management, and to establish the patient's goals and healthcare preferences [139, 140]. In 2013, ACEP included the following statement in their Choosing Wisely campaign: "Don't delay engaging available palliative and hospice care services in the Emergency Department for patients likely to benefit." [141]. Geriatric patients undergoing emergency surgery for illness or trauma often have higher morbidity and mortality outcomes than those undergoing elective surgery [142], and this is where physicians can utilize effective communication with the patient to share the outcomes and possible burdens of surgical interventions, with a focus on their quality, and not just quantity of life.

Unfortunately, palliative care consultations for surgical patients are less commonly requested than those with a medical diagnosis [143], and often only as the patient is approaching end of life, when the patient might be more appropriately referred to hospice.

In the United States, hospice and palliative care (HPM) fellowship training and board certification is growing, and since the American Board of Emergency Medicine held its first HPM board certification exam in 2008, it is an increasingly common pathway following emergency medicine residency training.

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4 Cardiovascular Comorbidities in the Elderly Undergoing Surgery

Kartik Dhaduk, Ammar Athar, Gabriela Andries, Wilbert S. Aronow, and William H. Frishman

Introduction

Advancing age is associated with a reduction in the physiologic reserve of all organ systems, even in the absence of any underlying pathology. With aging there is also an associated increased prevalence of multiple comorbidities and chronic diseases as well as polypharmacy. These factors contribute to the increased likelihood of developing complications during the perioperative and postoperative periods [1–3]. This issue is increasingly important as the elderly population continues to grow. Studies have estimated that approximately 53% of all surgical procedures are performed on patients over the age of 65 [4]. In the United States alone, the elderly population (above 65 years old) has tripled over the last 50 years. It is estimated that by 2030 there will be approximately 72 million individuals >65 years of age which represents almost 20% of the US population [5]. Unfortunately, although the aging population is rising, they remain poorly represented in clinical trials which mostly include patients between the ages of 18 and 64 years. Inadequate evidence and knowledge regarding responses of geriatric patients pose a unique challenge for physicians when evaluating this population prior to major operative procedures [6].

Cardiac disease is undoubtedly the most common comorbid condition in the elderly. Up to 80% of patients over 80 years old have identifiable cardiovascular diseases, which account for 40% of mortality. The age-related cardiovascular physiologic changes involve structural remodeling such as increased vascular intimal thickness and stiffness, less compliance from increased left ventricular wall thickness, modified contractile behavior, interstitial fibrosis, increased left atrial stiffness, altered regulation of the vascular tone, and a reduced responsiveness to beta-adrenergic modulation [1]. These physiologic changes subject the elderly to a substantially higher risk of adverse cardiovascular events related to the stress of surgery, blood loss, potential fluid and electrolyte shifts, drug-drug interactions, and the effect of anesthetic and analgesic agents during the perioperative period [4]. A preoperative evaluation of geriatric patients must be based on a thorough understanding of the patient's physical and functional status to allow the implementation of an appropriate perioperative care plan which aims to reduce risk and delay in recovery [5]. In this chapter, we will review common cardiovascular comorbidities and the pre- and perioperative

K. Dhaduk
Cardiology Division, Department of Medicine, Westchester Medical Center and New York, Valhalla, NY, USA

A. Athar · G. Andries · W. S. Aronow
W. H. Frishman (✉)
Cardiology Division, Department of Medicine, Westchester Medical Center and New York Medical College, Valhalla, NY, USA
e-mail: William.Frishman@wmchealth.org

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Table 4.1 Perioperative management of cardiovascular medications

Beta-blockers	Angiotensin converting enzyme inhibitors/ angiotensin receptor blockers (ACEI/ARB)	Calcium channel blockers	Diuretics
Continue beta-blockers for patients already taking them (class I)	It is reasonable to continue therapy perioperatively within patients with stable left ventricular heart failure (class IIa)	Insufficient evidence to recommend for or against the use of these agents perioperatively	Continue if needed for management of volume overload
It is reasonable to initiate beta-blockers >1 day prior to surgery for patients considered to be intermediate-high preoperative risk or for those that have three or more cardiovascular risk factors as per the Revised Cardiac Risk Index (class IIb)	It is reasonable to hold therapy 1 day prior to surgery in the absence of heart failure or unstable hypertension (class IIa)	Calcium channel blockers have been associated with postoperative bleeding presumably due to inhibition of platelet aggregation	Consider dose reduction in the presence of hypovolemia, hypotension, or electrolyte abnormalities
Statins	Nitrates	Alpha-2 agonists	Antiarrhythmics
Continue for patients already on treatment (class I)	Prophylactic intravenous nitroglycerin is not effective in reducing myocardial infarction in patients undergoing noncardiac surgery (class III)	Prophylactic use not recommended in patients undergoing noncardiac surgery (class III)	Amiodarone: continue for stable, monomorphic ventricular tachycardia
Preoperative initiation is reasonable in patients undergoing vascular surgery (class IIa)		Avoid abrupt discontinuation as it may result in rebound hypertension, headache, agitation, and tremor	Continued for sustained polymorphic ventricular tachycardia if no long QT syndrome
Preoperative initiation may be considered in patients with clinical conditions who are undergoing elevated risk procedures (class IIb)		Isoproterenol: reasonable to continue for torsades de pointes with recurrent pauses	

strategies that may help to modify surgical morbidity and mortality. Specific guidelines regarding particular cardiovascular medications are summarized in Tables 4.1 and 4.2 [7–13].

Systemic Hypertension

Background

Hypertension (HTN) is known to increase the risk of cardiovascular events, bleeding, cerebrovascular accidents, and mortality in the peri- and postoperative period [14]. It predisposes patients to a variety of systemic changes such as cardiovascular remodeling resulting in congestive heart failure, chronically elevated blood pressure causing renal impairment, and coronary and cerebrovascular occlusive disease increasing the risk for ischemic events. Existing hypertension is considered by most medical practitioners when determining whether or not to proceed with noncardiac surgery and is often the culprit for delaying procedures. In 2001, a meta-analysis of 30 studies found that 25% of patients undergoing major noncardiac surgery have perioperative hypertension and that this increases their risk of cardiovascular complications by 35%. In addition, induction of anesthesia can result in sympathetic inhibition and loss of the baroreceptor reflex, contributing to intraoperative blood pressure lability, which may increase the risk of myocardial ischemia [15]. While patients with untreated

Table 4.2 Antiplatelet and anticoagulation recommendations

Antiplatelet therapy (aspirin, clopidogrel, prasugrel, ticagrelor, cangrelor)		
Patients without coronary stents	*Patients with coronary stents*	
In patients who have received coronary stents and must undergo surgical procedures that require the discontinuation of P2Y12-inhibitors, it is recommended that aspirin be continued if possible and the P2Y12-inhibitor be restarted as soon as possible after surgery (class I)	Elective noncardiac surgery should be delayed 30 days after bare metal stent (BMS) and 6 months after drug-eluting stent (DES) placement (class I)	
In patients with no prior history of stenting and undergoing nonemergency/nonurgent noncardiac surgery, it may be reasonable to continue aspirin when the risk of potential cardiac event outweighs risk of bleeding (class IIb)	Elective noncardiac surgery after DES implantation in patients taking P2Y2-inhibitor may be considered after 3 months if risk of delay of surgery > risk of stent thrombosis (class IIb)	
	Elective noncardiac surgery should not be performed within 30 days after BMS implantation or within 3 months after DES implantation in patients in whom dual antiplatelet therapy will need to be discontinued perioperatively (class III)	
Anticoagulation		
Nonvalvular atrial fibrillation	*Bridging therapy*	*Prosthetic heart valves*
Direct-acting oral anticoagulants	*Bridging indicated*	*Unfractionated heparin* (UFH)
Interrupt therapy for all procedures for a duration based on the estimated creatinine clearance	Low thrombotic risk (risk <5%/year, CHA2DS2-VASc score ≤4 and no prior history of ischemic stroke, transient ischemic attack (TIA) or venous thromboembolism (VTE))	No substantiated specific recommendation currently exists regarding anticoagulation for prosthetic heart valves in the perioperative period
	Prior cerebrovascular accident (stroke, TIA) with no bleed risk	Available evidence seems to favor the use of UFH with further clinical trials ongoing
Vitamin K antagonist (warfarin)	High thrombotic risk (risk >10%/year, CHA2DS2-VASc score of >7, stoke, TIA, or VTE within last 3 months) consider bridging	*Mechanical mitral valve*: recommend perioperative anticoagulation bridging regardless of any risk factors for thromboembolism
Do not interrupt in patients undergoing procedures with no or low bleeding risk and absence of patient-related factors that increase the risk of bleeding	*Bridging NOT indicated*: moderate thrombotic risk with increased risk of bleeding	*Aortic valve*: recommend bridging if one of more additional risk factors (such as atrial fibrillation, previous thromboembolism, left ventricular dysfunction, hypercoagulable condition, or an older generation prosthetic aortic valve) are present
Interrupt therapy for procedures with intermediate or high bleed risk or uncertain bleed risk but with presence of patient-related factors that increase the risk of bleeding	No history of prior stroke, TIA, or VTE with no bleed risk	

hypertension have been found to have an exaggerated responses to the induction of anesthesia, patients with well-controlled preexisting hypertension were shown to respond similarly to those without hypertension [16] seemingly favoring treatment of perioperative hypertension. In regard to the geriatric population, Williamson et al. recommend targeting a perioperative blood pressure of less than 130/80 mmHg prior to surgery.

Perioperative Guidelines

Despite such reports of increased risk, existing guidelines for the management of perioperative hypertension more or less agree that mild to moderate preexisting hypertension is not a major contributor to increased intraoperative cardiovascular mortality. The American College of Cardiology/American Heart Association (ACC/AHA) Guidelines list uncontrolled hypertension as a minor perioperative risk factor [17] as most patients are not at an increased risk of intraoperative complications in the absence of severe hypertension, abnormal renal function or electrolyte abnormalities [18]. The European Society of Cardiology/European Society of Anesthesiology (ESC/ESA) guidelines recommend patients with new hypertension be screened for evidence of end organ damage in the perioperative period. Their recommendation is supported by the fact that end organ damage as evidenced by congestive heart failure or renal insufficiency significantly increases the probability of adverse cardiac outcomes [17]. In terms of postponement of surgery, the American and European guidelines seem to be in agreement for delaying elective surgery in the presence of severe hypertension as defined by systolic blood pressure >180 mmHg or diastolic blood pressure >110 mmHg [7, 8]. Isolated systolic hypertension has been known to produce a 40% increase in perioperative cardiovascular events [19], while diastolic pressure greater than 110 mmHg in the perioperative period has been associated with myocardial ischemia, infarction, dysrhythmias, neurologic complications, and renal failure [20]. Patients with diastolic blood pressure less than 110 mmHg were not found to be at increased operative risk [21]. See Table 4.3 for current recommendations [7–9].

Table 4.3 Hypertension recommendations

Mild-moderate (systolic blood pressure <180 or diastolic blood pressure <110)	Reasonable to proceed with surgery without initiating antihypertensive medication
	Treatment for hypertension may be started postoperatively after recovery
Severe (systolic blood pressure >180 or diastolic blood pressure >110)	Elective/urgent surgery: delay surgery until hemodynamic stability is achieved with medications
	Emergent surgery: proceed with surgery as the risks of postponement outweigh the benefit of treatment

Beta-Blockers

Although beta-blockers have been known to reduce the risk of intraoperative myocardial ischemia in untreated hypertensive patients [22], their initiation in the immediate perioperative period has been questioned by a higher rate of mortality (3.1% vs. 2.3%) and stroke (1% vs. 0.5%) [17]. The beneficial effects of beta-blockers likely stem from their ability to delay cardiovascular remodeling, thus delaying the development of significant perioperative risk factors such as advanced heart failure and progressively worse aortic stenosis. Both the ACC/AHA and ESC/ESA take a similar position recommending against initiation of a beta-blocker in the perioperative period [23] based on the evidence presented in the POISE trial [24]. Both the American and European guidelines also agree that beta-blockers should be continued perioperatively in patients already taking the medication. This is further supported by the finding that beta-blocker withdrawal in patients with underlying coronary artery disease can result in heightened angina, myocardial infarction, or sudden death. In patients already receiving beta-blockers, stopping treatment perioperatively was associated with a significant increase in postoperative mortality (50% vs. 1.5%) [25].

In patients with intermediate or high preoperative risk (Revised Cardiac Risk Index (RCRI) >3), the ACC/AHA recommends initiation of beta-blockers preoperatively at least 24 hours prior to surgery similarly to the Canadian Cardiovascular Society (CCS) Guidelines [9] and to the ESC/ESA guidelines which advise against perioperative initiation of beta-blockers in patients undergoing low-risk surgery [8].

Angiotensin Converting Enzyme (ACE) Inhibitors/Angiotensin Receptor Blockers (ARBs)

Currently available data suggest a lack of conclusive evidence to support absolute continuation or discontinuation of ACE inhibitors or ARBs in the perioperative period. The American, Canadian, and European guidelines appear to have reached a consensus that it is reasonable to hold ACE inhibitors and ARBs 1 day prior to surgery in the absence of heart failure or inadequately treated hypertension. One study of 150 vascular surgery patients found that the incidence of hypotension during anesthesia induction was significantly lower in patients who stopped taking captopril or enalapril on the evening before surgery compared to those who took the medication on the morning of surgery [10]. A higher incidence of severe hypotension has also been reported in patients who undergo general anesthesia taking an ARB. The European guidelines, however, defer slightly in their recommendations by advising continuation of ACEI/ARB under close monitoring in stable patients with left ventricular systolic heart failure [14].

Calcium Channel Blockers

Cardiovascular society guidelines are unanimously unable to recommend the use of calcium channel blockers perioperatively due to a lack of substantial evidence. Although preoperative use of diltiazem has been shown to reduce the risk of death and/or myocardial infarction [26], large-scale trials to demonstrate the efficacy of verapamil and dihydropyridines are lacking. In addition, calcium channel blockers have been associated with an increased incidence of postoperative bleeding presumably due to an inhibition of platelet aggregation [27].

Clonidine

The ACC/AHA, ESC/ESA, and CCS guidelines unanimously advise against the use of alpha-agonists perioperatively largely due to the findings of the POISE-2 trial which demonstrated an increased rate of nonfatal cardiac arrest and lack of reduction in death with perioperative clonidine use [11].

Diuretics

Though evidence in the current literature is limited, the ESC/ESA guidelines suggest that perioperative use of diuretics up to the day of surgery is reasonable in the management of volume overload. However, dose reduction and/or discontinuation of diuretics should be considered in the presence of hypovolemia, hypotension, or electrolyte disturbances as the use of diuretics in these conditions may increase the risk of hypokalemia, anesthesia-related complications, and cardiac arrhythmias [8].

Heart Failure

Background

Heart failure (HF), a cardiovascular syndrome usually defined by the presence of dyspnea, edema, fatigue, and/or decreased ventricular function [7], is playing an increasingly common role in preoperative risk assessment. With advances in available medical therapy and the development of more effective assistive devices, many adults who may have previously succumbed to the complications of HF are now progressing to an advanced age [28]. In fact, heart failure (HF) has been found to be present in as much as 20% of older adults undergoing surgery in the United States [29] and has been identified as a major risk factor for adverse cardiac events following noncardiac surgery [30]. Elderly patients with HF undergoing surgery have also been found to be at higher risk of hospital readmission and postoperative mortality as compared to those with coronary artery disease undergoing similar procedures [29]. It is thus prudent to identify which patients warrant further investigation when considering HF as an independent risk factor for those undergoing noncardiac surgery.

Risk Assessment

The clinical assessment of left ventricular (LV) function in patients with new or existing HF is paramount in the perioperative period and may significantly impact the postoperative outcome. Patients with newly diagnosed heart failure with reduced LV function are known to be at higher risk than those with existing HF [31] with an increase in postoperative risk with lower left ventricular ejection fraction (LVEF) [32, 33]. It is also important to identify certain clinical features such as hypotension, persistent tachycardia, worsening renal function, hyponatremia, history of multiple implantable cardioverter defibrillator (ICD) shocks, or recent hospitalizations as these are associated with worse short-term survival in patients with reduced LVEF [34]. Existing guidelines appear to support the role of perioperative LV assessment for patients with suspected HF or clinical evidence of worsening HF [7, 8]; however, the American and Canadian guidelines recommend against routine assessment of LV function for patients without heart failure [7, 9]. Although the ACC/AHA guidelines do not support the measurement of natriuretic peptides in perioperative LV assessment, the European and Canadian guidelines stated that measurement of natriuretic peptides is an acceptable method of LV assessment with the CCS guidelines specifically highlighting patients 65 years of age or older as appropriate candidates [9]. This recommendation is supported by a study in 2013 that found brain natriuretic peptide (BNP) or N-terminal prohormone BNP (NT-proBNP) levels may be helpful in identifying patients at higher risk for adverse outcomes when the diagnosis of HF is unclear [35].

Perioperative Medical Management of HF

The ESC/ESA guidelines are unique in that they advocate patients with existing HF undergoing intermediate or high-risk surgery be therapeutically optimized with medical management and that patients with newly diagnosed HF postpone surgery for at least 3 months to allow time for initiation and optimization of medical therapy [8]. This recommendation was corroborated and expanded upon by studies that support delaying elective surgery for at least 1 month for patients with decompensated heart failure with reduced ejection fraction (HFrEF) or new HF with preserved ejection fraction (HFpEF) or delaying urgent surgery by a couple of days to allow for medical optimization [31, 34]. See Table 4.4 for a summary of current recommendations [7–9].

Beta-Blockers

The ACC/AHA and ESC/ESA guidelines agree that patients including those with existing heart failure who are already receiving beta-blockers should continue them in the perioperative period [7, 8]. However, beta-blockers should not be initiated perioperatively as the beneficial effects of

Table 4.4 Heart failure recommendations

Risk assessment	Asymptomatic/HF not suspected: recommend against evaluation of LV function
	Symptomatic/suspected, existing or worsening HF: recommend assessment of LV function with echocardiography or if not feasible, BNP/NT-proBNP level
Perioperative management	Low-risk surgery: reasonable to proceed with surgery
	Intermediate-/high-risk surgery: recommend optimization of HF with medical therapy prior to surgery
	Newly diagnosed HF: recommend postponing nonemergent surgery for at least 3 months to allow for medical optimization
	Decompensated HF: recommend postponing nonemergent surgery for at least 1 month to allow for medical optimization

therapy can take weeks or months to manifest whereas the potential effects of intraoperative hypotension would be immediate.

ACE Inhibitors/ARBs

While all existing guidelines consider it reasonable to hold ACE/ARB in the perioperative period in order to reduce the risk of intraoperative hypotension, the European guidelines state that ACE inhibitors or ARBs may be given safely up until the night prior to the day of surgery [8].

Mineralocorticoid Receptor Antagonist

There is currently a lack of substantial evidence to support the use of these medications in the perioperative period, and we therefore advise deferring initiation of mineralocorticoid receptor antagonists until after surgery.

Digoxin

The role of digoxin is not well defined in the perioperative period, but it is reasonable to consider as an adjunct to other therapies in patients with HFrEF with persistent symptoms in the absence of renal failure.

Diuretics

These agents are recommended for HF patients with signs and symptoms of volume overload.

Arrhythmias

Background

Arrhythmias and conduction disorders are an increasingly common finding among the elderly population. The presence of symptomatic arrhythmias may indicate an increased risk of mortality and should be considered in the preoperative evaluation of patients undergoing noncardiac surgery. High-grade AV blocks, symptomatic ventricular arrhythmias, and supraventricular arrhythmias with uncontrolled ventricular rate are known to be major predictors of an increased perioperative risk [36]. Aberrant rhythms such as atrial fibrillation and ventricular tachycardia often signifies underlying heart disease and therefore merits evaluation in the perioperative period [8] no differently than they would in a patient not undergoing surgery. During preoperative risk stratification, the emphasis lies in identification and correction of reversible causes such as electrolyte abnormalities, acid-base disorders, or decompensated heart failure [28] as the use of antiarrhythmic drugs is not recommended in the absence of hemodynamic instability.

However, in the case of asymptomatic patients, evidence is not in favor of further evaluation during the perioperative period as patients with intraventricular conduction delays with or without the presence of bundle branch blocks were rarely found to progress to complete AV block during this time [37]. Furthermore, one study utilizing continuous electrocardiogram (EKG) found that ventricular arrhythmias including couplets and non-sustained ventricular tachycardia (NSVT) were not associated with an increase in adverse cardiac events after noncardiac surgery [38].

Perioperative Guidelines

The ACC/AHA guidelines are limited in their recommendations regarding the management of arrhythmias and conduction abnormalities in the perioperative period citing a lack of substantial evidence to support or oppose specific treatment modalities. They instead focus on the management of patients with cardiovascular implantable electronic devices (CIEDs) and advocate the early involvement of a designated clinical team to oversee the function of the CIED perioperatively and if need be during the procedure [7].

The ESC/ESA guidelines offer more specific recommendations based on the nature of the involved arrhythmia. In the presence of supraventricular tachycardia (SVT), the European guidelines advise continuation of oral antiarrhythmic drugs prior to surgery as well as electrical cardioversion if the patient is hemodynamically unstable [8]. For patients with bradyarrhythmias, there is no difference in the indications for temporary pacemakers during the perioperative period when compared to criteria for placement of permanent pacemakers. The ESC/ESA also advocate the presence of external defibrillation equipment in patients whose ICDs were deactivated preoperatively. In regard to ventricular tachycardia (VT), the European guidelines recommend continuation of any oral antiarrhythmic drugs especially in patients with sustained VT [8].

Atrial Fibrillation/Flutter

Paroxysmal atrial fibrillation (AF) can be seen in approximately 10% of elderly patients in the community with incidence of chronic AF doubling with each decade of life after 60 years of age [28]. Both the American and European guidelines currently advocate the preoperative treatment of atrial fibrillation if the patient experiences hemodynamic instability. Beta-blockers have been shown to facilitate the conversion of AF to sinus rhythm after noncardiac surgery [39] and are thus the treatment of choice along with nondihydropyridine calcium channel blockers [40]. Amiodarone is the preferred agent in patients with heart failure as digoxin has been found to be ineffective during surgery. In addition, preoperative catheter ablation may be reasonable in patients with Wolff-Parkinson-White syndrome and preexcitation [8] based on the urgency and risk category of the planned procedure.

Recently revised ACC guidelines (2017) regarding perioperative bridging for patients with atrial fibrillation take into consideration both the type of anticoagulation the patient is already receiving as well as the future bleeding risk and thrombotic risk [12]. Bleeding risk is defined by the presence of at least one of the following factors: platelet abnormalities including aspirin use, major bleed or intracranial hemorrhage <3 months, supratherapeutic INR, or bleeding as the result of previous bridging. Thrombotic risk is assessed using CHADs-VASc with a score 1–4 corresponding to low risk, 5–6 moderate risk, and >7 high risk. Patients on a direct oral anticoagulants (DOAC) or patients on warfarin with CHADs-VASc <5 do not require bridging, and anticoagulation can simply be held for the procedure. Patients receiving warfarin with CHADs-VASc >7 without increased bleeding risk should receive periprocedural bridging with UFH or low molecular weight heparin (LMWH). Patients on warfarin with CHADs-VASc >5 and at least one increased bleeding risk factor are subject to individualized clinical judgment when determining the appropriateness of bridging anticoagulation.

Bradyarrhythmias

Patients with high-grade conduction abnormalities and symptomatic bradycardia may require perioperative temporary pacemaker placement [28] as unexpected complete atrioventricular block may increase operative risk [41] if necessary pacing equipment is not readily available during the procedure. Although prophylactic pacing prior to noncardiac surgery is not always indicated, preoperative temporary pacing may be beneficial in patients with prior symptomatic asystolic episodes [8]. We recommend having transvenous or transcutaneous pacing equipment on standby during the procedure in the event of intraoperative complete heart block.

Supraventricular Tachycardia (SVT)

According to the ESC/ESA guidelines, beta-blockers, calcium channel blockers, or amiodarone can be safely used as prophylactic treatment where needed in the perioperative management of SVT [8].

Ventricular Arrhythmias

Although considered general risk factors of development of arrhythmias, premature ventricular contractions and NSVT have not been shown to increase the risk of nonfatal MI or cardiac death in the perioperative period [38, 42]. Current evidence does not indicate a worse prognosis with these rhythm aberrancies [8].

Perioperative management of sustained monomorphic VT consists of intravenous amiodarone for hemodynamically stable patients [43] and electrical cardioversion in the presence of hemodynamic compromise [8].

For patients with hemodynamically stable, sustained polymorphic VT, amiodarone is an acceptable treatment option in the absence of the long QT syndrome [43]. Current evidence supports the use of magnesium sulfate for patients with the long QT syndrome and torsades de pointes [44]. In patients with torsades de pointes and concurrent sinus bradycardia, the use of beta-blockade with temporary pacing is advised with isoproterenol reserved for use in patients with recurrent, pause-dependent torsades de pointes without congenital long QT syndrome [43].

Cardiac Implantable Electronic Device (CIED)

Pre-procedural planning and evaluation of implantable cardiac devices are crucial steps during the perioperative period to prevent adverse cardiac events related to conduction abnormalities and device malfunction as the use of electrocautery during surgery may interfere with device function. The management of CIEDs must be individualized based on the exact type of device and is ideally conducted by a multidisciplinary team consisting of electrophysiologists and device manufacturer technicians. The Heart Rhythm Society (HRS) recommends pre-procedure device interrogation within 6 months of surgery for an ICD, 12 months for a PPM, and 3–6 months for a cardiac resynchronization (CRT) device [45] in order to ensure appropriate device functioning prior to surgery. This assessment should be performed perioperatively in order to confirm appropriate device programming and function based on the patient's underlying rhythm [45–52]. In the event of an emergent surgery, a magnet may be placed over the device for reprogramming in the presence of a trained cardiologist who can interpret EKG recordings to evaluate the device backup mode and function. Pacemakers should be switched to a non-sensing mode with pacemaker interrogation following surgery. If the use of electrocautery is planned during surgery, the ICD should be turned off intraoperatively and switched back on during post-op recovery [8]. See Table 4.5 for a summary of current recommendations [7–9, 43, 45].

Coronary Artery Disease (CAD)

The stress related to noncardiac surgery has many physiological effects on the body with regard to the cardiovascular system resulting in tachycardia, high blood pressure, and an increased free fatty acid concentration. These changes in turn increase myocardial oxygen demand and may precipitate ischemic heart disease [53, 54].

Patients with risk factors for CAD, known CAD or poor exercise capacity, need to be evaluated for perioperative cardiovascular risks. The role of the 12-lead EKG is limited but reasonable in patients with known CAD [7]. The perioperative assessment of left ventricular function with echocardiography may have a role in heart failure patients but not necessarily in CAD assessment [7]. Stress tests such as an exercise EKG, dobutamine echocardiography, or treadmill test are dynamic tests that have a valuable role in assessing a patient's ability to tolerate external stress. Stress tests can evaluate the ischemic threshold of the myocardium and localize CAD with regard to the amount of threatened myocardium with an excellent negative predictive value (95–100%) although the positive predictive value is limited (20–30%) [55]. The ACC/AHA 2014 guidelines recommend the use of noninvasive stress tests for patients with elevated cardiovascular risk and unknown or poor exercise capacity if it will change management. It is reasonable to forgo further exercise testing in patients with an elevated risk if the patient reports good (≥10 metabolic equivalent of task (METs)) or moderate to good functional capacity (≥4 METs to 10 METs). Relatively newer cardiovascular diagnostic modalities such as coronary calcium scores, CT angiography, and cardiac MRI continue to expand

Table 4.5. Arrhythmia recommendations

Atrial fibrillation (AF)	*Elective/urgent surgery*
	Proceed with surgery if hemodynamically stable
	Preoperative medical treatment indicated if hemodynamic stability is compromised
	Consider catheter ablation if Wolff-Parkinson-White
	Emergent surgery
	Consider electrical cardioversion if hemodynamically unstable
Anticoagulation	*Patients taking DOAC*
	Hold therapy. No indication for bridging anticoagulation
	Patients taking warfarin
	If CHADs-VASc <5, hold warfarin, no need for bridging
	If CHADs-VASc >7, hold warfarin, begin bridging anticoagulation with LMWH or UFH
Bradyarrhythmias	*Asymptomatic*: prophylactic pacing not indicated
	Symptomatic asystolic episodes: recommend transvenous/transcutaneous pacing equipment on standby intraoperatively
Supraventricular tachycardia	Treatment required only for hemodynamic instability
Ventricular arrhythmias	*Premature Ventricular Contractions (PVCs)/NSVT*: preoperative treatment not required
	Sustained monomorphic VT
	If hemodynamically stable, treat with IV amiodarone
	If hemodynamically unstable, electrical cardioversion
	Sustained polymorphic VT
	If no long QT syndrome, treat with IV amiodarone
	If suspected long QT syndrome, treat with IV magnesium
	Torsades de pointes (TdP)
	If concurrent sinus bradycardia, recommend temporary pacing
	If TdP only with recurrent pauses, can use isoproterenol
Cardiac implantable electronic devices	Recommend pre-procedure interrogation of device by a cardiologist to confirm proper settings and function
	Permanent pacemaker: expert interrogation within 12 months of surgery
	Device should be switched to non-sensing mode intraoperatively and interrogated postoperatively
	Implantable cardiac defibrillator
	Expert interrogation within 6 months of surgery
	If electrocautery use is planned, device should be turned off intraoperatively and switched on during recovery
	Cardiac resynchronization therapy: expert interrogation within 3–6 months of surgery

our ability to monitor different stages of ischemic heart disease [56]. The widespread use of these modalities still requires further study to establish efficacy and cost-effectiveness.

The evaluation of exercise capacity is vital in the perioperative assessment of elderly patients in order to determine whether further investigation is warranted. Metabolic equivalents (METs) is an objective method to describe the functional capacity or exercise tolerance where one MET is equivalent to a resting or basal oxygen consumption of a 40-year-old 70 kg man [57]. For example, daily living activities such as dressing, eating, and toilet use are equivalent to one to two METs, and sports activities such as swimming, singles tennis, and football require more than ten METs. The number of METs associated with the normal physiological stress level of most noncardiac surgeries with general anesthesia is four to five METs and can be correlated to a patients' capacity to walk four blocks or climb two flights of stairs without stopping due to limiting symptoms. Studies have shown patients with METs less than 4–5 are at increased perioperative cardiovascular risk [7]. One study with 600 participants reported association of major perioperative cardiovascular events with poor functional capacity (<4 METs) [58]. The objective assessment of exercise capacity is crucial as a study with 5939 patients found the subjective assessment of exercise capacity has minimal to poor correlation in prediction of cardiovascular complications and mortality [59]. The Duke Activity Status Index is a standardized 12-questionnaire-based index for functional status assessment, and studies have demonstrated that it correlates well with gold standard measures of functional capacity [60, 61].

According to the major perioperative cardiology guidelines [7, 8], there is no role for routine coronary revascularization prior to noncardiac surgery to reduce perioperative cardiac events [62]. If the perioperative ischemic work-up findings are significant and suggestive revascularization per existing guidelines, then coronary revascularization is recommended before planned major noncardiac surgery. Studies have shown reduced risk with intervention and better outcomes with coronary artery bypass graft (CABG) than percutaneous coronary intervention (PCI) [63]. For patients on dual antiplatelet therapy, it is recommended to delay noncardiac surgery for 2 weeks after balloon angioplasty, at least 30 days after bare metal stent (BMS) placement and 6 months after drug eluting stent (DES) placement. The risk of stent thrombosis is less with newer generation drug eluting stents. The updated guidelines for perioperative dual antiplatelet therapy (DAPT) have a class I recommendation to proceed with surgery if it is greater than 6 months post-DES implantation and class IIb recommendation to operate if 3–6 months have passed since DES implantation if the risk of delaying surgery is higher than the risk of stent thrombosis. Asymptomatic patients who have undergone CABG in the past 6 years can undergo elective or nonurgent noncardiac surgery without further angiographic evaluation except for patients with a high perioperative risk.

Several studies have reported on the prognostic use of postoperative elevation of troponin and BNP in predicting higher short-term mortality [64–66]. A prospective Vascular Events In Noncardiac Surgery Patients Cohort Evaluation (VISION) trial with 15,000 patients reported that age >75 years and troponin ≥0.04 are independent risk factors of 30-day mortality [65]. ACC/AHA guideline [7] for perioperative management recommends checking troponin and EKG in the setting of probable myocardial ischemia or infarction, but doing so in high-risk patients regardless of symptomatology is of uncertain value. Routine measurement of troponin levels in asymptomatic patients is not useful. Perioperative medication management is also crucial for better outcomes. A major trial for the use of perioperative aspirin (POISE 2 trial) [67] showed no benefit in outcomes including death or nonfatal MI (7.0% vs. 7.1%, $p = 0.92$) even in subgroup analysis, regardless of Revised Cardiac Risk Index (RCRI) score or aspirin use prior to randomization. However, it does increase the risk of major bleeding (4.6% vs. 3.8%, $p = 0.04$). A case-controlled study including 2816 patients undergoing major vascular surgery reported a lower adjusted odds ratio 0.22 (95% confidence interval 0.10–0.47) for perioperative mortality among statin users as compared with nonusers [68]. A study including 1163 patients of a predominantly elderly population showed a significant protective effect of statin use (odds ratio 0.52, $p = 0.001$) on various cardiovascular complications [69]. Another study with 577 elderly patients undergoing noncardiac vascular surgery reported significantly reduced perioperative MI or mortality rates in statin users compared to patients not on a statin (11% vs. 27%, $p < 0.0001$) [70]. The major guidelines [7, 8] recommend continuous perioperative use of statins in clinically indicated cases and initiation of statin therapy before vascular surgery. A propensity-matched study using perioperative beta-blockers reported a reduced mortality rate among high-risk patients (RCRI >2) undergoing major noncardiac surgery [71]. A randomized control study across 23 countries

(POISE trial) [72], with nearly 50% of the population age >70 years, showed beneficial effect of metoprolol use in MI (4.2% vs. 5.7%, $p = 0.0017$) within 30 days postoperatively. The same study also showed a higher incidence of stroke in the metoprolol group than with a placebo (1% vs. 0.5%, $p = 0.0053$) and higher mortality (3.1% vs. 2.3%, $p = 0.0317$). Thus, the utility of perioperative beta-blocker therapy remains questionable, but it is recommended not to withhold perioperative beta-blockers in the absence of bradycardia or hypotension. Patients with known ischemic heart disease who are at high risk for perioperative MI or those with ≥3 RCRI risk factors may benefit from starting a beta-blocker perioperatively. However, it would be reasonable to initiate beta-blocker therapy more than 1 week prior to surgery to determine safety and tolerability [7]. See Table 4.6 for a summary of current recommendations [7–9].

Dyslipidemia

Hypercholesterolemia is associated with various cardiovascular diseases. High total serum cholesterol, high low-density lipoproteins (LDL), or low high-density lipoproteins (HDL) have been reported as a strong risk factor for atherosclerosis and coronary events [73–75]. Aronow and colleagues reported the impact of HDL level on new coronary events in elderly patients as decrease of every 10 mg/dl of serum HDL cholesterol would increase the event rates by 1.7 times in men (at 40-month follow-up) and 1.95 times in women (at 4-year follow-up) [73].

Erosions and rupture of the coronary plaques are the primary precipitants of acute coronary events in the operative and nonoperative setting [76]. Statins have anti-inflammatory and plaque-stabilizing properties in addition to cholesterol-lowering property. A 6-month follow-up study

Table 4.6 Coronary artery disease recommendations

Risk assessment	*Exercise capacity*
	Poor functional capacity (<4 METs) is associated with major perioperative cardiovascular events
	Objective assessment of exercise capacity is crucial; subjective assessment of exercise capacity has minimal to poor correlation in prediction of cardiovascular complications and mortality
	12-lead EKG: reasonable in patients with known CAD
	Echocardiography: no role in preoperative CAD assessment
	Stress test: recommend in patients with elevated cardiovascular risk and unknown or poor exercise capacity if it will change management
	It is reasonable to forgo further exercise testing evaluation in patients with elevated risk if the patient has good (≥10 METs) or moderate to good functional capacity (≥4 METs to 10 METS)
	Coronary calcium scores, CT angiography, cardiac MRI: further randomized controlled trials are needed to evaluate the role in perioperative evaluation
Perioperative management	*Role of pre-op angiography and interventions*
	If perioperative ischemic work-up warrants revascularization per existing guidelines, then coronary revascularization is recommended
	No role for routine pre-op coronary revascularization
	Asymptomatic patients who have undergone coronary bypass graft (CABG) in the past 6 years can undergo elective or nonurgent, noncardiac surgery without further angiographic evaluation except for patients with high perioperative risk
	Checking biomarkers: routine measurement of troponin levels in asymptomatic patients is not useful
	Low-intermediate-risk patients: recommend checking troponin and EKG in the setting of probable myocardial ischemia or infarction
	High-risk patients: checking troponin and EKG regardless of symptomatology is of uncertain evidence

(with >66% patients with age >65 years) on postoperative cardiovascular outcomes after vascular surgery comparing placebo group to patients on atorvastatin showed three times higher incidence rate of cardiac events in placebo group (26% vs. 8%, $p = 0.018$) where statins were started on average of 30 days prior to surgery [77]. The major studies on fluvastatin [78, 79] also reported the cardiovascular benefit of statin in the perioperative period of noncardiac surgery. A study comparing 577 elderly patients (mean age 74 years) undergoing noncardiac vascular surgery treated with and without statins reported significant positive impact of statin on lowering perioperative MI rate (6% vs. 14%, $p = 0.001$) and 2-year mortality rate (6% vs. 16%, $p = 0.0002$), showing patients using statins had 57% lesser odds of perioperative MI or death at 2-year follow-up after controlling for other variables [68]. While studies have shown positive results of statin in the perioperative period, a prospective study comparing postoperative cardiac outcomes after continuing or discontinuing the chronic statin therapy after major vascular surgery (infrarenal aortic surgery) was done which showed that the discontinuation of postoperative statin (>4 days) was an independent predictor of postoperative cardiac myonecrosis (OR 2.9, 95% confidence interval 1.6–5.5) [80].

Current perioperative guidelines from ACC/AHA recommend continuing the statin therapy in patients currently taking it as a class I recommendation. It is reasonable to begin the perioperative statin in patients undergoing the vascular surgery, and perioperative initiation of statins may be considered if a patient has clinical indications according to the guideline and undergoing high-risk surgeries. During the perioperative period, statins with the longer half-life (e.g., atorvastatin) or extended release formulations (e.g., lovastatin) are preferred as a bridge immediately post-surgery when oral intake is not feasible [7, 8]. The main concern for the statin use is a side effect profile which includes muscle damage. Due to multiple factors perioperatively such as renal function impairment after major surgery and anesthetic drug use that may increase the risk of statin-induced myopathy, early initiation of the statin is recommended to detect and manage the potential side effects. If the statin-naive patient is undergoing vascular intervention, the statin should ideally be started at least 2 weeks prior to the procedure for a maximal plaque-stabilizing effect and should be continued at least 1-month post-intervention [7, 8]. See Table 4.7 for a summary of current recommendations regarding dyslipidemia and peripheral arterial disease [7–9].

Table 4.7 Dyslipidemia and peripheral arterial disease

Dyslipidemia recommendations	It is reasonable to begin statins perioperatively in patients undergoing vascular surgery
	Perioperative initiation of statins may be considered if a patient has clinical indications according to established guidelines and is undergoing high-risk surgery
	If a statin-naïve patient is undergoing vascular intervention, statins should ideally be started at least 2 weeks prior to the procedure for a maximal plaque-stabilizing effect *and* should be continued at least 1 month post-intervention
Peripheral arterial disease recommendations	Conservative and medical management of modifiable risk factors that affect perioperative morbidity and mortality is strongly recommended for better outcomes

Peripheral Arterial Disease (PAD)

Peripheral arterial disease (defined as an ankle-brachial ratio of less than 0.9 or previously vascularized with surgery or percutaneous transluminal angioplasty) is one of the common manifestations of atherosclerosis. Patients with PAD have a higher risk of concomitant atherosclerotic disease in other arteries including coronaries and cerebral vasculature [81], and therefore, these patients are at elevated risk of all-cause mortality, cardiovascular mortality, and mortality from coronary artery disease [82, 83]. Considering this, it is appropriate to evaluate the presence of ischemic heart disease in these patients from the medical history, a routine clinical exam and tests, but there is no evidence supporting routine investigations with an exercise or imaging test to detect asymptomatic atherosclerosis, unless the patient has more than two of the following risk factors: ischemic heart disease, heart failure, stroke or transient ischemic attack, renal dysfunction (serum creatinine >2 mg/dl or creatinine clearance <60 ml/min/1.73 m^3), and diabetes mellitus requiring insulin treatment [8, 84].

Not only the atherosclerotic cardiac disease but also the presence of atherosclerotic disease in other vessels has an impact on perioperative complications. A study showed a 2–3 times elevated risk in patients with two or more atherosclerotic diseases than only one [85]. An elderly population study [86] reported the prevalence of modifiable risk factors for symptomatic PAD as age (odds ratio, men = 1.052, women 1.025), cigarette smoking (odds ratio, men = 2.552, women 4.634), hypertension (odds ratio, men = 2.196, women 2.777), diabetes mellitus (odds ratio, men = 6.054, women 3.594), serum HDL cholesterol (odds ratio, men = 0.948, women 0.965), and serum LDL cholesterol (odds ratio, men and women = 1.019). Conservative and medical management of modifiable risk factors, which affects the perioperative morbidity and mortality, is strongly recommended in the guideline for better outcomes [84].

Valvular Heart Disease

Background

Valvular heart lesions are common in elderly people. Significant valvular stenosis or insufficiencies are of important consideration because it can lead to an unfavorable hemodynamic state in the perioperative period. Anticoagulation management in valvular heart disease, especially in prosthetic heart valves, needs to be managed properly considering the risks of surgery-related bleeding events versus a prothrombotic valvular state and consequences of thromboembolism.

Aortic Stenosis (AS)

AS is most common valvular heart disease in elderly people and usually results from degenerative calcification of the aortic valve. A 2013 meta-analysis study reported AS prevalence rate was 12.4% in the elderly (age more than 75 years) with a severe AS prevalence rate of 3.4% [87]. A study by Kertai reported higher perioperative cardiovascular complications (MI and mortality) from severe aortic stenosis compared to moderate aortic stenosis (31% vs. 11%, $p = 0.04$) [88]. This shows a substantial rate of disease burden in the general elderly population which requires medical attention before major surgeries.

Advances in the anesthetic approach and surgical approach and in perioperative care have had a major impact on declining cardiac risk in patients with significant AS undergoing noncardiac surgery. A recent tertiary center study [89] with a propensity score analysis showed that patients undergoing nonemergent noncardiac surgery with moderate AS (aortic valve area: 1.0 cm^2 to 1.5 cm^2) or severe AS (aortic valve area <1.0 cm^2) compared to patients without AS had a 30-day mortality rate of 2.1% vs. 1.0% ($p = 0.036$) and a postoperative myocardial infarction rate of 3.0% vs. 1.1% ($p = 0.001$). The worst primary outcomes (defined as a composite of 30-day mortality and postoperative MI) were reported in moderate AS (4.4% vs. 1.7%; $p = 0.002$) and severe AS (5.7% versus 2.7%; $p = 0.02$) compared to patients without AS, and the predictors were high-risk surgery, symptomatic AS, coexisting mitral regurgitation, and preexisting CAD.

Transthoracic echocardiography (TTE) is a standard method of assessment for the aortic valve. The perioperative management ACC/AHA guideline recommends preoperative echocardiography in suspected moderate or higher degree of AS if no prior echocardiogram is available within 1 year or if there is a significant clinical status change since the last evaluation (level of evidence: C), and in patients who meet standard indication of valvular intervention based on symptoms and severity of the valvular problem, an intervention before elective noncardiac surgery is effective in reducing perioperative risk. In those patients who are high-risk candidates for surgical AVR (aortic valve replacement), studies have demonstrated that TAVR (transcatheter aortic valve replacement) is a good alternative option [90]. Recent studies have reported on favorable outcome of TAVR in intermediate- and low-risk patients as well [91, 92]. If the patient is not a candidate for valve replacement, percutaneous balloon aortic valvuloplasty may be considered as a bridging procedure during a need for urgent noncardiac surgery with hemodynamic instability [1]. A study in patients aged >75 years with asymptomatic severe AS [93] reported intraoperative hypotension is frequent and requires aggressive management, but intermediate- to low-risk noncardiac surgery is relatively safe in a controlled setting. ACC/AHA guideline reports emergency noncardiac surgery may occur in patients with significant valvular disease, but the risk can be minimized by making an accurate diagnosis of the type and severity of valvular diseases, the appropriate choice of anesthetic agents, and a high level of both perioperative and postoperative patient care in the ICU setting.

Mitral Stenosis (MS)

Patients with severe MS are at an increased risk of perioperative complications and should be managed similarly to patients with AS. The main perioperative concerns for the MS patient are hemodynamic alterations, pulmonary edema from volume status changes, and the occurrence of arrhythmias such as atrial fibrillation.

The guidelines on perioperative MS management recommend valvular interventions before elective noncardiac surgery if the patient meets an indication for intervention. The noncardiac surgery may be considered without intervention if it's emergency or the valve anatomy is not favorable for percutaneous mitral balloon commissurotomy but with invasive cardiac hemodynamics monitoring and optimization [7]. The European guidelines on perioperative valvular management [94] recommend no indication of any mitral valve interventions if patient is asymptomatic with systolic pulmonary artery pressure (SPAP) <50 mmHg or nonsignificant mitral stenosis (valve area <1.5 cm^2). If a SPAP is >50 mmHg in an asymptomatic patient or the noncardiac surgery-related risk is high, a patient may benefit from intervention (percutaneous mitral commissurotomy or open surgical repair) prior to major surgery.

Prosthetic Valves

Patients with mechanical heart valves have a similar risk of perioperative morbidity and mortality compared to patients with native cardiac valves, reported by one study [95], as a risk of bleeding (18.6% vs. 14.2%, $p = 0.989$), thromboembolism (3.6% vs. 2%, $p = 0.989$), and mortality at 3 months (1.4% vs. 1.3%, $p = 0.825$). The guidelines also suggest that patients with prosthetic valves can undergo noncardiac surgery without any additional risk when there is no evidence of valve or ventricular dysfunction [7, 8]. The main clinical problem for prosthetic heart valve patients remains with anticoagulation management when a brief interruption of therapy is required to achieve adequate hemostasis. With major surgery the risk of perioperative bleeding and thrombosis should be weighed in individual cases. Overall, mechanical valves are comparatively more thrombogenic than bioprosthetic valves, and caged ball valves are more thrombogenic than tilting disk valves. Currently, the anticoagulation in prosthetic heart valves is an uncertain topic with multiple ongoing clinical trials, but the evidence is more toward the use of intravenous UFH perioperatively [7, 8].

The latest guidelines regarding the anticoagulation recommend that perioperative anticoagulation bridging is appropriate with a mechanical mitral valve regardless of any risk factors for thromboembolism and for the aortic valve if one or more of the following risk factors such as AF, previous thromboembolism, LV dysfunction, hypercoagulable condition, or an older generation prosthetic aortic valve are present [7]. Patients receiving an oral vitamin K antagonist (VKA) such as warfarin may require bridging with unfractionated heparin or low molecular weight heparin, starting once the INR goes subtherapeutic, until 4 hours before surgery, and then restarting warfarin based on hemostatic status of the patient but at least 12 hours post-surgery. VKA should be restarted at a preoperative maintenance dose plus a 50% booster dose for two consecutive days followed by a preoperative maintenance dose. Heparin should be continued until the therapeutic INR level from VKA is achieved [7, 8]. When rapid correction of anticoagulation is required, fresh frozen plasma and prothrombin complex concentrate (PCC) are the choices. Vitamin K does not have any immediate effects, but it delays the INR level to quickly reach the therapeutic level again. Factor Xa inhibitors (rivaroxaban and apixaban) and direct thrombin inhibitors (dabigatran) did not have any reversal agent until the recent FDA approval of andexanet alfa and idarucizumab, but their use in various clinical settings, safety and efficacy have yet to be investigated [96, 97]. See Table 4.8 for a summary of current recommendations [7–9].

The other important perioperative point to consider is antibiotic prophylaxis as prosthetic heart valves are high risk for infective endocarditis. The antibiotic approach and regimen for prophylaxis during major surgery should be considered as per standard guidelines [98].

Table 4.8 Valvular heart disease recommendations

Aortic stenosis	*Pre-op echocardiography (Echo)*: may be considered in suspected moderate to severe AS if no prior echo is available within 1 year or if there is a significant clinical status change since the last evaluation (level of evidence: C)
	Interventions: recommended if symptoms and severity of stenosis meet criteria for valve replacement or repair
	Emergent surgery: the risk can be minimized by high-level perioperative care and post-op care in an intensive care unit
Mitral stenosis	*Interventions*: recommended if symptoms and severity of stenosis meet criteria for valve replacement or repair
	Systolic pulmonary artery pressure (SPAP) <50 mm Hg: no indication of mitral valve intervention if nonsignificant mitral stenosis (valve area <1.5 cm^2)
	Systolic pulmonary artery pressure (SPAP) >50 mm Hg: if patient is asymptomatic or surgery related risk is high, patient may benefit from an intervention (percutaneous mitral commissurotomy or open surgical repair) prior to major surgery
	Emergent surgery: can be considered without valvular intervention *but* with close perioperative care
Prosthetic heart valves	Mechanical valves are comparatively more thrombogenic than bioprosthetic valves
	Caged ball valves are more thrombogenic than tilting disk valves

Conclusion

The aging process brings physiological, anatomical, and cognitive changes, with resultant loss of ability to cope with operative stress. In addition, elderly patients often have multiple cardiac comorbidities, complex medication regimens, functional limitation, cognitive impairment, and frailty. All these factors may play a role in increasing the likelihood of postoperative cardiac and noncardiac complications. As the world population is becoming older, geriatric surgery has become more frequent and requires physicians to become more familiar with special issues that are unique to this group. Preoperative cardiac risk assessment involves a multidisciplinary approach and should focus on the urgency of the procedure, patient's baseline functional capacity, and cardiac risk profile. It is also critical that physicians carefully weigh the risk and benefit of surgery, value of additional cardiac testing, and patient's long-term goals.

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5 Reversal of Oral Anticoagulants in the Elderly

Firas Jafri, Saleha Batool, Kartik Dhaduk, and Robert G. Lerner

Introduction

The geriatric population is increasing in the United States and throughout the world. There are many factors that contribute to making aging itself a hypercoagulable state (Table 5.1) [1–9]. This hypercoagulable state results in a high prevalence of venous thromboembolic disease. Additionally the rising prevalence of cardiac disease, particularly atrial fibrillation (AF) with its risk of stroke, has resulted in a great need for anticoagulation treatment. For many years the only available oral anticoagulants were vitamin K antagonists (VKAs), which in the United States is predominantly Warfarin.

Venous thromboembolism (VTE) is widely prevalent with an increase with age. According to the report by American Heart Association, roughly the incidence of VTE each year in United States is roughly about 375,000 to 425,000 new cases each year [9]. A study which looked at the prevalence of VTE and future trend shows that the incidence of VTE increases as the age of the patient progresses [10]. A 25-year population-based study reveals the annual reported incidence of venous thromboembolism ranging widely from 43.7 to 145.0 per 100,000 people [11].

Table 5.1 Aging is a hypercoagulable state

Fibrinogen level increases [1]
D-dimer increases [2]
F1+2 increase [3]
Factor V, VII, VIII, IX levels increase [1]
Von Willebrand factor increases [1]
ADAMTS13 decreases [4]
Factor VIII and IX activation peptides increase [5]
Factor VIIa increases [5]
Thrombomodulin decreases [6]
PAI-1 increases [7]
Homocysteine increases [8]
Endothelial dysfunction increases [6]

The many shortcomings of Warfarin anticoagulation as well as advances in biochemistry and the understanding of the thrombotic pathways have led to the development of small molecules that directly target specific molecular entities in the coagulation mechanism. These agents collectively have been called new oral anticoagulants (NOACs), direct oral anticoagulants (DOACs), or targeted oral anticoagulants (TOACs). Several have been approved by the FDA and introduced to the market.

Although the NOACs have been widely accepted as having many advantages over Warfarin, there has been a hesitancy to use them because of a lack of a way to reverse the anticoagulant effect, i.e., an antidote. Warfarin has had well-known reversal mechanisms including vitamin K, fresh frozen plasma (FFP), and coagulation

F. Jafri (✉) · K. Dhaduk
Department of Medicine, New York Medical College and Westchester Medical Center, Valhalla, NY, USA

S. Batool · R. G. Lerner
Department of Hematology and Oncology, New York Medical College and Westchester Medical Center, Valhalla, NY, USA

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factor concentrates, but only recently have reversal agents for the NOACs been available. Accordingly we will review and contrast VKAs and NOACs and their reversal agents. Figure 5.1 shows the coagulation cascade and point of action of VKAs and NOACs.

History of Drug Development

The history of the VKAs is especially interesting. The events that led to the discovery of Warfarin started with a hay shortage due to a drought in the northern plains. This led to the importation

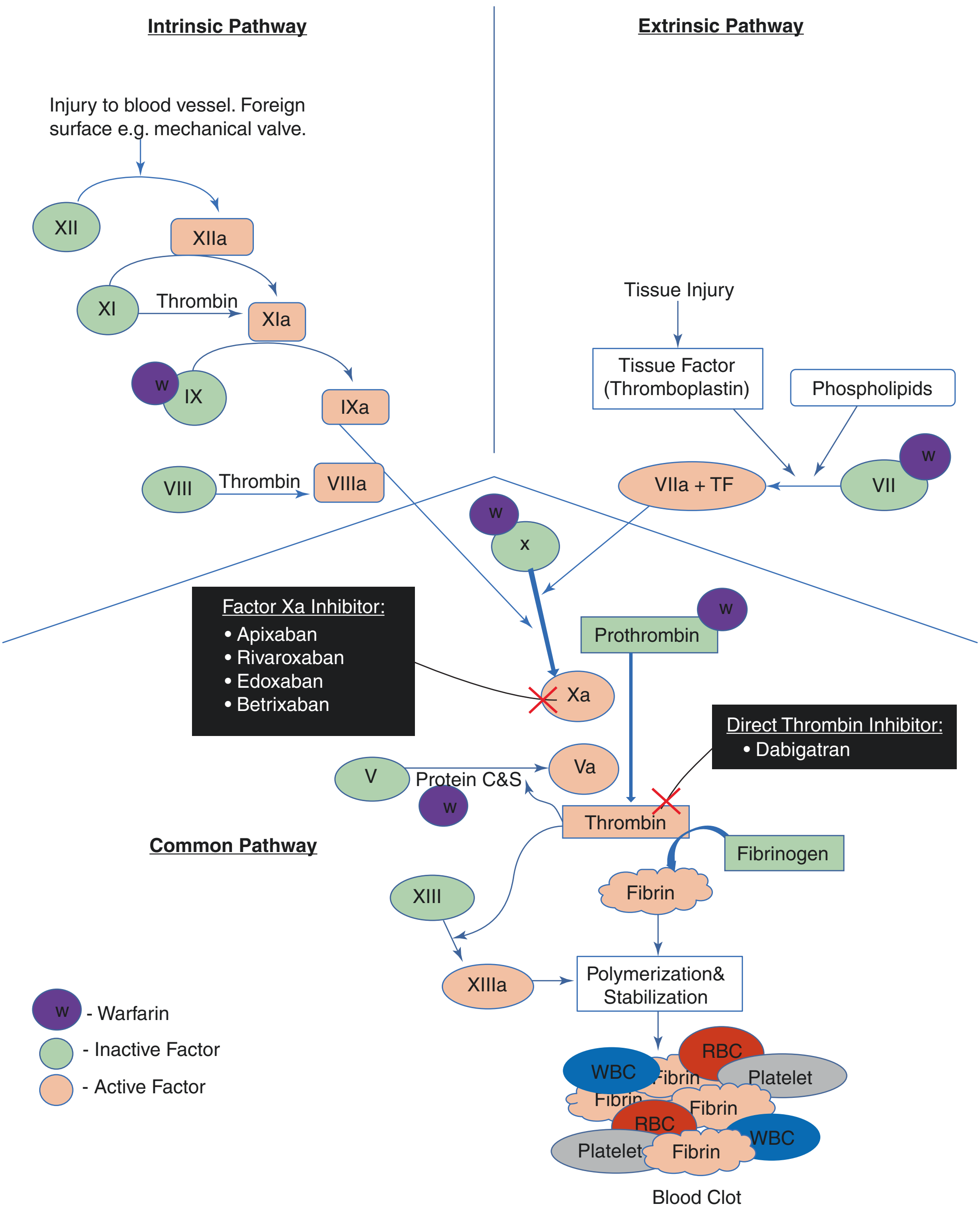

Fig. 5.1 The coagulation cascade and point of action of VKAs and NOACs

of sweet clover plants from Europe for cattle feed. Cattle fed spoiled sweet clover developed a hemorrhagic disease called sweet clover disease described by Schofield in 1922. Roderick found that these cattle were deficient in prothrombin in 1929. One snowy morning in February 1933, Ed Carlson, a farmer from Deer Park, Wisconsin, came into Karl Paul Link's laboratory carrying a milk can full of blood that refused to coagulate. Outside he had a small heap of spoiled sweet clover hay and a dead heifer freezing in the back of his truck [12]. Dr. Link finally synthesized dicumarol in 1940. The work was funded by the Wisconsin Alumni Research Foundation and led to the product named Warfarin. The Nobel Prize in Medicine in 1943 was awarded to Drs. Dam and Doisy for the discovery of vitamin K and its chemical nature. Link had postulated that dicumarol might be useful as a rodenticide and in 1948 Warfarin was launched as a rat poison. The first clinical studies of Warfarin were in 1955, and President Eisenhower was treated for his heart attack with Warfarin in the same year [13].

The development of the NOACs is much more a routine story of modern biochemistry and pharmacology. Factor Xa (FXa) is a critical serine protease situated at the confluence of the intrinsic and extrinsic pathways of the blood coagulation cascade. FXa catalyzes the conversion of prothrombin to thrombin via the prothrombinase complex. Its singular role in thrombin generation, coupled with its potentiating effects on clot formation, renders it an attractive target for therapeutic intervention [14]. The ability to synthesize molecules targeted to the active site of FXa resulted in the anti-Xa NOACs.

Leeches have been used medicinally for 2500 years. Direct thrombin inhibitors were initially derived from leeches and subsequently synthesized. Dabigatran (Pradaxa®) was synthesized and introduced to the market as an orally active direct anticoagulant directed against thrombin rather than FXa.

There have been many studies comparing Warfarin use to the NOACs for anticoagulation studying safety, efficacy, and bleeding risks. A recent review in the Journal of the American geriatric society provided a meta-analysis of Rivaroxaban, Apixaban, and Dabigatran compared with Warfarin use. They evaluated the bleeding risk, stroke risk, and thrombosis risk. They concluded that in elderly adults enrolled in randomized trials, bleeding with NOACs was not different from that with VKAs [15].

Warfarin Use and Reversal

According to the FDA-approved package label, Coumadin® is a vitamin K antagonist indicated for prophylaxis and treatment of venous thrombosis and its extension, pulmonary embolism (PE), prophylaxis, and treatment of thromboembolic complications associated with AF and/or cardiac valve replacement and reduction in the risk of death, recurrent myocardial infarction (MI), and thromboembolic events such as stroke or systemic embolization (SE) after MI [16].

There are many issues with Warfarin use in addition to the risk of hemorrhage (Table 5.2). According to the package label although there are no overall differences in effectiveness or safety observed between geriatric and younger patients, patients 60 years or older appear to exhibit greater than expected INR response to the anticoagulant effects of Warfarin [16].

Reversal of Warfarin anticoagulation is often required because of excessive elevation of the INR, bleeding, or clinical circumstances such as preparation for surgery. Reversal of anticoagulation does

Table 5.2 Risk of Warfarin use

The dosing is variable and must be individualized [16]
Initial and maintenance doses are different [16]
Continuous monitoring is required to achieve optimal anticoagulation [16]
Tissue necrosis can occur especially in individuals lacking protein C either congenitally or acquired, with limb ischemia in heparin-induced thrombocytopenia or heparin-induced thrombosis thrombocytopenia syndrome [16]
Calciphylaxis may occur especially in dialysis patients [16]
There are numerous drug-drug, drug-food, and botanical interactions [16]
Use in pregnancy and with liver disease has limitations [16]

leave the patient with the previously present thrombotic risk. Reversal may be accomplished by discontinuing Warfarin or administration of oral or parenteral vitamin K1. One study suggested that even with markedly elevated INRs in the absence of bleeding results were similar.

Rapid reversal can be accomplished using prothrombin complex concentrate (PCC), FFP, or activated factor VII treatment.

Management of Warfarin in the perioperative period is complicated and depends on clinical evaluation of the level of risk of thrombosis and bleeding in the individual patient and the planned surgery. Many different guidelines have been published, and a convenient compendium of these guidelines which uses an algorithm to guide dosing is available as an online app [look for MAPPP (management of anticoagulation in the periprocedural period) in your app store].

Dabigatran Use and Reversal

Dabigatran (US brand name Pradaxa®) is a direct thrombin inhibitor approved in 2010 by the US Food and Drug Administration (FDA). It undergoes 80% renal elimination and must be used cautiously in renal impairment. The RE-LY trial (Dabigatran vs. Warfarin) [17] randomized 18,113 patients to Dabigatran 150 mg (D150) twice daily, Dabigatran 110 mg (D110) twice daily, or open-label Warfarin. Majority of the participants (82% percent of patients) were aged >65 years, and 40% were aged >75 years. The rates of stroke were 1.53% per year for D110, 1.11% per year for D150, and 1.69% per year for Warfarin [18]. Both doses of Dabigatran were non-inferior to Warfarin, and the 150 mg dose of Dabigatran was superior to Warfarin. Both doses of Dabigatran were associated with a lower risk for intracranial hemorrhage (ICH) when compared to Warfarin, across all age groups. However, in patients >75 years of age, both doses of Dabigatran were associated with a higher risk for extracranial bleeding, particularly gastrointestinal (GI) bleeding [19]. Because of increased risk of stroke and major bleeding with D110, D150 was approved by FDA, even though the rate of major bleeding was higher with D150.

Renal function (CrCl) and age were found to be the two most important determinants of the plasma concentration of Dabigatran, with a 68% higher trough concentration in patients >75 years of age as compared to those <65 years of age. In addition, low body weight and female sex were associated with higher plasma concentrations of Dabigatran [20]. According to the FDA-approved package label even though the risk of stroke and bleeding increases with age, the risk and benefit profile are favorable in all age groups.

RE-COVER trial randomized 2500 patients with acute VTE to either Dabigatran 150 mg orally twice daily or Warfarin. At approximately 6 months of follow-up, there were similar rates of the primary outcome of VTE or VTE-related death in each arm (2.5–2.7%). There was no difference in major bleeding risk (1.6–1.9%), but the risk of any bleeding was reduced by 26% with Dabigatran (16% vs. 22%) [21].

According to the FDA-approved package label, Pradaxa® (Dabigatran etexilate mesylate) capsules are indicated:

- To reduce the risk of stroke and SE in patients with non-valvular AF
- For the treatment of deep venous thrombosis (DVT) and PE in patients who have been treated with a parenteral anticoagulant for 5–10 days to reduce the risk of recurrence of DVT and PE in patients who have been previously treated for the prophylaxis of DVT and PE in patients who have undergone hip replacement surgery

There is a black box warning about the risk of thrombotic events with premature discontinuation of the drug and the risk of spinal/epidural hematoma.

The spinal/epidural hematoma problem arose with all the NOACs when routine preoperative lab results failed to indicate that a patient was anticoagulated.

A specific reversal agent (Idarucizumab) is available and marketed as Praxbind®.

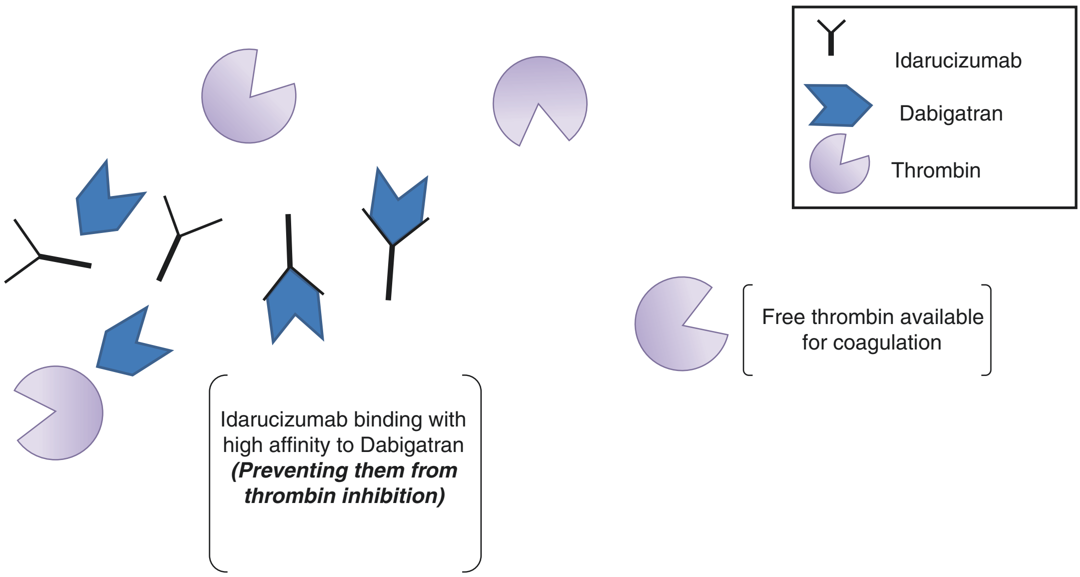

Fig. 5.2 The mechanism of action of Idarucizumab, which binds with Dabigatran molecule making more thrombin available for coagulation, is demonstrated

Figure 5.2 demonstrates the mechanism of action of Idarucizumab which binds with Dabigatran molecule making more thrombin available for coagulation.

According to the package label, Praxbind® is a humanized monoclonal antibody fragment (Fab) indicated in patients treated with Pradaxa® [22] when reversal of the anticoagulant effects of Dabigatran is needed:

- For emergency surgery/urgent procedures [22]
- In life-threatening or uncontrolled bleeding [22]

This indication is approved under accelerated approval based on a reduction in unbound Dabigatran and normalization of coagulation parameters in healthy volunteers. Continued approval for this indication may be contingent upon the results of an ongoing cohort case series study. The subsequent cohort study REVERSE-AD trial concluded that in emergency situations, Idarucizumab rapidly, durably, and safely reversed the anticoagulant effect of Dabigatran [23].

The recommended dose is 5 g given as two separate vials of 2.5 g with limited data to support additional dosing.

Rivaroxaban and Apixaban Use and Reversal

Rivaroxaban (brand name Xarelto®) is a direct FXa inhibitor predominantly metabolized by the liver, with one-third of the drug undergoing renal elimination. It has a long half-life, once-daily dosing, and reliable anticoagulation without a need for laboratory monitoring. As per the package insert, it has been approved by FDA for treatment of DVT and PE; for prophylaxis of DVT in patients undergoing hip or knee replacement surgery, to reduce the risk of stroke and SE in patients with non-valvular AF; and for the reduction in the risk of recurrence of DVT and/or PE in patients at continued risk for recurrent DVT and/or PE after completion of initial treatment lasting at least 6 months and in combination with aspirin, to reduce the risk of major cardiovascular events (cardiovascular (CV) death, MI and stroke) in patients with chronic coronary artery disease (CAD) or peripheral artery disease (PAD) [24].

ROCKET AF (Rivaroxaban compared with Warfarin for prevention of stroke and embolism trial in AF) [25]. This trial randomized 14,264 patients with AF and a $CHADS_2$ score of ≥2 to

Rivaroxaban (20 mg daily or 15 mg daily in patients with a CrCl of 30–49 ml per minute) or Warfarin. The mean age of the patients was 73 years, with a mean $CHADS_2$ score of 3.5. In the primary analysis, the Rivaroxaban group had a lower rate of stroke (1.7% per year) as compared to Warfarin group (2.2% per year). Rates of major bleeding were similar for Rivaroxaban and Warfarin (14.9% vs. 14.5%), although rate of major GI bleed was higher in the Rivaroxaban group (3.2% vs. 2.2%). Rates of ICH were lower in the Rivaroxaban group than in the Warfarin group (0.5% vs. 0.7% per year). At a mean follow-up of 2 years, Rivaroxaban was non-inferior to Warfarin for stroke or SE, without increasing the bleeding rates [25]. A study of 6229 elderly patients (>75 years of age) as a part of a prespecified secondary analysis of the ROCKET AF trial found no difference in the primary efficacy outcome (stroke and SE) between Warfarin therapy and Rivaroxaban. Similarly, there were no differences in major bleeding events between the Warfarin and Rivaroxaban groups. However, the incidence of GI bleeding was higher in patients treated with Rivaroxaban compared to Warfarin [26].

RECORD 1 trial conducted in 2008 compared the efficacy and safety of Rivaroxaban, an oral direct inhibitor of FXa. 4541 patients were randomized to receive either 10 mg of oral Rivaroxaban once daily, beginning after surgery, or 40 mg of Enoxaparin subcutaneously once daily, beginning the evening before surgery, plus a placebo tablet or injection. The primary efficacy outcome (DVT, PE, or death) occurred in 18 of 1595 patients (1.1%) in the Rivaroxaban group and in 58 of 1558 patients (3.7%) in the Enoxaparin group. Major VTE occurred in 4 of 1686 patients (0.2%) in the Rivaroxaban group and in 33 of 1678 patients (2.0%) in the Enoxaparin group. Major bleeding occurred in 6 of 2209 patients (0.3%) in the Rivaroxaban group and in 2 of 2224 patients (0.1%) in the Enoxaparin group. A once-daily, 10-mg oral dose of Rivaroxaban was significantly more effective for extended thromboprophylaxis than a once-daily, 40-mg subcutaneous dose of Enoxaparin in patients undergoing elective total hip arthroplasty [27].

In 2010 an open-labelled, randomized trial was conducted, namely, EINSTEIN-DVT trial, a trial compared Rivaroxaban with Enoxaparin plus VKAs (Warfarin or Acenocumarol). Rivaroxaban showed non-inferior efficacy with respect to DVT in comparison with Enoxaparin plus VKAs [28].

Published in 2012, EINSTEIN-PE randomized 4832 patients with acute PE to Rivaroxaban or standard therapy with Enoxaparin and a VKAs. At a mean follow-up of 7 months, Rivaroxaban was non-inferior to standard therapy in terms of the rate of recurrent symptomatic VTE (2.1% vs. 1.8%) and had a similar risk of clinically significant bleeding (10.3% vs. 11.4%) [29].

Apixaban (brand name Eliquis®) is a direct FXa inhibitor approved by the FDA in 2012. As per the package insert, it can be used for stroke prevention in AF, for prophylaxis of DVT in patients undergoing hip or knee replacement surgery, and in 2014 for treatment of DVT and PE [30].

The ARISTOTLE trial [31] randomized 18,201 patients with AF and 1 additional risk factor for stroke to Apixaban or dose-adjusted Warfarin. The median age of the population was 70 years with 31% of the population >75 years of age. The mean $CHADS_2$ score was 2.1, and the mean time in therapeutic range of Warfarin cohort was 66%. The primary outcome of stroke or SE occurred in 1.27% patients per year in the Apixaban group versus 1.60% per year in the Warfarin group. The rate of ICH was 0.33% per year in the Apixaban group and 0.80% per year in the Warfarin group. The clinical benefit of Apixaban over Warfarin was consistent across all patients irrespective of their $CHADS_2$, CHA_2DS_2-VASc, and HAS-BLED scores. In addition, Apixaban decreased all-cause mortality when compared to Warfarin [31].

The Apixaban Versus Acetylsalicylic Acid to Prevent Stroke in AF Patients Who Have Failed or Are Unsuitable for VKAs Treatment (AVERROES) trial [32] showed greater efficacy for Apixaban in preventing stroke or SE events and similar rates of bleeding compared to Aspirin, making this a good option in elderly patients considered unsuitable for Warfarin therapy.

Apixaban was given 5 mg twice daily in the ARISTOTLE study, although 2.5 mg twice daily was used in a subset of patients with two or more of the following criteria: ≥80 years, body weight ≤60 kg, or a serum creatinine level of ≥1.5 mg/dl. The superiority of Apixaban relative to Warfarin for preventing stroke was consistent, irrespective of the degree of renal impairment [31].

Both Rivaroxaban and Apixaban have an FDA-approved reversal agent marketed as ANDEXXA® (coagulation FXa (recombinant), inactivated-zhzo).

Figure 5.3 demonstrates the mechanism of action of Andexanet Alfa. The molecule of Andexanet Alfa is similar in size as that of FXa. Andexanet Alfa binds with FXa inhibitors making it unavailable for it to bind and inhibit FXa.

ANDEXXA®, coagulation FXa (recombinant), inactivated-zhzo is a recombinant modified human FXa protein indicated for patients treated with Rivaroxaban and Apixaban, when reversal of anticoagulation is needed due to life-threatening or uncontrolled bleeding [33]. This indication is approved under accelerated approval based on the change from baseline in anti-FXa activity in healthy volunteers. There have been two cohort studies ANNEXA-A and ANNEXA-R. On the basis of these two studies in healthy volunteers in which Andexanet Alfa reversed the anticoagulant effects of Apixaban and Rivaroxaban, the FDA granted accelerated approval to Andexanet Alfa in May 2018 for the treatment of life-threatening or uncontrolled bleeding in patients receiving either of these two FXa inhibitors [34]. An improvement in hemostasis has not been established. As with Praxbind®

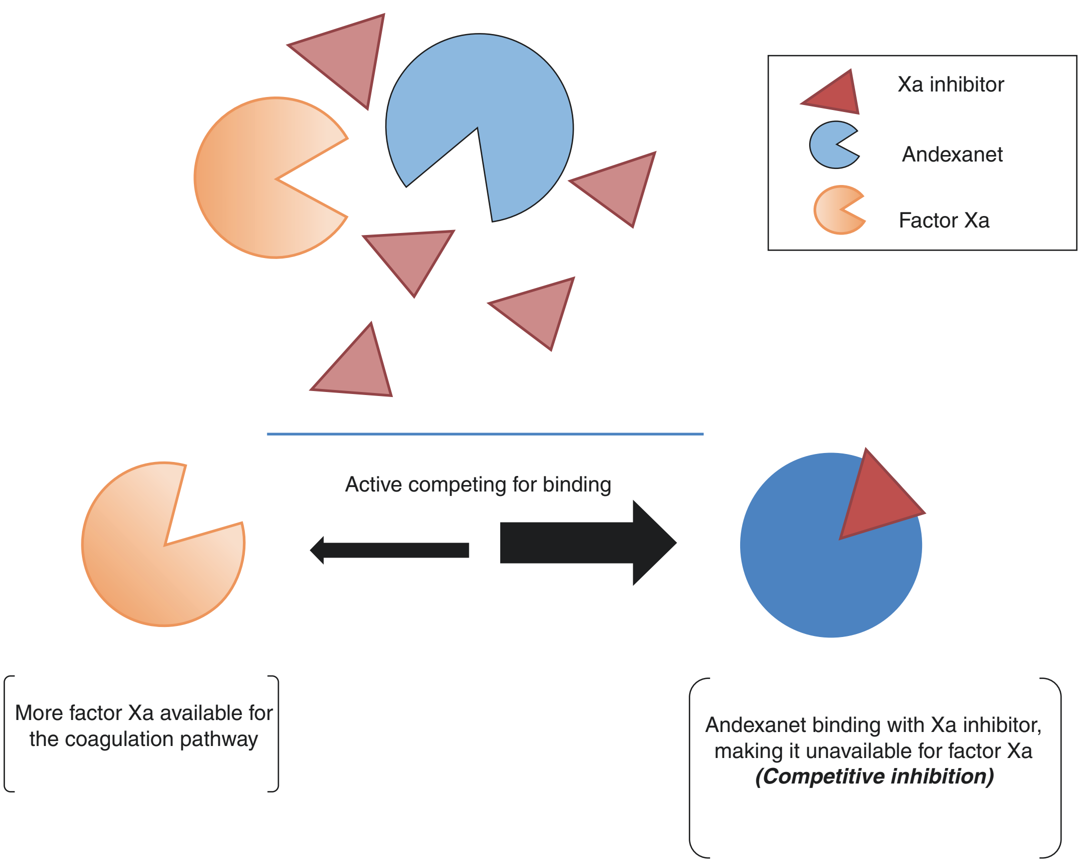

Fig. 5.3 The mechanism of action of Andexanet Alfa is demonstrated

continued approval for this indication may be contingent upon the results of studies to demonstrate an improvement in hemostasis in patients. ANDEXXA® has not been shown to be effective for, and is not indicated for, the treatment of bleeding related to any FXa inhibitors other than Apixaban and Rivaroxaban [33].

Coagulation FXa (recombinant), inactivated-zhzo should be able to reverse the anticoagulant effect of other FXa inhibitors, but there are no published clinical trials and it is not indicated.

Another small molecule, Ciraparantag, has been shown to reverse FXa inhibitors in vitro, but there is no application for FDA approval at the time of this writing.

There are other FXa inhibitors like Edoxaban (Savaysa®) which is a direct inhibitor of activated Factor X with a rapid onset of action. It is administered orally once daily and has proven antithrombotic efficacy [35]. In 2015 Edoxaban was approved by FDA for prevention of thromboembolic events in patients with valvular AF [36]. Another FDA-approved FXa inhibitor for extended VTE prophylaxis after discharge from a medical illness is betrixaban (Bevyxxa®) [37]. However there are no specific reversal agents approved for these agents.

Prothrombin Complex Concentrates

Prothrombin complex concentrates have been widely used as a reversal agent for VKAs. However they have been used to control bleeding in multiple clinical situations, including in attempting to reverse FXa inhibitors. There are individual reports but no convincing clinical information of their efficacy.

Conclusion

There have been multiple randomized clinical trials demonstrating safety and efficacy of NOACs in multiple clinical indications with notable exception of mechanical heart valves. Depending upon the indication and patient population, NOACs may be no different, safer, or more effective than Warfarin. The decision to select a NOAC or a more traditional medicine such as Warfarin should involve a discussion with patient reviewing the risk and benefits or both approaches. Warfarin has always had multiple specific reversal agents. With the introduction of specific reversal agents for Rivaroxaban, Apixaban, and Dabigatran, a major cause of hesitancy to their use has been removed.

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6 Frailty Assessment as Measurement of Physiologic Reserves in the Elderly

Kartik Prabhakaran, David J. Samson, and Rifat Latifi

The number of elderly persons in the world population has seen a continued increase in the twenty-first century that is expected to continue [1, 2]. As the population continues to age, an understanding of the physiologic consequences of aging and resultant effects on risk upon patient-centered outcomes has become very important. Advanced age is associated with high risk of developing disease processes and leads to both pathologic and natural age-related organ dysfunction, which in turn lead to a higher risk of morbidity and mortality [3]. Concomitant with the overall increase in elderly, there is an increase in the demand for surgery among the aging population [4]. The physiologic decline associated with aging is increased with adverse postoperative outcomes [5, 6]. Yet, within the elderly population, there is substantial heterogeneity among surgical outcomes [7], owing to heterogeneity among the elderly population with respect to physiologic reserve, burden of comorbid conditions, and functional independence. This heterogeneity among the elderly has led to the development of a concept termed "frailty" which refers to both intrinsic and extrinsic factors that contribute to a state of vulnerability to health-related stressors [3, 8]. Understanding the distinction between chronologic age and frailty is predicated on the understanding that not all elderly persons are frail [9] and that frailty itself is a distinct disease process worthy of measurement and study [10].

Although frailty is widely recognized and accepted, there continues to be significant debate on the most appropriate method for its assessment. Whereas most frailty researchers agree on the necessity of a multidimensional approach, there is significant variability among the specific variables used in assessment, inclusion/exclusion criteria, clinical applicability, and validation across the available instruments of assessment [11].

This chapter provides an overview of frailty indices and measurements of physiologic reserves in the elderly by discussing the physiologic changes associated with aging, frailty as a measure of biological age, the various tools and indices available for the assessment of frailty, and the application of frailty to clinical practice (specifically in emergency general surgery).

K. Prabhakaran (✉)
Section of Trauma and Acute Care Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Department of Surgery, New York Medical College, Valhalla, NY, USA
e-mail: Kartik.Prabhakaran@wmchealth.org

D. J. Samson
Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

R. Latifi
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA

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Biologic Basis for Frailty

Aging is accompanied by decline and deterioration of organ systems on a functional level which leads to an overall decrease in physiologic reserve and the ability to withstand stress and physiologic insults [12]. This functional decline on an organ system level has its origins in the process of aging on a cellular level and is characterized by loss of homeostasis and a breakdown in regulatory pathways and molecular structures [13]. Normal mechanisms of cell maintenance such as DNA repair, clearance of defective mediators of cell function, and defense against pathogens are integral to cellular and organ system homeostasis. However, these mechanisms begin to fail with advanced aging. Instead, these homeostatic mechanisms are often replaced by DNA damage, cell cycle dysregulation and/or senescence, oxidative damage, and aberrant enzymatic degradation [14, 15]. This cellular dysregulation goes hand in hand with endocrine dysfunction as the normal production and regulation of essential hormones diminish and are replaced by hormonal upregulation of cellular aging and death in the form of apoptosis and senescence [16].

The Impact of Aging on Organ Function

The cellular changes associated with aging translate into significant organ-specific alterations that affect overall physiology. For example, with aging, the cardiopulmonary system is affected over time by a progressive loss of cardiac myocytes, which in turn leads to increased myocyte volume across both ventricles [17]. The concomitant decrease in arterial compliance leads to increased afterload, impaired diastolic filling, and left ventricular dysfunction [18]. When combined with increasing prevalence of underlying cardiovascular disease in the elderly, these “normal” physiologic changes associated with aging portend a state of decreased cardiovascular reserve. The aging process also results in progressive compromise of pulmonary function. When combined with changes in pulmonary mechanics, gas exchange, and respiratory muscle strength, the aging process results in a significant reduction in normal gas exchange as measured by pulmonary function tests [19, 20]. Gradual compromise of the mucociliary reflex and diminishing ventilator response to hypercapnia impair the elderly patient’s ability to clear respiratory secretions and respond to physiologic stressors and insults [21].

Kidney function and nutrition are also progressively impaired during the normal aging process. Kidneys undergo an overall loss of volume and function of the renal cortex, primarily in the form of glomerulosclerosis and senescence of the renal tubule; and these processes are further accelerated by comorbid conditions such as hypertension, diabetes, and atherosclerosis [22]. In the face of physiologic stress (e.g., disease, injury, or surgery [23]), these alterations in renal physiology cause a significant reduction in renal physiology reserve which places the elderly patient at significant risk of acute kidney injury and renal failure. With respect to nutritional status, the prevalence of malnutrition in the elderly population is well known. In addition to decreased appetite and oral intake, the gastrointestinal system undergoes significant atrophy and deterioration as a consequence of the normal aging process [24]. Neuromuscular atrophy and autonomic dysregulation associated with aging produce significant changes, in the form of discordant muscular contractions along the gastrointestinal tract which gives rise to impaired swallowing and peristalsis. Aging of the gastrointestinal system is also accompanied by declining secretory and absorptive capacity of both the stomach and small intestine mediated by decreased production of gastric acid and pepsin, as well as villous atrophy of the small bowel. Taken together, these changes have a profound impact on the elderly patient’s nutritional status which comprises a principal defense against physiologic stress.

The cognitive decline associated with aging is a well-known phenomenon. Apart from the increased prevalence of neurologic disease processes such as dementia and neurodegenerative diseases in the elderly population [25, 26], the normal aging brain is associated with cortical atrophy and impairment of cerebral blood flow [27]. These changes not only place the elderly patient at increased risk for cerebrovascular accidents but also contribute to profound impairments in visual, auditory, and sensory function which give rise to potentially detrimental effects upon quality of life, self-perception, functional independence, and fall risk. Moreover, increased sensitivity to analgesia and anesthesia, as well as increased risk for delirium, places the hospitalized elderly patient at a significantly higher risk for morbidity and mortality [28].

Frailty as a Measure of Biological and Physiologic Reserve

The heterogeneity among the elderly population with respect to both the prevalence of comorbid conditions, functional status, and age-related physiologic decline has given rise to the concept of frailty. Despite variations in measurement, interpretation, and application, frailty is conceptually understood to represent an entity, related to but distinct from chronologic age, that correlates with increased vulnerability to disease [29]. Given the discordance between chronologic age and frailty, it is important to note that not all elderly persons are frail. Studies have shown that approximately 20% of community-dwelling persons over the age of 50 years are frail, with higher percentages of frailty observed among patients in clinical settings [9, 30]. While there is no universally applicable or accepted definition of frailty, it is important to understand that frailty is a dynamic and multidimensional entity that exists across multiple domains including disability, comorbidity, functionality, and psychosocial integrity [31, 32]. Despite inherent genetic predispositions toward the development of comorbid conditions which are included in most definitions of frailty, it is important to recognize frailty as a conglomerate of symptoms or "syndrome" that is not merely a phenotype but acquired during various stages of aging based on the accumulation or risk factors that span the domains of lifestyle, socioeconomic status, psychological well-being, nutrition, disability, and comorbid conditions [33]. Furthermore, it is important to note that variables such as gender, geographic/demographic effects, and educational and cognitive function can affect the onset, severity, and prevalence of frailty.

Measurement of Frailty: Tools and Indices

Measurement of frailty should be informed by an established definition of this condition. A consensus definition of frailty does not currently exist. This may explain the many dozens of instruments available to assess frailty. Frequently described elements of definitions are weakness, challenges to mobility, weight loss, progressive decline in system function, decreased physiologic reserve across multiple organ systems, decreased resistance or increased susceptibility/vulnerability to stressors, and increased risk of adverse events such as surgical complications, disability, decline, and death [34, 35].

The mere fact that today we have 13 scales of frailty (Table 6.1) means that none of them is "the best" and validated in a randomized multi-institutional long-term study. The table includes details about the component domains included in each instrument along with ranges of possible scores and threshold values for what should be considered frailty or different levels of frailty. Specific domains encompassed by different instruments include activities of daily living (ADLs), instrumental ADLs (IADLs), cognition, comorbidities/disease history, demographics, energy, history of falls, mobility, musculoskeletal signs, neurologic signs, nutritional status, physical activity, polypharmacy, sensory function, social relations/support, strength, and weight loss.

From a theoretical perspective, the first notable instrument for measuring frailty was introduced in 2001 by Fried et al. [8]. Expressing their perspective as a phenotype model of frailty, these authors targeted a wasting syndrome. They stated that declines in lean body mass, strength, fitness, balance, ability to ambulate, and level of activity combine into a frailty cycle marked by low

Table 6.1 Measures of frailty frequently found in the literature

Index	Items	Domains	Range of scores, thresholds	Reference(s)
1. Fried Frailty Phenotype Cardiovascular Health Study (CHS)	5	Weight loss, low physical activity, exhaustion, slowness, weakness	0–5 present; frailty ≥3 items; pre-frail 1–2 items; robust = none	[8, 36–41]
2. Canadian Study of Health and Aging (CHSA) Accumulated Deficits Frailty Index and modifications	5–70	Presence and severity of current diseases, ability in the activities of daily living, and physical and neurological signs from the clinical examinations	Proportion present: (0.0–1.0); frailty = score ≥ 0.25	[37, 42–51]
3. CSHA Clinical Frailty Scale	1	Global clinical impression	7–9 levels 1 very fit, 2 well, 3 managing well, 4 vulnerable, 5 mildly frail, 6 moderately frail, 7 severely frail, 8 very severely frail, 9 terminally frail	[43, 52]
4. FRAIL Scale	5	Fatigue, resistance, ambulation, illness, and loss of weight	0–5; frailty ≥3 items; pre-frail 1–2 items; robust = 0 items	[56, 57]
5. Study of Osteoporotic Fractures (SOF) Frailty Index	3	Weight loss, exhaustion, unable to rise from chair 5 times	0–3; frailty ≥2 items; pre-frail = 1 item; robust = 0 items	[38, 58]
6. Edmonton Frailty Scale	8	Cognition, general health status, functional independence, social support, medication use, nutrition, mood, continence, functional performance	0–17, frailty ≥7	[59]
7. Program of Research to Integrate the Services for the Maintenance of Autonomy (PRISMA-7)	7	Age, sex, activities of daily living, social support, physical mobility	0–7; frailty ≥3	[61]
8. Sherbrooke Postal Questionnaire	6	Living situation, number of medications, physical mobility, vision, hearing, memory	0–6; frailty ≥2	[60]
9. Vulnerable Elders Survey	13	Age, physical activities, functional activities, self-rated health	0–10; frailty ≥3	[62]
10. Strawbridge Functional Domains Model	16	Physical functioning, nutritive functioning, cognitive functioning, sensory problems	0–4; frailty ≥2	[63]
11. Comprehensive Assessment of Frailty	8	Weakness, self-reported exhaustion, slow gait speed, low physical activity, standing balance, rising from chair 3 times, picking up pen from floor, putting on and removing jacket, supplemented by selected lab tests	0–35; not frail = 1–10; moderately frail = 11–25; severely frail = 26–36	[64, 65]
12. Groningen Frailty Indicator	25	Mobility, physical fitness, vision, hearing, nourishment, morbidity, cognition, psychosocial	0–15; moderately to severely frail ≥4	[66, 67]
13. Tilburg Frailty Indicator	15	Sex, age, marital status, country of birth, highest educational level, monthly household income, diseases/chronic disorders, recent health/loss events, living situation	0–15; frail ≥5	[68]

energy and physiologic reserve. They analyzed data from the prospective Cardiovascular Health Study (CHS). Among five criteria comprising the CHS Fried Frailty Phenotype instrument, the first was unintentional weight loss (shrinking), defined as >10 pounds lost in prior year. Weakness was characterized by grip strength in the lowest quintile by gender and body mass index. Poor endurance was given by self-report of exhaustion. Slowness of ambulation was noted if performance was in the slowest quintile for gender and height. Low activity was measured by kilocalories/week: males <383 Kcals/week and females <270 Kcals/week. The range of possible scores is 0–5. The threshold for frailty was ≥3 criteria present. Intermediate or pre-frail was defined as 1 or 2 criteria present. Patients who lack any of the criteria would be classified as robust. Other authors have since adapted the frailty phenotype instrument, using the same domains but different specific criteria [36–41].

The second main theoretical approach to frailty is the deficit accumulation model put forward by Rockwood and Mitnitski, investigators who participated in the Canadian Study of Health and Aging (CSHA) [42]. The underlying concept of this model is simply that frailty develops as the number of clinical deficits rises. The original CSHA Frailty Index included 70 items in the domains of the presence/severity of current diseases, impaired ADLs, and physical and neurological signs from clinical examination. The Frailty Index is scored in terms of proportion of items present, so the range is between 0.0 and 1.0. An individual is considered frail if the proportion is ≥0.25.

Rating all 70 items on the full Frailty Index can be quite time-consuming; thus many adaptations of the Frailty Index have appeared that used fewer numbers of items, including 51 [43], 50 [44], 48 [45], 47 [37], 44 [46], 40 [47], 38 [48], 11 [49, 50], and 5 [51]. One widely used adaptation of the Frailty Index is the 11-factor modified frailty index (mFI), developed by Farhat, Velanovich, and associates [49, 50]. Items included in this instrument are diabetes mellitus, congestive heart failure, hypertension requiring medication, transient ischemic attack or resolved cerebrovascular accident, dependent functional status, myocardial infarction, peripheral vascular disease or rest pain, cerebrovascular accident with residual neurological deficit, chronic obstructive pulmonary disease (COPD) or pneumonia, impaired sensorium and either prior percutaneous coronary intervention, prior cardiac surgery, or angina. Specific definitions for all of these items are given in an appendix of the 2013 Velanovich article [49]. A proposed threshold for frailty using the mFI is ≥3 items present. Subramaniam et al. studied a five-factor version of the mFI [51] that included dependent functional status, diabetes, COPD, congestive heart failure, and hypertension requiring medication. These investigators found that the 5-factor mFI and the 11-factor mFI performed similarly in predicting mortality and postoperative complications using the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) dataset.

In 2005, Rockwood et al. proposed a simpler alternative to the 70-item CSHA Frailty Index [43] that relies on a clinician's global judgment of the patient's frailty status. In its original form, the CSHA Clinical Frailty Scale separates individuals into seven levels: very fit; well; well, with treated comorbid disease; apparently vulnerable; mildly frail; moderately frail; and severely frail. A revision of the Clinical Frailty Scale has nine levels: very fit; well; managing well; vulnerable; mildly frail; moderately frail; severely frail; very severely frail; and terminally ill [52].

A third theoretical framework concerning frailty has not yet been converted into an assessment instrument. The World Health Organization (WHO) World Report on Ageing and Health from 2015 [53] identifies a construct called intrinsic capacity. While most frailty measurement instruments focus on deficits and weaknesses, this framework focuses more positively on functions that are present. It makes use of the International Classification of Functioning, Disability, and Health framework. Intrinsic capacity is defined as "…the composite of all the physical and mental capacities that an individual can draw upon at any point in their life…" and is composed of these domains: cognition, locomotion, psychological states, vitality, and sensory functions [54]. Preparatory work to construct an instrument based on this approach is ongoing [55].

Among less widely published assessment instruments, the FRAIL Scale name is an acronym of the included domains: fatigue, resistance, ambulation, illness, and loss of weight [56, 57]. The scale was produced by the International Academy Nutrition and Aging Task Force on Frailty Assessment of Older People in Clinical Practice. Fatigue is rated by self-report. Resistance is defined as the ability to climb one flight of stairs. Ambulation is the ability to walk one block. The threshold for illnesses is >5. Loss of weight means >5%. Scores range from 0 to 5; frailty is ≥3 items present, pre-frail is 1–2 items, and robust is 0 item.

The Study of Osteoporotic Fractures Frailty was described by Ensrud et al. [39, 58]. It was developed within the conduct of this prospective cohort study. It includes three items: weight loss (>5%); exhaustion (unable to rise from a chair 5 times without using arms); and self-report reduced energy level. Ranging from 0 to 3, frail is ≥2 items, pre-frail is 1 item, and robust is 0 item.

The Edmonton Frail Scale entails eight items on these domains: cognition, general health status, functional independence, social support, medication use, nutrition, mood, and continence and functional performance [59]. Most items could be scored as either 0 or 1 point, while others can be scored up to 2 points. The range of possible scores was 17 and frailty was ≥7 points.

Raîche et al. developed two instruments at Sherbrooke University in Quebec, Canada. The first was the Sherbrooke Postal Questionnaire [60], encompassing six items addressing living alone; taking ≥3 medications daily; using a cane, walker, or wheelchair; impaired visual acuity; impaired hearing acuity; and memory problems. Frailty is ≥2 items present. The Program of Research to Integrating the Services for the Maintenance of Autonomy (PRISMA-7) [61] instrument was developed for assessing community-dwelling adults aged ≥75. The seven items in this tool were age ≥85, male sex, health problems limiting ADLs, need for regular assistance, being homebound, social support, and need for a cane, walker, or wheelchair. Frailty is judged if ≥3 items are present.

The Vulnerable Elders Survey (VES-13) [62] is a 13-item instrument developed in 2001 using data from the Medicare Current Beneficiary Survey. Domains include age, physical activities, functional activities, and self-rated health. Score can range from 0 to 10 and frailty is defined by scores ≥3.

The Strawbridge Functional Domains Model instrument [63] was developed in 1994 for the prospective Alameda County Study. It included 16 items in four domains: physical functioning (sudden loss of balance, weakness in arms, weakness in legs, dizziness/faintness upon standing quickly); nutritive function (loss of appetite, unexplained weight loss); cognitive functioning (attentional difficulty, word finding difficulty, difficulty remembering things, and misplacing things); and sensory problems (reading a newspaper, recognizing a friend across the street, reading signs at night, hearing over the phone, hearing a normal conversation, hearing a conversation in a noisy room). Problems in ≥2 domains represented frailty.

The Comprehensive Assessment of Frailty [64, 65] combines an adapted version of the Fried Frailty Phenotype and other information. Additional data is gathered for body mass index (BMI, with gender-specific thresholds), serum albumin, forced expiratory volume in 1 second (FEV1), creatinine, and a modified physical performance test. The last part evaluates standing static balance, chair rise, putting on and removing a jacket, picking up a pen from the floor, and turning 360 degrees. The maximum score is 35. Scores ≤10 are not frail, 11–25 are moderately frail, and 26–35 are severely frail.

The Groningen Frailty Indicator [66, 67] was created in the Netherlands for evaluation of community-dwelling elderly. Fifteen items belong to eight domains: mobility, physical fitness, vision, hearing, nourishment, morbidity, cognition (perception), and psychosocial. Scores range between 0 and 15. Scores ≥4 are considered moderately to severely frail.

The Tilburg Frailty Indicator [68] comes from Denmark and has undergone thorough evaluation of reliability and validity. Unscored items include demographics (sex, age, marital status, country of birth, education, and monthly household income), overall assessment of healthy lifestyle, ≥2 diseases and/or chronic disorders, personal losses in past year, and satisfaction with home living environment. Fifteen-scored items addressed physical, psychological, and social domains. Score ranges from 0 to 15 and the frailty threshold is ≥5.

Application of Frailty Measurements to Surgical Practice

While frailty score may have academic importance and has become a subject of intense literature debate and writings, the fact remains that only in select elective surgical procedure this may be modified.

The modifications and improvement of frailty may be important on the four questions:

1. Whether to perform surgery at all?
2. When to perform surgery, if truly necessary?
3. Is there a need for any preoperative intervention?
4. How can we modify and improve postoperative outcomes?

   Regarding the first class, forgoing surgery may in some instances be the better choice for the most frail. Abundant evidence has accumulated to show that frailty measures predict adverse outcomes such as surgical complications and postoperative mortality [45, 49, 69–81]. Shared decision-making between patients, caregivers, and surgeons should carefully weigh the potential benefits and harms of both operative and nonoperative options. Consultation with palliative care specialists may be desirable.

If decision-makers (patient, family, and the surgeon and other members of the team) have selected the surgical option, choosing the optimal time could be crucial to achieving good outcomes. Assuming that it is possible to delay surgery, time could be well spent assuring that comorbid conditions are appropriately managed. Furthermore, surgeons are increasingly pursuing prehabilitation of surgical candidates. Prehabilitation can be broadly defined as any intervention intended to bolster the physiologic reserve of frail patients and mitigate risks of adverse postoperative outcomes [81]. Interventions may include exercise, improvements to nutrition, and inspiratory muscle training.

Preoperative and postoperative actions would also be essential to optimizing surgical outcomes for frail individuals. Prior to surgery, anesthesiologists and surgeons must apply meticulous care to assessment, monitoring, and management of major organ system functioning, hemodynamics, laboratory test results, and mental status. Following surgery, frail patients may require prolonged stays in intensive care units. Discharge to rehabilitation programs and skilled nursing facilities may be necessary.

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Part II

System Based Specialized Surgical Problems in Geriatric Surgical Patients

7 Anesthetic Concerns in the Elderly

Sarah C. Smith

The aging body is more susceptible to illness and less resilient in the face of disease, such that geriatric patients consume a disproportionate share of healthcare resources. Of the more than 100 million in- and out-patient procedures performed annually in the USA, 32–35% are for those aged 65 and older [1]. As many of these procedures require anesthesia management, anesthesiologists must be familiar with the physiological effects of aging and how these changes influence the response to surgery and anesthesia.

As patients age, there are fundamental changes in body composition and organ function that alter the pharmacokinetics and pharmacodynamics of drugs, including those used during the administration of anesthesia. The accumulation of comorbid conditions that is typical of advancing age also alters responses to drugs administered in the perioperative period. Not only are elderly persons more sensitive to sedative hypnotics, but they also have a higher incidence of certain side effects, including perioperative neurocognitive dysfunction (PND).

While these general principles are widely known, applying them to individual patients is particularly challenging. What is known of changes in pharmacokinetics and pharmacodynamics in the older population is generally based on limited studies in otherwise healthy persons between the ages of 60 and 80. Extrapolating this knowledge to the increasing numbers of octogenarians, nonagenarians, and even centenarians who present for surgery and anesthesia is problematic. Older persons are also more likely to be taking a number of medications on a routine basis compared to their younger counterparts. The anesthesiologist must also consider how each of these drugs may interact with medications administered within the perioperative period [2].

Aging-Related Changes in Organ System Function: Impact on Anesthetic Management

Central Nervous System (CNS)

Aging is strongly associated with a decrease in cognitive function, characterized by impairments in memory [3], reaction time [4, 5], and creativity [6, 7]. While previously acquired knowledge and skills often remain intact in "normal" aging, even these abilities can be lost in age-related pathological states such as Alzheimer's disease (AD), other forms of dementia, or as a result of cerebrovascular accidents (CVA). The magnitude of cognitive decline increases steadily with age, such that among nonagenarians and centenarians only one third have cognitive functioning that could be

S. C. Smith (✉)
Division of Cardiothoracic Anesthesia, Department of Anesthesiology, Westchester Medical Center, New York Medical College, Valhalla, NY, USA
e-mail: Sarah.Smith@wmchealth.org

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classified as normal while another third are moderately impaired and the remaining third are profoundly demented [8].

Age-related cognitive decline parallels changes in the CNS at the gross anatomical, cellular, and neurochemical level. A recent MRI study of healthy adults showed that whole brain volume decreases 0.32% annually after age 20, with an acceleration of volume loss observed after age 70 [9]. Some of this decrease in volume is due to neuronal loss that occurs throughout adulthood, such that by age 90, even cognitively normal individuals have only 90% of the neurons they had as a young adult. The loss of neurons is not uniform, with the hippocampus being largely spared while the neocortex, basal forebrain nuclei, and brainstem monoaminergic systems are more significantly affected [8].

Alterations in neuronal morphology that occur with advancing age may be even more important functionally than overall neuronal loss. For example, the dendritic arbors of pyramidal neurons in the hippocampus and prefrontal cortex regress with age, with losses of dendritic length and number being associated with loss of neuronal connectivity and cognitive functioning [10]. Neurogenesis decreases with age, as do neuroprotective mechanisms, leaving the aging brain highly susceptible to oxidative stress and other sources of cellular damage. These changes result in the aged brain being more vulnerable to injury and less able to adapt to pathological states through neuronal plasticity.

Levels of several neurotransmitters including acetylcholine, dopamine, serotonin, and glutamate (Glu) decrease with age, resulting in corresponding changes in receptors for these chemicals [11]. Proton magnetic resonance spectroscopy (H^1-MRS) allows for the measurement of certain neurometabolites to be measured noninvasively in humans, and several such studies have shown significant changes associated with aging. Levels of Glu, the primary excitatory neurotransmitter in the brain, have been shown to fall with aging, as do levels of n-acetyl aspartate (NAA), a marker for neuronal metabolic efficiency and functioning. The aging brain also has increased levels of choline (Cho), an indicator of neuroinflammation. Although changes in NAA, Glu, and Cho are associated with normal aging, the changes are more pronounced in patients who have lower scores on neurocognitive testing [12].

The neurocognitive changes associated with aging parallel a generalized increase in sensitivity to anesthetics and analgesics. The minimum alveolar concentration (MAC) is defined as the percentage of volatile anesthetic at 1 atmosphere required to produce immobility in 50% of a population in the presence of surgical stimuli. After peaking at 6 months, MAC decreases steadily with age, such that patients in their eighth and ninth decades of life require only approximately two thirds the level of volatile agent as a patient in young adulthood [13]. Changes in GABA receptor function result in an increased sensitivity to benzodiazepines in geriatric patients, while other agents including propofol, etomidate, and opioids are also noted to be more potent. A decrease in cerebrospinal fluid (CSF) volume and an increase in dural permeability result in geriatric patients requiring lower volumes of local anesthetics for neuraxial anesthesia, while a decrease in peripheral nerve myelination also decreases the dose required for peripheral nerve blockade [2].

Cardiovascular

The incidence of cardiac pathologies including ischemic and valvular heart disease increases with age, but even if these conditions are absent, there are changes in the cardiovascular system that affect anesthetic management. Aging is associated with a generalized loss of compliance in the tissues of the heart and vascular system as elastin production declines leading to its replacement by stiffer collagen fibers. There are several clinical manifestations of this loss of compliance. Because stroke volume is preserved, but the aorta is less compliant, systolic blood pressure (SBP) is generally higher in older adults. The pressure wave generated by ventricular contraction travels more quickly through the stiffened arterial system such that a reflective pressure wave may return to the heart before ejection is complete

[14]. This increase in afterload over time may contribute to the development of left ventricular hypertrophy (LVH) and subsequent diastolic dysfunction, which may progress to diastolic heart failure. The incidence of diastolic heart failure has been increasing in recent decades such that it is now more prevalent than systolic heart failure. Importantly, both diastolic dysfunction and diastolic heart failure are associated with an increased risk of adverse cardiac events following non-cardiac surgery as well as prolonged lengths of stay (LOS) [15].

Although resting sympathetic tone is high in geriatric patients, the response to beta-stimulation is diminished, such that maintenance of cardiac output (CO) is more preload dependent. Preload stability is dependent upon the function of the venous system to serve as a reservoir for most of the body's blood volume. As the venous system also becomes less compliant with age, this stabilizing factor on preload is also diminished. The result is significant blood pressure lability in geriatric patients under anesthesia, with precipitous hypotension often occurring due to the vasodilating effects of induction agents and potential rebound hypertension following treatment with vasoconstrictors. Goals for anesthetic management for these elderly patients should include careful maintenance of preload, as too little will not allow sufficient ventricular filling due to noncompliance of the myocardium, while too much may raise left atrial pressures and cause pulmonary edema. Elderly patients are more reliant upon the atrial kick for ventricular filling, so maintenance of sinus rhythm and prompt treatment of tachycardia are also important [14].

Pulmonary

Lung function peaks in the third decade of life and steadily declines thereafter due to changes in the lung parenchyma, chest wall, and respiratory muscles. The lung parenchyma becomes more compliant with age, resulting in a loss of structural support that helps keep small airways open, such that atelectasis develops more easily, particularly in the perioperative setting due to mechanical ventilation, pharmacologic paralysis, and surgical positioning. There is an enlargement of airspaces, such that the alveolar surface area declines, leading to ventilation-perfusion (VQ) mismatching, decreased diffusing lung capacity for carbon monoxide (DLCO), and impaired oxygenation [16]. The dead space ventilation increases due to this expansion of airspaces as well, such that geriatric patients must maintain a higher resting minute ventilation than younger persons to maintain normocarbia [17].

Aging is associated with a loss of intervertebral disk space, leading to kyphosis and a chest cavity that is shorter and more barrel-shaped than in young adulthood. This anatomical change is mechanically disadvantageous, resulting in increased work of breathing. Simultaneously, diaphragmatic and intercostal muscle strength decreases, such that it is more challenging for geriatric patients to increase minute ventilation in response to stress or exercise [17]. Together these changes result in a chest wall that is less compliant with age, contributing to deleterious changes in lung mechanics. The total lung capacity (TLC) is largely preserved, but a rise in functional residual capacity (FRC) and residual volume (RV) results in a corresponding decline in vital capacity (VC). The forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) decrease with age, while the ratio FEV1/FVC is also lower due to an increase in airway resistance [16].

Geriatric patients also have a diminished respiratory drive in response to hypoxia and hypercarbia and a higher incidence of central sleep apnea. Decreased mucociliary function [18], diminished cough reflexes, and weakness of respiratory musculature frequently impair the ability of geriatric patients to clear mucus and debris from the airway, increasing the risk of perioperative aspiration [17]. Predictably, age is an independent risk factor for a variety of postoperative pulmonary complications (PPC) [19, 20], including unplanned reintubation [21] and pneumonia [22].

A number of strategies can be employed in the perioperative period to minimize the risk of PPCs in elderly patients, including avoidance of general anesthesia and utilization of lung-protective ventilation. During mechanical ventilation, low tidal volumes (6–8 mL/kg), avoidance of unnecessarily high levels of inspired oxygen (FiO_2), and the use of recruitment maneuvers may decrease the risk of PPCs. The ideal level of positive end-expiratory pressure (PEEP) during general anesthesia is unclear as studies have shown both low (<2 cm H_2O) and high (>10 cm H_2O) levels of PEEP to be deleterious. Reversal of nondepolarizing neuromuscular blockade should be complete in geriatric patients as residual weakness in the recovery period can also increase the risk of PPCs. Adequate analgesia, chest physiotherapy, incentive spirometry, and early mobilization are also strategies that can be implemented in the immediate postoperative period [23].

Gastrointestinal

Liver mass decreases 20–40% from young adulthood to old age with a corresponding decline in hepatic blood flow. Bile acid secretion declines with age, while biliary cholesterol increases, contributing to an increased risk of gallstones and gallbladder disease in the elderly. There is also evidence that the regenerative capacity of the liver decreases in old age, particularly in the presence of significant hepatic disease. It may be presumed, therefore, that geriatric patients are at a higher risk of hepatic dysfunction in the setting of pathophysiologic stress such as shock. Human and nonhuman primate studies of the effects of aging on Phase I metabolism have yielded mixed results, as there is much interindividual variability in the activity of the involved hepatic enzymes regardless of age. However, the increased risk of adverse drug events in elderly patients suggests there may be an overall decline in hepatic drug metabolism associated with aging [24]. Additionally, mortality due to liver disease increases markedly after age 45 before beginning to decline again after age 85. The decrease in liver disease mortality in those in their ninth and tenth decades of life likely reflects the presence of underlying protective physiologic factors, suggesting that the absence of significant liver disease is essentially a prerequisite for achieving extremely old age [25].

Both esophageal motility and gastric emptying decline with age, perhaps contributing to the higher risk of perioperative aspiration that is observed in geriatric patients [14]. The American Society of Anesthesiologists (ASA) perioperative fasting guidelines make no specific recommendations for the elderly, however [26]. Atrophic gastritis is associated with aging and may contribute to hypocalcemia in this population. Pancreatic function, however, remains largely intact in advanced age [14].

Renal

While it was once thought that aging itself resulted in a significant decline in renal function, more recent evidence suggests that when confounders such as hypertension, diabetes, and heart failure are accounted for, renal function remains relatively normal in advanced age. Although renal mass and the number of glomeruli decrease approximately 20–30% by age 80, clearance of drugs remains in the low-normal range when compared to younger adults. The clearance of waste products and maintenance of fluid homeostasis also remain largely intact [27].

Nonetheless, all causes of renal dysfunction increase in frequency with advancing age, such that a large portion of the geriatric population has renal pathology, although not as a result of aging *per se*. Because the serum creatinine commonly obtained as part of preoperative laboratory studies is a poor indicator of renal function, many geriatric patients presenting for surgery may have occult renal dysfunction and will have decreased clearance of drugs common in anesthetic practice, particularly certain neuromuscular blocking agents. Changes in the renin-angiotensin-aldosterone system, a diminished sense of thirst, and a decreased ability to thermoregulate in the setting of high temperatures make geriatric patients susceptible to dehydration. Hypovolemia in the preoperative fasting state may, therefore, be more pronounced in older patients, and the anesthesiologist must be prepared to administer necessary intravenous volume expansion. The aging kidney may also be more susceptible to acute insults, including intraoperative hypotension. Careful titration of vasopressors and volume expansion during anesthesia are particularly important to maintain blood pressure within a range consistent with baseline to minimize the risk of perioperative acute kidney injury (AKI) [14].

Endocrine and Thermoregulatory Systems

The incidence of Type 2 diabetes increases with age, but even those geriatric patients without such a diagnosis have altered responses to serum glucose levels and insulin compared to their younger counterparts. Aging is associated with a decrease in insulin secretion as well as an increase in insulin resistance, primarily in skeletal muscle, whereas the hepatic response to insulin remains relatively intact. This change may parallel the sarcopenia, or loss of muscle mass, that is common in old age [28]. Perioperative hyperglycemia is associated with a variety of adverse outcomes, including infection, poor wound healing, and perioperative neurocognitive dysfunction, so glucose monitoring should be strongly considered in elderly patients undergoing major surgery. The precise range in which to maintain perioperative blood glucose levels is unclear, however, intensive glucose management (maintenance of serum glucose at 80–100 mg/dL) is associated with an increased risk of stroke and death. Subsequently, there is a great deal of variability between the recommendations of different specialty organizations regarding when perioperative insulin therapy should be initiated. However, most recommend treatment for glucose levels over 180 mg/dL [29].

Aging is associated with a number of endocrine disturbances that appear to contribute to sarcopenia, the progressive loss of muscle mass that occurs in older people contributing to generalized weakness, increased fall risk, and susceptibility to musculoskeletal injury. Sex hormones decrease in both men and women, with testosterone decline being more significantly linked to sarcopenia in men. Unfortunately, studies investigating testosterone supplementation in older men have shown an increased risk of cardiovascular events. Dehydroepiandrosterone (DHEA), a precursor for estrogen and androgens in skeletal muscle, also steadily falls with age. Decreased vitamin D levels, declines in insulin-like growth factor (IGF) and growth hormone (GH), as well as perturbations of the hypothalamic pituitary adrenal (HPA) axis resulting in elevated cortisol levels are also thought to contribute to sarcopenia [30].

Although thyroid function is not affected by aging itself, disorders resulting in hypothyroidism become progressively more common with age, particularly among women, for whom hypothyroidism is ten times more common than in men. Hypothyroidism in the elderly is underdiagnosed, as several of its symptoms, such as fatigue, weight gain, and cold intolerance, are also common in normal aging. Postoperatively hypothyroid patients have an increased risk of atrial fibrillation, particularly after cardiovascular procedures. Severe hypothyroidism could manifest in the postoperative period as poor wound healing, infection, or even myxedema coma. While severe hypothyroidism should be corrected before elective surgery, there is a paucity of evidence that correction of mild to moderate hypothyroidism improves surgical outcomes [31].

The elderly are more prone than younger adults to both hypo- and hyperthermia due to diminished thermoregulatory mechanisms. A variety of systems are engaged to maintain constant body temperature. Thermosensory afferents send signals regarding body and skin temperature to the CNS which then activates compensatory mechanisms to maintain temperature within a narrow range. Increased temperature results in vasodilation at the periphery such that heat can be discharged to the surroundings. Lower temperature conversely results in vasoconstriction and increased production of norepinephrine as well as increased thermogenesis from shivering. Aging is associated with a loss of sensory function such that temperature information is not relayed to the CNS as effectively as in younger adults. Further, thermogenesis is limited in the elderly, while vasoconstrictive and vasodilatory responses to temperature changes are also blunted [32].

General, neuraxial, and regional anesthesia impairs all aspects of the thermoregulatory system, and the effects are more pronounced in the elderly [33–35]. Because operating rooms are kept relatively cold and patients are at least partially exposed during surgery, this generally manifests as intraoperative and postoperative hypothermia, which is associated with prolonged anesthesia recovery, cardiac morbidity, and impaired drug metabolism. Perioperative hypothermia also promotes infection, impedes wound healing, and may result in coagulopathy which can exacerbate surgical bleeding. Intraoperative temperature monitoring is, therefore, of particular importance in geriatric surgical patients, and multiple warming methods should be considered, including heating of intravenous fluids, hot air or water blankets, and avoidance of unnecessary skin exposure [33].

Pharmacology of Anesthetics and Analgesics in the Geriatric Population

Geriatric patients are generally more sensitive to anesthetics and analgesics and display prolonged reactions to these drugs when compared with younger adults. Although there are some modest changes in pharmacokinetics associated with aging, most of this alteration in the response to sedative hypnotics is due pharmacodynamics effects. As mentioned in the preceding section, renal and hepatic clearance of drugs declines only minimally in the geriatric population in the absence of pathology. Phase I and Phase II metabolism in the liver is for the most part unchanged in geriatric patients. Protein binding of drugs may also decrease in advanced age, but clinically this seems to be of limited significance [27].

Aging is associated with an increased percentage of adipose tissue and lower total body water, resulting in a higher volume of distribution (V_d) and subsequent duration of action for lipophilic drugs [2]. Propofol is highly lipophilic and is noted to have an exaggerated sedative effect for a given dose in the elderly. Further, because of the increased V_d, the time to reach a steady state during a propofol infusion and the time required for recovery are also increased. Because of the cardiovascular changes associated with aging that have been previously discussed, hypotension may be profound after propofol induction in elderly patients. A 25–50% reduction in induction dose for propofol is recommended in the geriatric population, particularly in the setting of cardiac disease or frailty. Although etomidate provides a more hemodynamically stable induction than propofol, the dosing of this drug should also be decreased.

Long-acting opiates such as morphine and hydromorphone should be used with caution in the elderly, particularly in the setting of end-organ dysfunction. The pharmacokinetics of the shorter-acting fentanyl and remifentanil are largely unchanged in advanced age, but changes in pharmacodynamics result in these drugs being notably more potent. By the ninth decade of life, a 50% reduction in dosing of these drugs is recommended compared to young adults [36].

Prolonged duration of action of neuromuscular blockade (NMB) in the geriatric population is of particular concern. Residual NMB in the postoperative recovery period may result in hypoxia and hypercarbia, as well as increase the risk for reintubation, aspiration, and pneumonia. The duration of action of the aminosteroid NMBs, vecuronium and rocuronium, is prolonged by approximately 50% in the geriatric patients due to changes in pharmacokinetics as well as aging-related changes at the neuromuscular junction. By comparison, the benzylisoquinoline NMBs, atracurium and cisatracurium, are eliminated by Hoffman elimination, and their duration of action does not appear to be prolonged in the elderly [37].

As previously described, for volatile anesthetics MAC peaks at age 6 months and then declines throughout life, likely due to changes in GABA receptor function. After age 40 MAC decreases approximately 6% per decade, particularly during coadministration of other sedatives, including benzodiazepines, opiates, and nitrous oxide. Despite this well-known phenomenon and the fact that many modern anesthesia machines can be programmed to calculate age-adjusted MAC values automatically, there is evidence that elderly patients are routinely overdosed with volatile agents during general anesthesia [38]. Similar overdosing of fentanyl and propofol during induction of anesthesia has also been demonstrated [39]. Excess doses of anesthetics and analgesics contribute to a variety of postoperative complications, including PND, which will be discussed in detail in a following section of this chapter. It is important for anesthesiologists to be aware of the increased sensitivity among elderly patients to a variety of drugs used in the perioperative setting and to make dosing adjustments accordingly.

Preoperative Optimization and Assessment

Geriatric patients scheduled for elective surgery should undergo a comprehensive assessment addressing not only comorbidities but functional status, mental health, and social circumstances. Structured preoperative assessment allows for risk stratification such that patients and their families can be appropriately counseled regarding probable surgical outcomes and the likelihood of complications. This is also an opportunity for older patients to designate an appropriate surrogate and ideally develop a written advance directive that reflects their individual values and preferences. Establishing an advance directive in anticipation of a scheduled surgery and hospitalization can ensure that goals of care are understood by the patient, family, and perioperative medical team, minimizing the risk of psychosocial stress and conflict that may arise in the setting of an adverse outcome or complication [40].

The American Society for Enhanced Recovery and Perioperative Quality Initiative (ASER/PQI) has issued a joint consensus statement recommending nutritional screening for all elective surgery patients, with special recommendations for those in the geriatric age group. Initial screening includes an assessment of weight and inquiring about recent eating habits and unintended weight loss. For those over age 65, all-cause mortality begins to rise below a BMI of 24 kg/m^2 and doubles at 22 kg/m^2 for women and 20 kg/m^2 for men. For this reason, the ASER/PQI joint statement recommends that elderly adults scheduled for elective surgery with a BMI of less than 20 kg/m^2 should be referred to nutritional counseling, while the trigger for those under age 65 is 18.5 kg/m^2. Although neither specific nor sensitive for malnutrition, the serum albumin level is a simple and inexpensive indicator, with a value less than 3 g/dL being of concern. Patients reporting an unintended weight loss of greater than 10% in 6 months or those who report consuming less than half their normal intake in the preceding week are also considered high risk and should be referred for nutritional counseling.

Preoperative nutritional optimization for high-risk individuals should include nutritional supplementation for 7 days prior to surgery and avoidance of unnecessary prolonged fasts. More than increasing caloric intake, preoperative nutritional supplementation should emphasize increased protein consumption as this promotes wound healing, decreases the risk of pressure ulcers, and bolsters immune function. Arginine supplementation can also be considered, as it is required for proper T-cell function and the synthesis of endothelial nitric oxide. Omega-3s, as found in fish oil, and antioxidants are also sometimes used during the nutritional optimization period to further support the immune system. If a patient is unable to consume nutritional supplementation orally, enteral or parenteral supplementation should be considered with the guidance of a dietician [41]. Adults at normal risk for aspiration according to current ASA guidelines can consume a light meal within 6 hours of surgery and may continue to consume clear liquids until 2 hours before surgery [26]. Additionally, a preoperative drink containing greater than 45 g carbohydrates is recommended for all adults undergoing major surgery [40]. Oral, enteral, or parenteral nutrition should be reinitiated as soon as possible postoperatively, and supplementation in the post-discharge period may be necessary for elderly adults following major surgery [41].

Preoperative geriatric assessment should include an assessment of frailty, an age-related decline in strength, functional status, and physiologic reserve associated with adverse postoperative outcomes. Frailty can be assessed by a number of different scoring systems, incorporating quantitative measurements, such as grip strength or walking speed, as well as qualitative metrics such as independence in activities of daily living (ADL), mood, and degree of social support [40]. Derived from the Canadian Study of Health and Aging, the seven-point Clinical Frailty Scale is a simple global assessment of frailty that can be completed easily in the preoperative clinic. Using this scale, a patient who is robust, active, and energetic would receive a score of 1, while one who is somewhat dependent on others in ADLs would receive a score of 5. A score of 7 would indicate severe frailty, characterized by complete dependency or terminal illness [42]. The Edmonton Frail Scale (EFS) involves both subjective and objective assessments across 17 different domains, including cognition, mood, medication use, and functional independence. Although somewhat more complex than the Clinical Frailty Scale, EFS can generally be completed within 5 minutes and is, therefore, also appropriate for use by non-geriatricians in the preoperative clinic setting [43].

Regardless of the particular scale or scoring system utilized, frailty is strongly associated with mortality, complications, and prolonged LOS among geriatric surgical patients [44]. While it is not clear that frailty is a process that can be meaningfully reversed in the preoperative period, it does provide useful risk stratification and may guide surgical and anesthesia-related decision-making. For example, frail geriatric patients may be better candidates for less invasive forms of surgery and other treatment, while the anesthetic management of these patients should include measures such as close attention to maintenance of normothermia and strategies to minimize the risk of postoperative delirium [40].

Implementation of comprehensive perioperative optimization programs for geriatric patients have been demonstrated to decrease complications, shorten LOS, and be cost saving. The Duke Perioperative Optimization of Senior Health program involves a preoperative visit with a multidisciplinary team for elective surgery patients over age 85 or 65 in the presence of multiple comorbidities, cognitive dysfunction, unintended weight loss, significant hearing or visual deficit, or polypharmacy. During this assessment, patients are assessed and optimized across multiple domains, including mobility, nutrition, pain, cognition, and advanced care planning. Postoperatively, these patients are followed daily by a geriatric consult team. A cohort study of this program demonstrated that the intervention cohort had a lower risk of any complication and shock. Average LOS was shorter by 2 days, while 7- and 30-day readmission rates were also reduced. These patients returned home to self-care more frequently than those who did not participate in the program [45]. The University of Michigan Surgical Home incorporates several preoperative interventions including a home-based walking program, smoking cessation, incentive spirometry, and education regarding nutrition, stress management, and advanced care planning. Although not specifically targeted at the geriatric population, a cohort study of the Michigan Surgical Home in which the average patient was 60 years old demonstrated a LOS decrease of 2 days and an average total cost savings of nearly $7000 per patient [46].

Perioperative Complications in the Elderly

Stroke

Perioperative ischemic stroke is a rare, but potentially devastating complication that occurs with increasing frequency in advanced age. Strokes can occur intraoperatively or in the immediate recovery period, but most frequently strike over 24 hours after surgical intervention [47]. One retrospective study of over 350,000 patients undergoing non-cardiac, non-vascular, and non-neurological surgery found that while the incidence of perioperative stroke was only 0.2/10,000 for those under age 45, for those over 75, the rate rose to 15.7/10,000 [48]. The risk is substantially higher for cardiac and vascular procedures. A prospective study of over 16,000 open heart surgery patients found an overall risk of 4.6% with the highest incidence observed following double valve surgery (9.7%) [49]. In addition to age, there are several other modifiable and nonmodifiable risk factors for perioperative stroke, including renal failure, diabetes, hypertension, and female sex [49, 50]. Those who have experienced a myocardial infarction (MI) in the preceding 6 months and those with a history of prior stroke are also at increased risk [51]. For the open heart population, prolonged periods of cardiopulmonary bypass (CPB) and high transfusion rates are also factors [49].

While it is possible that better blood pressure and glycemic control in the preoperative period may decrease stroke risk, there is no evidence to support a specific strategy to address this. Additionally, it is unclear whether avoidance of general anesthesia (GA) and the utilization of neuraxial or regional techniques offer any advantage. There is evidence that allowing blood pressure to deviate more than 20–30% from baseline intraoperatively probably increases risk, so careful attention to hemodynamics in the elderly is important to minimize stroke risk [47]. Among non-cardiac and non-vascular procedures, orthopedic surgery is associated with a higher risk of stroke, perhaps because deliberate hypotension is frequently utilized in these procedures to minimize bleeding and improve surgical exposure [48]. Avoidance of hypo- and hyperglycemia is also warranted both for the prevention and management of perioperative stroke. Monitoring of EEG activity or cerebral oximetry should be strongly considered during high-risk procedures, including open heart surgery or major vascular procedures.

Anesthesiologists should maintain a high index of suspicion for stroke in elderly patients displaying neurological changes during or after surgery. This is challenging, however, because residual effects of sedative hypnotics or delirium can either mask or be confused with an acute stroke. Suspected strokes should be investigated quickly by a multidisciplinary stroke team, referred to by many institutions as “stroke codes.” Rapid evaluation with imaging should be pursued and treatment with thrombolytics considered. The risk-benefit evaluation of thrombolytic therapy and other anticoagulants in the immediate postoperative period is challenging, however, because of the risk of postsurgical bleeding [47].

Cardiovascular Events

The risk of perioperative cardiovascular complications, including acute myocardial infarction (MI), acute heart failure, arrhythmia, and cardiovascular mortality, increases in a nonlinear fashion with age [52]. A Danish study of over 300,000 non-cardiac elective surgery patients showed that risk for major adverse cardiovascular events (MACE), defined as non-fatal MI, stroke, or cardiovascular mortality, dramatically increased with age. For example, in the 40–50-year-old age group, the risk of MACE and death was 0.06% and 0.07%, respectively, while in the 80–90-year-old age group, this had increased to 1.67% and 1.95%, respectively. Among those above 90 years old, the risk of MACE was 3% and risk of death was 4%. This corresponded to an odds ratio (OR) of 1.87 per decade for MACE. These authors emphasized that while the absolute risk remained relatively low in even those over age 90, other series had found higher risk levels, perhaps because in the Danish health system, high-risk elderly patients were being effectively excluded from surgery [53]. Another study of over 11,000 Canadian men undergoing prostatectomy for cancer revealed similar results. These authors identified an OR of 1.54 for perioperative cardiovascular complications among those 60–69 years old when compared to those under age 60, while the OR increased to 3.33 for those in the 70–79-year-old age bracket [54].

Among cardiac surgical patients, a similar nonlinear relationship has been observed with age for postoperative complications and mortality. However, improvements in surgical techniques and intensive care have resulted in more patients in extreme old age undergoing these procedures. A study of octogenarians undergoing open cardiac surgery showed an in-hospital mortality rate of 3.9%, with emergent surgery being associated with a higher risk of death. However, these authors noted that 91% were discharged home in good clinical condition [55]. A series of 42 nonagenarian cardiac surgery patients demonstrated very high rates of complications, including respiratory failure and infection, but a 30-day survival rate of 95%. At the time of publication, 81% of the patients in the series were still alive an average of 2.53 years after surgery, with one patient surviving for over 7 years [56].

Therefore, anesthesiologists can anticipate encountering more patients in the ninth and tenth decades of life presenting for elective surgery, even for cardiac procedures. Prevention of cardiovascular complications in this age group begins with preoperative optimization, including management of heart failure by existing guidelines and continuation of beta-blockade if applicable. As the elderly tend to have higher blood pressures than their younger counterparts, management should be tailored to an individual's baseline to prevent a variety of complications that may result from hypotension, including myocardial ischemia. Elderly patients should be closely monitored in the perioperative period for evidence of ischemia, heart failure, and arrhythmia given their increased risk [40]. Commonly used cardiac risk indices, including the Revised Cardiac Risk Index and Gupta MI and Cardiac Arrest calculator, have been shown to be inaccurate in the elderly and underestimate risk. A recently derived and validated Geriatric-Sensitive Perioperative Cardiac Risk Index based on National Surgical Quality Improvement Program (NSQIP) data was found to outperform these other two models in those over age 65 and may provide better risk stratification for geriatric patients [52].

Perioperative Neurocognitive Disorders

The PND include delirium and postoperative cognitive dysfunction (POCD), both of which occur with increasing frequency in the elderly. Delirium is characterized by altered or fluctuating levels of consciousness, disorientation, and disordered thinking and may be either hyper- or hypo-active. Both forms of delirium are associated with prolonged LOS and poor surgical outcomes, while the acute incidence of delirium also increases the risk of POCD [57]. A definitive diagnosis of POCD is challenging in most clinical scenarios as it requires a documented change in neurocognitive testing before and after a surgical intervention. Patients rarely undergo this type of testing outside of the research setting. Nonetheless, a decline in cognitive functioning is often recognized by the families of elderly patients after surgery and is a primary concern of elderly patients undergoing surgery.

Of the 16 million Americans over age 60 who undergo surgery annually, 10–40% will experience PND, such that the personal and financial costs of this problem are quite vast [58].

In addition to being associated with poor outcomes, there is also some concern that POCD is associated with an increased risk of dementia or acceleration of otherwise normal cognitive decline. The clinical data on this issue is quite mixed, with some studies showing that older adults undergoing surgery and anesthesia have no increased risk of dementia or cognitive dysfunction 1–5 years post-surgery [59, 60] while others indicate that there is indeed an increased risk [61, 62]. Certain elderly patients may experience an improvement in cognitive functioning following surgery, as has been reported following coronary artery bypass grafting (CABG), presumably due to improvements in cerebral perfusion and overall levels of functioning due to coronary revascularization [63].

Among the nonmodifiable risk factors for PND are longer and more invasive surgical procedures, a prior diagnosis of stroke or dementia, and a lower level of educational attainment. Other factors that can potentially be optimized pre- or postoperatively include smoking, diabetes, metabolic syndrome, and postoperative renal or pulmonary complications [63].

There is growing evidence that the risk of PND can be decreased by minimizing the exposure to anesthetics and analgesics. The CODA trial investigated this possibility by randomizing non-cardiac surgery patients over age 60 either to have anesthetic depth titrated to bispectral index

(BIS) or to have the BIS values blinded to the anesthesia provider. Titration of anesthesia to a BIS of 40–60 resulted in lower cumulative doses of propofol and average concentrations of volatile agent, while rates of delirium and POCD at 3 months were significantly reduced [64]. A recent Cochrane meta-analysis of several trials, including CODA, confirmed this finding [65].

The ASA Perioperative Neurotoxicity Working Group has published several recommendations for the prevention and management of PND. The first of these is that elderly patients should be informed of the risk of PND such that they can plan to make cognitively taxing decisions before undergoing surgery and engage with family and friends, as effective social support is a mitigating factor in the development of PND. The Working Group also recommends that geriatric surgical patients undergo a brief cognitive screening as part of the preoperative evaluation, particularly as patients with preexisting neurocognitive dysfunction are at increased risk for PND. Finally, these authors recommend using age-adjusted MAC values to titrate anesthetic depth in older adults, maintaining cerebral perfusion by limiting intraoperative hypotension, and utilizing EEG-based monitoring (such as BIS) when available [58].

Limiting exposure to postoperative opiates may also be effective in reducing PND in older adults, as suggested by the recent DEXACET trial. This randomized placebo-controlled trial included patients over age 60 (median age 69) undergoing on-pump CABG with or without valve replacement. Patients were randomized postoperatively to receive either placebo or standing intravenous acetaminophen every 6 hours for the first 48 hours in conjunction with propofol or dexmedetomidine sedation. Although there was no difference between the propofol and dexmedetomidine groups, patients receiving intravenous acetaminophen had less breakthrough pain and required less morphine analgesia postoperatively, resulting in a lower risk for delirium (10% vs. 28%), shorter duration of delirium (1 vs. 2 days), and reduced length of ICU stay (29.5 vs. 46.7 hours) [66].

Conclusion

As the US and global populations continue to age, the number of geriatric patients, including those in extreme old age, will present with increasing frequency for both elective and emergent procedures requiring anesthesia management. The anesthesiologist must be aware of the normal processes of physiologic aging and how these changes adversely impact different organ systems. Older patients also typically have higher rates of comorbidities than their younger counterparts, and anesthesia management plans should be individualized to address the specific risk factors of each patient. While pharmacokinetic changes attributable specifically to advancing age are relatively modest, the frequency of renal and hepatic dysfunction is high in the geriatric population such that response to drugs used during anesthetic management may be exaggerated and difficult to predict. It is very well established that sedative hypnotics, including anesthetic agents and opiates, are more potent in the geriatric population, and careful titration of these drugs is essential. Residual effects of anesthesia or excess sedation from analgesics and anxiolytics increase the risk of a variety of complications. Particularly noteworthy is the increasing recognition that relative overdose of anesthetics and analgesics in the elderly contributes to the development of PND, a costly complication of surgery and anesthesia that may contribute to permanent cognitive decline. The adoption of perioperative optimization programs for geriatric patients can likely mitigate this and other complications.

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8 Nutrition Support in Elderly Patients Undergoing Surgery

Shekhar Gogna, Jaqueline Maxwell, Anthony J. Policastro, and Rifat Latifi

"How we nourish and treat our elderly population during next decade or two will influence greatly how we define our character individually and as a society culture and nation. Nutrition support involves more than putting food on the table, putting an enteral tube feed into the gastrointestinal tract or putting a parenteral feeding catheter into a central vein." – Stanley J Dudrick, MD, FACS

Advanced age is an independent predictor of poor nutritional status and postoperative mortality in surgical patients [1]. The etiology of malnutrition in the elderly is multifactorial and encompasses low nutrient intake, reduced appetite, chronic disease, multiple medication, and/or psychological condition [2]. Malnutrition is associated with higher rates of perioperative complication such as impaired wound healing, longer length of hospital stay, and increased morbidity and mortality [3, 4]. The nutritional interventions alter this risk when applied appropriately. In this chapter we will describe the systematic approach to assess, intervene, and analyze the nutritional status in the elderly undergoing major surgery. We begin with expounding the prevalence and pathogenesis of malnutrition in the elderly undergoing surgery. The second part defines the malnutrition in the elderly and the methods to screen and diagnose malnutrition in the elderly. This is followed by a description of the nutrition intervention plan for elderly surgical patients. The nutrition intervention plan includes the nutritional counseling, mode of nutritional support, and the timing of administration of nutrition in pre- and postoperative period. The final section of this chapter will highlight the areas of current and future research on malnutrition in the elderly undergoing surgery.

Prevalence and Pathogenesis of Malnutrition in the Elderly Undergoing Surgery

More than one-third of all inpatient surgical procedures in the USA were performed on patients aged 65 years and older in 2007, and this number is expected to double by 2020 [5]. The prevalence of malnutrition in non-institutionalized elderly in the USA is 1–15%. This proportion increases dramatically to 25–60% for patients in geriatric care facilities and 35–65% in hospitalized elderly [6]. Malnutrition in the elderly is prevalent in pre-hospital, hospital, and post-hospital periods,

S. Gogna
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

J. Maxwell
Clinical Nutrition, Westchester Medical Center, Valhalla, NY, USA

A. J. Policastro
Trauma and Critical Care, Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: Rifat.Latifi@wmchealth.org

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with gradual deterioration in nutritional stores as patients traverse through each of these phases. Aging promotes malnutrition, which in turn is an increased risk for hospitalization in the elderly [7]. Inadequate nutritional intake continues in hospital and after discharge [8]. Despite being frequent, malnutrition remains under-diagnosed and untreated and has been correctly referred to as the "skeleton in the hospital closet" [9]. Studies have shown that there was a threefold increase in hospital costs when patients were malnourished. Nationally the annual cost of disease-associated malnutrition is over \$15.5 billion. The elderly bear a disproportionate share of this cost on both the state and national levels [10].

The pathogenesis of malnutrition is multi-pronged and is depicted in Fig. 8.1. Malnutrition is often due to a combination of the following factors: inadequate food intake; food choices that lead to dietary deficiencies; and systemic illness that causes increased nutrient requirements, increased nutrient loss, poor nutrient absorption, or a combination of these factors [11]. Physiologic aging promotes loss of cells in the myenteric plexus and decreased gastric emptying, possibly associated with reduced nitric oxide concentrations [12]. This neuronal dysfunction promotes increased transcription of IL-6, TNF-α, and glucagon-like peptide which promotes anorexia, loss of muscle mass, and sarcopenia [12, 13]. Malnutrition resulting from this promotes further immune dysregulation, hence precipitating vicious cycle.

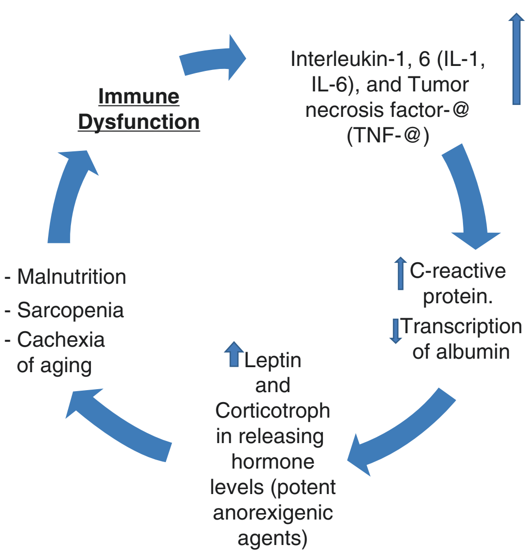

Fig. 8.1 Pathophysiology of malnutrition

Definition and Detection of Malnutrition in Elderly

Disagreement exists among health professionals regarding the use of terminologies such as malnutrition, starvation, cachexia, and sarcopenia. To address this issue, the representatives of the four of the prominent global parenteral and enteral nutrition societies, European Society for Clinical Nutrition and Metabolism (ESPEN), American Society for Parenteral and Enteral Nutrition (ASPEN), The Parenteral and Enteral Nutrition Society of Asia (PENSA), and Latin American Congress of Clinical Nutrition, Nutrition Therapy, and Metabolism (FELANPE), met at ESPEN Congress in Copenhagen, Denmark (September 2016) to create a consensus statement on diagnosing malnutrition [14]. The ESPEN suggested a grading approach that could encompass various types of signs, symptoms, and etiologies to support diagnosis. ASPEN emphasized weight loss as a key indicator for malnutrition, while FELANPE suggested that the anticipated consensus approach needs to prioritize a diagnostic methodology that is available for everybody since resources differ globally. Finally, and PENSA highlighted that BMI varies by ethnicity/ race and that sarcopenia/muscle mass evaluation is important for the diagnosis of malnutrition. Malnutrition can be defined as "a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease" [15]. The global consensus and uniform guidelines are an ongoing work, but the identification of two or more of the following six characteristics is recommended for diagnosis for malnutrition: (1) insufficient energy intake, (2) weight loss, (3) loss of muscle mass, (4) loss of subcutaneous fat, (5) localized or generalized fluid accumulation, and (6) diminished functional status as measured by handgrip strength [16].

We believe that improved knowledge and awareness of classifications of malnutrition are crucial for optimal nutritional treatment in order to minimize complications after surgery in the elderly. Table 8.1 depicts the various subclasses of malnutrition with or without inflammation and malnutrition/undernutrition without the disease [17]. In order to intervene appropriately to optimize nutritional status in elderly patients, malnutrition must first be identified correctly. The first step in the identification process is a thorough history and physical examination. It should be kept in mind that due to physiological changes induced by the aging process, interpretation of standard nutritional assessment parameters should be adjusted for the geriatric population. This is especially important for anthropometric and biochemical tests. Medical and surgical history should focus on recent unexplained weight loss, depression, dementia, other neurologic diseases, chronic infections, malignancy, and end-organ disease or failure, and the malnutrition can very well be a presentation of a serious disease or condition. It is important to keep in mind that depression and malignancy are the top two reasons for malnutrition in the elderly [18].

Table 8.1 Sub-classification of clinical nutrition concepts, i.e., nutrition disorders and nutrition-related conditions. [ESPEN committee consensus, 80% agreement]

Malnutrition
Disease-related malnutrition (DRM) with inflammation
Chronic DRM with inflammation; synonym, cachexia
A cancer cachexia and other disease-specific forms of cachexia
Acute disease- or injury-related malnutrition
DRM without inflammation
Hunger-related malnutrition
Socioeconomic- or psychologic-related malnutrition
Sarcopenia
Frailty
Overnutrition
Overweight
Obesity
Sarcopenic obesity
Central obesity
Micronutrient abnormalities
Deficiency
Excess
Refeeding syndrome

Adapted from Cederholm et al. [17], with permission

Nutritional Screening: Definition and Description

Both ASPEN and ESPEN guidelines have a consensus that the next key step in the evaluation of nutritional status is malnutrition risk screening to identify “the risk” status using any validated screening tool (Table 8.2). The real reason behind the development of these multidimensional screening and scoring tools is the limited information provided by anthropometric or biochemical tests. ESPEN recognizes the following risk screening tools to be used in the hospital and elderly care and community settings: Nutritional Risk Screening 2002 (NRS-2002), Mini Nutritional Assessment-Short Form (MNA-SF), and Malnutrition Universal Screening Tool (MUST) [19].

Nutritional Risk Screening-2002 (NRS-2002) scoring system utilizes the three markers of nutrition, BMI score, weight loss score, and acute illness score [20]. The Mini Nutritional Assessment (MNA) was designed specifically as an assessment tool for the elderly. The distinct advantage of MNA is that all screening methods detect undernutrition in elderly patients, but for the frail elderly, the MNA screening is more sensitive because it evaluates both the physical and mental aspects that impact nutrition in geriatric patients. The MNA-SF is a quick and easy questionnaire to use and has been shown to predict adverse outcomes and mortality and predicts the risk of developing undernutrition at an early stage [21]. The Malnutrition Universal Screening Tool (MUST), though not developed specifically for geriatric patients, is another assessment tool available for adult patients of any age group and in any care setting. The MUST consists of three components – BMI score, weight loss score, and acute illness score – which are each given a numerical value ranging from 0 to 2 [22].

Subjective Global Assessment (SGA) introduced by Detsky in 1987 includes functional

Table 8.2 Survey of existing approaches used in screening and assessment of malnutrition and cachexia

	NRS-2002[a]	MNA-SF[a,b]	MUST[a]	ESPEN 2015[a]	ASPEN/AND[a]	SGA[a]	Evans 2008[c]	PEW 2008[d]	Fearon 2011[c]
Etiologies									
Reduced food intake	X	X	X	X	X	X		X	X
Disease burden/ inflammation	X	X	X	X	X	X	X	X	X
Symptoms									
Anorexia		X				X	X		
Weakness									
Signs/phenotype									
Weight loss	X	X	X	X	X	X	X	X	X
Body mass index	X	X	X	X			X	X	X
Lean/fat free/muscle mass		X		X	X	X	X	X	X
Fat mass					X	X	X		
Fluid retention/ascites					X	X			
Muscle function; e.g., grip strength					X	X	X		
Biochemistry						X	X		

Adapted from Cederholm et al. [17], with permission
NRS-2002 Nutritional Risk Screening-2002, *MNA-SF* ¼ Mini Nutritional Assessment-Short Form, *MUST* Malnutrition Universal Screening Tool, *ESPEN* European Society for Clinical Nutrition and Metabolism, *ASPEN* American Society of Parenteral and Enteral Nutrition, *AND* Academy of Nutrition and Dietetics, *SGA* Subjective Global Assessment, *PEW* Protein Energy Wasting
[a]Malnutrition approach
[b]Adapted for older adults
[c]Cachexia approach
[d]Adapted for chronic kidney disease

capacity and the clinician's overall impression of the patient's status in which they are designated as "normal," "mildly malnourished," or "significantly malnourished." This screening test includes a history of weight loss, poor dietary intake, and loss of subcutaneous tissue and muscle wasting on physical exam [23]. However, the important limitation of SGA is that a physician has to be experienced to be able to use this tool in order to diagnose the elderly with malnutrition with higher sensitivity.

Cachexia is often used as a synonym for malnutrition in the elderly on day-to-day basis in clinical practice. To clarify for the healthcare providers, the consensus panel developed a set of diagnostic criteria to make a definitive diagnosis of cachexia. The key component is at least a 5% loss of edema-free body weight during the previous 12 months or less. The time frame may be disease-specific and is likely to be shorter in cancer (3–6 months) and longer in the chronic kidney or heart failure or COPD (12 months). The synonymous use of cachexia with malnutrition should be avoided because it suggests that the disease is mainly associated with nutritional problems and will be resolved by adequate nutrition which is not true; hence the utility of screening for cachexia is still far from practical use in surgical practice [24, 25].

Biochemical Tests

Serum proteins synthesized by the liver have been used as markers of nutrition including albumin, prealbumin, transferrin, total lymphocyte count, retinol-binding proteins, and thyroxine-binding globulin [26]. Serum albumin is the most commonly used marker since it can predict mortality in older people. However, albumin with a long half-life of 18 days apart from the nutritional state is also affected by inflammation, infection, cirrhosis, fluid status, and steroid intake, thus limiting its utility in acute settings.

Aging itself is associated with a modest decline in serum albumin levels, with a decrease of 0.8 g/L per decade after the age of 60 [27]. Prealbumin [also known as transthyretin (TTR)] has been used as a surrogate marker for protein malnutrition since the 1970s. A consensus statement regarding the use of prealbumin from 1995 states that a level between 50 and 109 mg/L is indicative of the significant risk of malnutrition and a level less than 50 mg/L was an indicator of poor prognosis. However similar to albumin the serum values of prealbumin also change quickly in acute inflammatory phase [28]. Transferrin is more sensitive marker of early protein-energy malnutrition but is also affected by a number of other conditions including but not limited to pregnancy, iron deficiency, hypoxia, chronic infection, and hepatic disease [29]. Total lymphocyte count (TLC) has also been suggested as a marker of malnutrition with TLC of less than 1500/mm^3. This value was found to be associated with a fourfold increase in mortality [30]. Similarly, insulin-like growth factors (IGF) and fibronectin have been used as a measure of malnutrition, but similar to abovementioned biochemical markers, their use has not been validated internationally. To date, there is no single biochemical marker of malnutrition as a screening test. The main value of biochemical markers is in a detailed assessment and monitoring [31]. They can be used to support the presence of systemic inflammatory response and further contribute to the identification of the etiologic basis for the diagnosis of malnutrition proposed by ESPEN (Table 8.1).

Body Composition and Anthropometric Tests

There have been rapid advances in the field of nutritional support in recent years; the updated guidelines from all the major societies (ASPEN and ESPEN) use anthropometric tests and body composition in some form or the other in defining and stratifying patients. As shown in Tables 8.1 and 8.2, the etiology-based classification and screening tools all use anthropometric tests. The recent approach is to use a combination of phenotypic and etiologic criteria for malnutrition diagnosis, and anthropometric tests are included under phenotypic tests [14, 32]. The anthropometric tests utilized in the assessment are weight loss, body mass index (BMI), and assessment of muscle mass (mid-brachial, mid-calf) and muscle function by using grip strength exercise. The data on the correlation between the rate of weight loss and poor surgical outcomes is very robust, and Global Leadership Initiative on Malnutrition (GLIM) meeting at the ESPEN Congress 2016 strongly considers non-intentional weight loss as one of the robust criteria of diagnosis of the malnutrition [33]. The utility of low BMI as one of the criteria has met with mixed skepticism. The proportion of the overweight population in the USA is comparatively higher than Europe and Asia, so low BMI as criteria of malnutrition in the USA is the area of controversy and future research. Measurement of muscle mass has strong evidence of utility as an indicator of malnutrition. The recommended radiologic methods to measure it are the use of dual-energy absorptiometry, bioelectrical impedance, ultrasound, computed tomography, or magnetic resonance imaging, but these methods are still not widely available. Physical examination or anthropometric measures of the calf or arm muscle circumference are therefore included as alternative measures [34]. Importantly, the reference standards for muscle mass may warrant an adjustment for age, race, and sex.

Studies have shown that functional measurement with handgrip strength and quadriceps strength is also related to mortality while muscle mass was not [35]. The concepts that underlie the utility of function as a surrogate for nutrition status is that muscle structure changes with malnutrition leading to loss of contractile elements, increased muscle fatigue, and altered contraction patterns [36]. Nevertheless, the assessment of muscle function using grip strength is recommended as a supportive measure in the GLIM consensus. In situations where muscle mass cannot be readily assessed, the muscle strength, e.g., handgrip strength, is an appropriate supporting proxy.

The underlying aim is to screen the elderly at the risk of malnutrition using the validated screening tool in the elderly population such as MNA-SF than to diagnose them by using above-mentioned tests “in collaboration” to utilize the information to improve nutritional status pre- or postoperatively.

Nutrition Intervention Plan

The specific nutritional requirements of older patients are difficult to quantify exactly because of the physiologic diversity and heterogeneity of this population along with the high prevalence of the chronic disease. The plan to utilize the nutritional intervention starts with estimating the nutritional requirements of the elderly after they have been positively screened and diagnosed with the help of tests mentioned above. After estimating the need for requirements, we will discuss the preferred and employed mode of nutrition delivery in elderly who are waiting for surgery or might have already faced it.

Estimating the Need for Nutritional Requirements in Elderly

The first step in estimating the need for nutritional requirement begins with calculating the nutrient balance of the patient. Nutrient balance is a gradient between nutrient intake and loss of nutrients [37]. Nutrient intake is estimated by obtaining a dietary history and then calculating the calorie and protein intake, whereas nutrient losses are estimated by calculating the basal energy expenditure (BEE) and then adding any abnormal nutrient losses, such as those from external fistula output, diarrhea, or proteinuria. BEE can be estimated by applying the Harris-Benedict equations and adding a correction factor depending on the degree of metabolic stress in the patient [38].

$$\begin{aligned}\text{Men } 66.47 &+ 13.75(\text{weight in kg}) \\ &+ 5.0(\text{Height in cm}) \\ &- 6.76(\text{Age in years})\end{aligned}$$

$$\begin{aligned}\text{Women } 665.1 &+ 9.56(\text{weight in kg}) \\ &+ 1.85(\text{Height in cm}) \\ &- 4.68(\text{Age in years})\end{aligned}$$

BEE is sufficient to initiate nutritional therapy in the elderly [39]. The primary nutrient substrate required by the surgical patient, especially the elderly patient, is protein, which plays an essential role in the metabolic response to stress. The rationale behind this concept is that amino acids are ordinarily mobilized from endogenous muscle to provide precursors for hepatic gluconeogenesis, and this step does not function efficiently in elderly; hence the provision of protein is necessary in the times of surgical intervention which is a major stress factor for elderly. The protein requirement is estimated by nitrogen loss in the urine by measuring 24-hour urinary urea nitrogen (UUN). The accurate formula accounts for urinary nitrogen excreted in forms other than urea (20%) together with fecal and cutaneous losses (2 g/d):

$$\begin{aligned}\text{Total nitrogen losses} = {} & 24\,\text{h}\,\text{UUN}(\text{g}/\text{d}) \\ & + 0.20 \times 24\,\text{h}\,\text{UUN} \\ & + 2\,\text{g}/\text{d}\end{aligned}$$

The protein requirement in elderly patients is slightly higher to the amount of 1–1.2 g/kg body weight, because of their age-related impaired capacity for protein synthesis. They require around 20–30 kcal/kg/day of energy, depending on their activity, and also energy expenditure decreases with age due to the decline in body cell mass. Many elderly people also suffer from fluid and specific micronutrient deficiencies, which should be corrected by supplementation [40].

Baseline fluid requirements of elderly patients without renal and/or cardiac insufficiency are usually estimated at 25 mL/kg/d. Fluid requirements may be increased with vomiting, diarrhea, enterocutaneous fistula, polyuria, or excess perspiration; fluid intake may require restriction in chronic renal insufficiency, pulmonary insufficiency, or congestive heart failure. The risk of both dehydration and fluid overload is high in the elderly [41].

Hospitalized elderly have an increased risk of developing vitamin D deficiency due to the lack of sun exposure. This can further lead to depression, cognitive changes, and increased fracture risk. The recommended daily allowance (RDA) of vitamin D in this patient population is 800–1000 IU. Calcium deficiency is very commonly seen in geriatric patients. To reduce the risk of osteoporosis, the RDA for calcium is 1200 or 1500 mg/dl. Vitamin B12 and folate are obtained adequately by diet alone, but in some patients, oral supplementation may be required. Postoperatively, elderly are at higher risk for developing a vitamin B12 deficiency due to impact of general anesthesia (nitrous oxide), which irreversibly binds and oxidizes the cobalt atom, thus inactivating B12 [42]. Some other well-known reasons are decreased intake, decreased absorption, hypochlorhydria, atrophic gastritis, and long-term use of acid-reducing medications. Vitamin B12 deficiency is often missed in the elderly. Symptoms of vitamin B12 deficiency such as depression, cognitive decline, mild to moderate dementia, irritability, tremors, confusion, and neuropathies are commonly seen in the elderly and often assumed to be symptoms of aging rather than a consequence of a nutritional deficiency and therefore are not further investigated [43].

Elderly patients that show signs of neurological deterioration after an operation should be further evaluated for vitamin B12 deficiency. The RDA for vitamin B12 is 1000 mg/day orally. Doubling of the daily multivitamin dose can be safely done while nutritional support is ongoing and until the normal nutritional status is achieved [43].

The Mode and Timing of Nutritional Delivery – What, When, and Why?

Elderly undergo surgery for various reasons, and depending on the acuity, it can be emergent or elective. In the case of emergent settings, "life first" dictum holds the priority followed by an evidence-based nutritional intervention which plays a huge role in improving the quality and longevity of life. Elective settings allow the time to screen, diagnose, and intervene preoperatively and to plan for postoperative nutritional intervention.

Nutritional intervention/therapy is defined according to ESPEN as:

Nutrition therapy is the provision of nutrition or nutrients either orally (regular diet, therapeutic diet, e.g. fortified food, oral nutritional supplements) or via enteral nutrition (EN) or parenteral nutrition (PN) to prevent or treat malnutrition. "Medical nutrition therapy" is a term that encompasses oral nutritional supplements, enteral tube feeding (enteral nutrition) and parenteral nutrition. [17, 44]

Whenever possible oral intake is the preferred and recommended route for nutritional intervention in all age groups. In a recent Cochrane analysis of 33 studies analyzed, twenty-nine showed that oral nutritional therapy (ONT) led to an increase in energy and nutrient intake (level of evidence Ia). We do understand that there are inherent practical limitations of ONT such as poor compliance, low palatability, the inability of family support to arrange for food, severe dysphagia, and side effects such as nausea and diarrhea [45]. Postoperative ileus due to abdominal surgery may inhibit early oral food intake. Major open gastrointestinal surgery, excess fluid administration, opioids for pain management, and surgical complications are some of the commonest causes of ileus limiting oral intake. A wholehearted effort should be made to avoid them as far as possible.

One of the major issues that warrant the attention is the mythical concept of preoperative fasting in the elderly. The patients are often placed on restrictive diets based on their comorbidities or made NPO for tests and interventions. We all are familiar with the overbookings of the operating room and the increased workload that leads to frequent NPO orders in patients, further increasing the risk of malnutrition. The American College of Surgeons National Surgical Quality Improvement Program (NSQIP)/American Geriatrics Society (AGS) best practices guidelines published in 2012 did address this concern [46]. In elderly undergoing non-emergent surgical procedures, fasting from the intake of clear liquids for at least 2 hours, light meal and/or milk for 6 hours, and additional fasting (8 hours or more) may be required depending on the amount and type of food ingested such as fried, fatty foods, or meat that may prolong gastric emptying before elective procedures requiring general anesthesia or regional anesthesia or recommending sedation/analgesia. However, caution should be addressed in the elderly with certain comorbidity such as diabetes or a hiatal hernia where the timing of preoperative fasting has to be modified.

Early initiation of feeds whenever feasible is recommended to enhance the outcomes. More independence to choose from the menu, friendly atmosphere, ad lib oral intake, early mobilization, and assisted feeding are some of the common useful steps that can be instituted to promote oral intake in the elderly population.

Enteral nutrition is started if the patient is not expected to eat for more than 7 days after surgery or if they cannot maintain more than 60% of the recommended oral intake for 10 days or more [47]. Enteral nutrition is provided with the help of tube feeds. As shown in Fig. 8.2, adequate access can be achieved in most patients with minimal intervention, with fewer patients requiring more complex approaches. Once determined to be an appropriate candidate for the initiation of enteral support, the naso- or orogastric tube provides temporary conduits for delivery that can be used immediately following clinical or radiological confirmation of appropriate placement. The pliable naso-enteric tubes can be placed with endoscopic assistance or placed "blindly" with

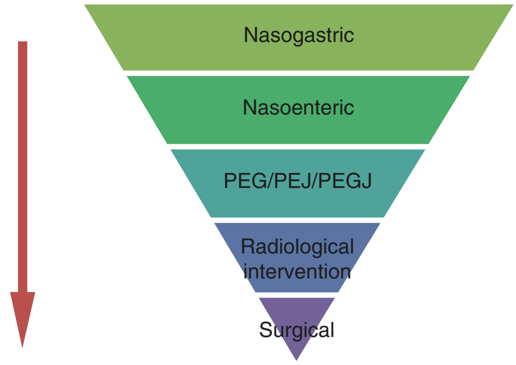

Fig. 8.2 Increased clinical complexity demands a more invasive surgical gut access (SGA) for nutrition; however, the subset of patients decreases with increased complexity of SGA

the assistance of either promotility agents or various signaling devices (commonly known as @@ Coatrack/Kao tubes). As with all minor and major procedures, the complications and risk associated with placement include esophageal perforation, increased incidence of sinusitis, and unintentional placement into the bronchopulmonary tree [48].

Greater than 4 weeks of enteral access requires the placement of surgical gut access (SGA) by the percutaneous, endoscopic, or surgical route. Percutaneous endoscopic gastrostomy (PEG), PEG with the jejunal extension (PEGJ), direct percutaneous endoscopic jejunostomy (DPEJ), and surgical gastrostomy/jejunostomy are the available options. The surgical steps can be found in any standard surgical textbook or standard review articles [49]. Studies have shown that after supplemental tube feeding, total energy and nutrient intake was markedly improved [50, 51]. The enteral feedings via percutaneous endoscopic gastrostomy (PEG) are tolerated much better as compared to nasogastric (NG) tube feeding in the elderly [46]. The practical questions regarding the timing of the intervention need to be addressed and applied uniformly in the hospitals. Both ESPEN and ASPEN guidelines recommend that elective operative interventions be postponed for enteral nutrition in patients with elevated nutritional risk. These patients should receive nutritional intervention sooner than later

[41]. Nutritional intervention after emergency surgery in elderly should be started as soon as feasible because the early nutritional support reduces the disease severity, diminishes complications, and decreases the intensive care unit (ICU) length of stay [52, 53].

The issue of tube feeds (TFs) in the elderly is inherently associated with ethical and humane considerations. This is important to mention that TFs are not a replacement of oral feeding as elderly should get an equal chance of having oral feeds because they can maintain their nutritional needs with oral nutrition and assisted feeding so the geriatric care programs should inculcate this concept. Additionally, the patient's expressed wishes and goals of care should be discussed with them and their families while considering SGA.

The formula feeds can be tailor-made in elderly depending on the disease process. Patients with normal digesting ability should receive polymeric feedings. Patients with malabsorption syndromes require elemental or predigested feedings. Fiber-supplemented feedings are contraindicated in hemodynamic unstable patients with dysmotility [54]. Antioxidant vitamins and trace minerals are recommended in both enteral and parenteral regimens. Immune-modulating enteral formulations have been shown to be beneficial in surgical critically ill patients. These formulations contain arginine, glutamine, nucleic acids, omega-3 fatty acids, and vitamin antioxidants [55].

The enteral route should always be preferred except for the following contraindications: intestinal obstructions or ileus, severe shock, intestinal ischemia, high-output fistula, and severe intestinal hemorrhage.

Apart from these indications, if the energy and nutrient requirements cannot be met by oral and enteral intake alone (<50% of caloric requirement) for more than 7 days, a combination of enteral and parenteral nutrition (PN) is recommended (grade of recommendation, good clinical practice, ASPEN). This idea of combining the two modes of nutrition therapy has 100% consensus among the ESPEN committee members [56]. Combined nutrition is not necessary if the expected time period of PN is <4 days. If the expected PN period is expected to last between 4 and 7 days, nutrition can be hypocaloric with 2 g carbohydrate and 1 g amino acids/kg body weight administered via a peripheral catheter, and if it is likely to last more than 7–10 days [57], it is recommended that a central venous catheter should be inserted. The long-term parenteral nutrition is delivered via appropriate devices such as port and Broviac or Hickman catheter. However, in the elderly population, routine postoperative PN use is associated with higher complication rates because of higher rates of insulin resistance leading to hyperglycemia and cardiac and renal dysfunction [58]. The potential solution is to increase the lipid content of PN formula and keep the calories between 18 and 20 kcals/kg and a glucose infusion rate at 3.0–3.5 mg/kg/minute in the elderly instead of carbohydrates.

Refeeding Syndrome

During the initiation of any nutritional intervention in an undernourished elderly patient, it is mandatory to pay attention to the risk of refeeding syndrome. In this syndrome, phosphate can drop precipitously by introducing glucose rapidly, and electrolyte shifts also result in lower serum levels of potassium and magnesium. All of these changes occurring with rapid refeeding can invoke neurologic symptoms. Therefore, malnourished elderly require a gradual intake of nutrients (especially glucose) with strict monitoring of serum electrolyte levels [59]. Thiamine should be provided when refeeding syndrome is suspected or anticipated. Thiamine is an important co-enzyme in several metabolic enzymes such as pyruvate dehydrogenase and α-ketoglutarate dehydrogenase. When reintroducing carbohydrates in undernourished patients, the demand for thiamine increases [60].

Areas of Future Research: Metabolomics in Nutrition

The area of nutrition is a complex one due to the underlying interaction between numerous internal and external factors. Thus, decoding this complexity requires dedicated research strategies and exploring the future ventures pertinent to it.

Efforts are underway to support evidence-based nutritional research and achieve effective diet-based disease prevention. In this context, the global metabolite analysis, or “metabolomics,” is becoming an appealing research tool for the scientists. Metabolomics is defined as the screening of small-molecule metabolites present in samples of plants, animals, or microorganisms. By comparing metabolome profiles (metabolic phenotypes or “metabotypes”), the patterns of variations between different groups can be determined and labeled as healthy versus diseased [61]. By discerning the molecular composition of food and individual’s nutrition and health status, metabolomics will provide valuable information to physicians in terms of diagnosis and diet counseling. Metabolomics will identify the individual variations in dietary requirements classifying individuals into specific groups based on their “metabotype.” This strategy could lead to the development of “personalized nutrition,” in which diet is attuned to the nutritional needs of individual patients [62, 63]. The introduction of metabolomics in the field of nutrition is bound to open the doors of revolution in the field of nutrition science in the near future.

Summary

The elderly population in the world is rising, and this group is at high risk for malnutrition and hence poor outcomes after surgical intervention. Prompt recognition is therefore required in order to initiate timely interventions. Multimodal assessments using screening tools, serum, and radiological testing are utilized to assess the severity of malnutrition. Nutritional assessment should be comprehensive and continue at regular intervals during hospitalization. The prominent societies have published their evidence-based guidelines which are available to help clinicians; the common theme is that early feeding should be instituted whenever possible. The combination of oral and enteral feed (tube feeds) is acceptable when needed. The use of parenteral nutrition can bridge the crises until the definite form of gut access is available. Along with the carbohydrates and proteins, the micronutrient supplementation holds an important place in nutritional intervention for the elderly. Further research in basic and clinical areas is indicated and necessary to define more nutritional and metabolic changes that occur with aging and to define the indications and nutritional support techniques for optimal management of these changes. The meticulously designed controlled study protocols specifically for geriatric populations with subgroup analysis on frail elderly are the need of the hour.

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9 Neurosurgery in the Elderly

Julia Pazniokas, Brianna Theriault, and Christian A. Bowers

The conversation surrounding neurosurgery in elderly patients has drastically changed in the past 30 years. It was only 30 years ago that an innovative groundbreaking geriatric neurosurgery review determined that the current age limit of 65 was arbitrary and must be reconsidered [1]. In contrast, now there are reports of successful neurosurgical interventions in patients as old as 103 years of age, and neurosurgery in the geriatric population is common. Recent literature in nearly every neurosurgical subspecialty concludes that advanced age alone should not preclude a patient from surgical consideration. In fact, a growing body of literature suggests that comorbidity status, or frailty, as measured typically by the modified frailty index (mFI), is significantly more predictive of outcomes and should be emphasized over age in the surgical decision-making process since not all elderly patients are the same.

The combination of a continuously increasing life expectancy, advancements in neurosurgical technologies, and improved neurocritical care and neurosurgical postoperative care have all led to a rapidly growing pool of potential candidates for neurosurgical procedures. The American population of people >60 years old increased by 25% between 2002 and 2010 [2] and is projected to increase to 90 million by 2050 [3]. This particular predicted demographic growth is extremely relevant to neurosurgery as the peak incidence for many operative neurosurgical conditions occurs after age 60. Elderly patients represent an increasingly larger proportion of patients presenting to hospitals and requesting neurosurgical consultation [4].

In particular, elderly spine surgery is constantly increasing annually. Between 1990 and 2004, there was 28-fold increase in anterior discectomy and fusion surgeries performed on patients aged 65 years and above [5]. Intracranial tumor diagnoses are also more common in the elderly, with a reported peak incidence at age 75 [6]. Also, the elderly have a relative risk of brain cancer of 3.18 when compared to young adults [7]. Likewise, vascular pathology increases constantly as age increases. The incidence of subarachnoid hemorrhage increases fivefold between the fourth to six decades and the eighth decade, from 15 per 100,000 per year to 78 per 100,000 per year [8].

The historical dogma is that elderly patients have increased mortality rates and increased complication rates following neurosurgical interventions. However, an abundance of recent data demonstrates that many elderly patients undergo neurosurgery with good outcomes and low mortality rates. Unfortunately, the traditional

J. Pazniokas · B. Theriault
New York Medical College, Valhalla, NY, USA

C. A. Bowers (✉)
Department of Neurosurgery, Westchester Medical Center, New York Medical College, Valhalla, NY, USA
e-mail: Christian.Bowers@wmchealth.org

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belief that elderly patients are unfit for neurosurgical interventions has contributed to decreased neurosurgical access. The elderly have been shown to have decreased rates of transfer to neurosurgical units and experience longer delays for urgent diagnostic CT scans upon emergency department presentation [9]. Elderly patients with glioblastoma are also less likely to receive multimodal treatment and are more likely to receive diagnosis without histopathologic verification [10].

There is a vast body of subspecialty neurosurgical literature reporting outcomes in elderly patients. Although elderly patients traditionally demonstrated higher mortality rates and complication rates, both have decreased significantly over time [4].

Spine

The disease burden caused by spinal pathology in elderly patients is associated with more disability than CHF, COPD, or diabetes [11]. This disability is secondary to various manifestations of degenerative spinal pathology, including osteoporotic fractures, lumbar disc herniation, lumbar stenosis, and spondylolisthesis. The exponential explosion in the incidence, and treatment costs, of spine surgery in the Medicare population over the past decades have led many to question the benefit and medical necessity of spine surgery in elderly patients. Other reports suggest that elderly patients undergo unwarranted prolonged trials of conservative treatment without any evidence of its efficacy due only to their advanced age [12]. Prolonged medical management in one small series of elderly patients with disc herniation, stenosis, or spondylolisthesis demonstrated no significant improvement in any patient-centered outcome [13]. While a trial of medical management is absolutely indicated for elderly patients with low back pain, age alone should not prevent patients from being considered for beneficial surgical interventions. This message, along with multiple examples of the good outcomes achievable in elderly patients, is one of the key tenets provided by this chapter.

Degenerative spine conditions are extremely common in the elderly and increase with age. Operations that are simple low-risk procedures in young, healthy patients often require more nuanced surgical decision-making in older patients with more comorbidities. As with any surgery, elderly neurosurgical patients carry some increased risk for adverse outcomes associated with anesthetic complications, including memory and cognition deficits. The long average operative time of complicated neurosurgical procedures makes this anesthetic risk even more concerning. Elderly degenerative spine patients are also more likely to have multilevel disease compared to their younger counterparts which complicates the diagnostic and the treatment considerations. For example, elderly patients may require multilevel fusions, which require longer anesthesia time and have increased risk, while also being more predisposed to complications (e.g., osteoporotic bone, thinner dura mater, etc.) [12].

Even after deciding to recommend surgical treatment for spinal pathology in an elderly patient, there is frequently no consensus on which specific procedure to perform. From 1980 to 2000, spinal stenosis surgery was the fastest-growing type of lumbar surgery performed in the USA [12]. In 2007, over 37,000 patients >65 in the Medicare Provider Analysis and Review database underwent surgery for spinal stenosis, with an associated total hospital bill of $1.65 billion [13]. RCTs have demonstrated patients with severe symptoms from spinal stenosis benefit more from decompression without fusion than from nonsurgical options [14]. Nevertheless, rates of decompression surgery or simple fusion in elderly patients declined between 2002 and 2007, while rates of complex fusions increased over the same period [14]. While major complications occurred in only 3.1% of total patients and the mortality rate was 0.4% within 30 days of discharge, "life-threatening complications" increased with age, complex fusions, and increasing comorbidities [13]. This analysis demonstrates that many elderly patients can safely undergo and benefit from degenerative spine surgery, but neurosurgeons must be more selective in which patients require complex fusions.

Osteoporotic spinal fractures are another major cause of disability and pain in the senior population. They are present in approximately one-quarter of women older than the age of 70 years and up to one-third of those older than the age of 80 years [15]. A significant portion of these fractures are refractory to non-operative treatment, leading many elderly patients to opt for surgical treatment with vertebroplasty and kyphoplasty. A systematic review of 69 clinical trials demonstrated surgery had a significant clinical benefit with ~90% rate of pain relief and significant decrease in disability postoperatively [16]. Despite this evidence supporting the efficacy of vertebroplasty and kyphoplasty, it is important to note that more invasive surgery may be required to address severe underlying pathology such as sagittal imbalance and to achieve long-term efficacy. However, many older patients with comorbidities may not be able to tolerate more invasive surgery.

It is important to recognize that surgical interventions in the elderly are often geared toward improving quality of life and functional status, rather than curing disease. The vast majority of studies on geriatric spinal surgery analyze complication and mortality rates, rather than functional outcomes. Studies have shown that elderly patients may even experience better improvement in health-related quality of life scores after surgical decompression of the lumbar spine when compared to their younger counterparts [17], even in the setting of increased rates of adverse events. Still, clear evidence-based guidelines are lacking for determining which elderly patients will benefit from lumbar spine surgery and how surgically aggressive surgeons should be with this population.

Intracranial Neuro-oncology

Intracranial tumors increase in incidence with age and peak around age 75 [18]. Nevertheless, elderly patients have not historically always been considered for surgical resection. Furthermore, despite elderly patients often being thought of as having worse outcomes after craniotomy for tumor resection, the evidence demonstrating poor outcomes after geriatric intracranial surgery is lacking, but many treatment guidelines are based off studies in which patients age >70 are excluded or underrepresented [19]. The most obvious example of differing treatment patterns between young and old patients is with the most common primary brain cancer – glioblastoma multiforme (GBM). The standard of care for patients with GBM is rapidly evolving in all age groups. While older patients were not necessarily offered resection in the past, more recent literature shows that they too may benefit from surgical interventions. Elderly patients with more benign tumors, including pituitary adenomas, meningioma, and vestibular schwannomas, frequently tolerate surgery nearly as well, if not as well, as their younger counterparts.

GBM

The belief that elderly patients with aggressive brain tumors (GBM, brain metastases, etc.) are poor surgical candidates arises from the fact that age is a poor prognostic marker for these pathologies. The overall median survival for GBM patients in 2015 was 15 months, but reported median survival for patients >65 was 4 months [20]. Despite the median age at diagnosis of GBM being 64 years, patients age >65 are statistically less likely to be offered multimodal treatment. Standard treatment in non-elderly patients involves surgical resection followed by radiotherapy with concurrent chemotherapy. Surgical resection in elderly patients, on the other hand, is not always offered or performed. This is despite the fact that many studies suggest that elderly patients benefit from maximal safe surgical resection, just like normal non-geriatric adult patients, as significant tumor resection prolongs patient survival due to cytoreduction [20].

Benign Tumors: Meningioma, Pituitary Adenoma, and Vestibular Schwannoma

The increasing availability and frequency of neuroimaging has contributed to an increase in the detection of incidental benign masses. In particular, elderly patients are more likely to undergo neuroimaging for a variety of reasons (working up cognitive decline, after a fall or car accident, etc.). Meningiomas are the most common benign intracranial tumor, and their incidence in the elderly has continued to increase. Surgical resection of meningiomas is done electively, due to their slow growth and insidious symptom onset. The natural history of meningioma varies, but studies of incidental meningiomas have reported that the majority exhibited no growth [21]. Additionally, tumors in elderly patients may actually grow slower than in younger patients [22]. A 2016 review of the literature on meningioma in the elderly generally reported few differences between elderly and non-elderly patients undergoing meningioma resection, but a large 2004 study demonstrated higher in-hospital mortality, adverse outcomes, and permanent deficits in elderly meningioma resection patients [23]. Elderly patients have higher frequencies of WHO grade II and III atypical meningiomas. Patients over 80 years old had higher rates of 1- and 5-year mortality, but not at 3 months after surgery. Many studies identify that ASA score, or other risk identification scales, predicts mortality better than age [24].

Optimal timing of meningioma resection is particularly important in elderly patients. Surgical decision-making is simple for small tumors that are amenable to stereotactic radiosurgery or for tumors causing significant symptoms or significant mass effect. Conversely, when elderly patients are diagnosed with large tumors causing few or no symptoms, surgeons must balance the complication risk associated with aggressive surgery with the possibility that delaying treatment may increase the likelihood of suboptimal outcomes in the future. While it has been demonstrated that elderly patients undergoing meningioma resection have favorable survival and clinical outcomes [24], the risk factors associated with good or bad outcomes have yet to be delineated, and therefore clear guidelines are still lacking on how best to manage geriatric patients presenting with symptomatic meningiomas. Incidental meningiomas should generally be followed with observation due to the shortened life expectancy.

There has been a large increase in the detection of pituitary adenomas in the elderly due to the increased neuroimaging. Most will remain asymptomatic and will not require treatment, but age should not preclude surgery in symptomatic patients. Elderly patients are more likely to have nonfunctioning PAs compared to patients <60 years old [25], and visual disturbances are the most common indication for surgery. These symptoms improve in elderly patients at similar rates to the general population, but elderly patients are at higher risk of postoperative complications including pituitary hemorrhage, hypertension, and SIADH. Mortality rates do not appear to increase with age [25].

There is a smaller body of literature on vestibular schwannoma resection in the elderly, likely due to the smaller number of patients. Studies have suggested a complication rate as high as 60% in patients age >65, while others report no difference in outcome between older and younger patients [26]. A 2016 study by Bowers et al. demonstrated that patients >65 had equivalent facial nerve outcomes, hearing preservation, and complication rates when compared to patients <65 [27].

As has been repeatedly demonstrated across the neurosurgical literature, good preoperative clinical status, frequently measured by frailty, is a better predictor of outcomes in elderly patients with benign intracranial tumors than age alone, as an emerging body of literature is supporting.

Traumatic Brain Injury

Traumatic brain injury is a major cause of morbidity and mortality in patients of all ages worldwide. While many young patients sustain TBIs after motor vehicle accidents, the majority of TBIs in the elderly are caused from falls around the home. Since interventions to reduce traffic accidents have been implemented, the incidence of TBI is decreasing in young patients. However, there has been no change in TBI incidence in the elderly. Additionally, as the elderly population increases in number, more TBIs will occur. In general, although TBI outcomes are improving, increasing age is still a significant risk factor for poor outcome. Elderly patients' increased pre-existing medical comorbidities, i.e., their frailty, lead to increased postoperative complications and difficult hospital courses. Additionally, elderly patients are more likely to be on antiplatelet or anticoagulation medications, thereby increasing their risk for a severe intracerebral bleed after trauma.

Several studies have considered how age affects outcome after TBI. Mosenthal et al. found that mortality progressively increased with each decade after age 50 and was doubled in patients >65 compared to younger patients. This increase in mortality occurred at all injury severity levels. Additionally, elderly patients were more likely to have poor functional outcome compared to young patients. Multivariate logistic regression analysis demonstrates age is an independent risk factor for increased mortality, even after controlling for complications and comorbidities. Similarly, Kuhne et al. saw that mortality steadily increased with age starting at age 56. This increase was independent of injury severity [28]. Furthermore, Stochetti et al. found that patients older than 59 years had six times the probability of having unfavorable outcomes after TBI [29]. The odds ratio was equally high for patients with poor health status before TBI. This finding was corroborated by Susman et al., who saw that despite similar GCS at admission to young patients and lower injury severity scores, elderly patients tended to have more unfavorable outcomes [30].

A series published by Lau et al. compared patients >80 years old to a younger patient cohort [31]. They found that these older patients tended to have longer hospital stays and more postoperative complications. Unexpectedly, they found that there were no differences in 30-day mortality or rates in return to baseline functional status. This suggests that elderly patients may require longer postoperative medical care and increased complication rates, but they can also recover back to their baseline. Interestingly, one study found that the mortality rate of elderly patients beyond 6 months post-injury was comparable to rates for the general population. The amazing conclusion that "6-month survivors could expect to have a normal lifespan" is encouraging given how bleak this elderly TBI literature looked in the past [32].

Conclusions

While the published data and subjective evidence show that increased age is a predictor for mortality and worse outcome after TBI, it likely is not the only factor. Elderly patients tend to sustain more severe injuries despite an often less severe mechanism of injury. Their increased likelihood of comorbidities also predisposes them to postoperative complications. These complications may be survivable in a young patient but can be devastating in an elderly patient. Taken together, the data suggests that careful assessment of risk must be conducted on a patient-by-patient basis to determine if early surgical intervention or medical management is appropriate following TBI.

Subdural Hematoma

Acute Subdural Hematoma

Acute subdural hematoma is a common neurosurgical condition, occurring in up to 29% of all cases of TBI [33]. While young patients often suffer aSDH after high-velocity trauma, older patients may suffer SDH after low-velocity injuries, such as falls. This difference is due to age-related brain atrophy in the elderly, which causes increased tension on the bridging subdural veins leading to shearing injuries, most commonly after falls. Elderly aSDH patients do not commonly present with primary brain injury and swelling, like that seen in younger aSDH patients due to the differences in force of the injuries causing the aSDH [34]. The force from a ground-level fall, a common cause for aSDH in elderly patients, is the opposite of the high-speed mechanism that most commonly causes aSDH in younger patients.

Older data suggests that acute subdural hematoma (aSDH) in the elderly is nearly a distinct entity compared to that in younger patients, with elderly patients suffering mortality rates as high as 74–88% [35, 36]. Other studies demonstrate that surgical intervention in elderly aSDH patients results in few functional survivors [37]. Although few studies have been published in the past decade, more recent data suggests that mortality rates in elderly aSDH patients have improved and are similar to younger patients (35–50%) [35]. In 2016 Raj et al. studied patients age >75 and demonstrated an overall 1-year mortality rate of 50% [38]. Nonsurvivors had worse GCS score on presentation, but there were no significant differences in those on antithrombotic medication or with INR >1.5. Still, there was a considerable absolute difference in mortality between INR <1.5 and >1.5 groups, which would likely be significant in a larger study. Premorbid functional dependence at time of injury was also predictive of mortality [37]. This study demonstrates the importance of premorbid status and comorbidities in stratifying elderly patients with TBI.

Chronic Subdural Hematoma

Chronic subdural hematoma is a distinct neurosurgical entity from acute SDH and is much more common in the older patient population. Large studies have demonstrated that older age is an independent risk factor for morbidity and mortality after surgical drainage of cSDH [39]. Other studies have suggested that clinical exam on presentation is a more pertinent predictor of outcomes. There is no consensus on outcome prognostication in elderly patients with cSDH and which elderly patients are likely to suffer complications.

Multiple studies have been published on the outcomes of the oldest elderly patients, nonagenarians, but the conclusions are unclear and contradictory. Stippler et al. concluded that patients >90 years of age have poor outcomes after suffering chronic subdural hematomas, regardless of whether they undergo surgical drainage or conservative treatment [40]. Dobran et al. also concluded that nonagenarians were at higher risk of postoperative complications compared to patients <80 years of age, but that average functional recovery, at 1 month and 6 months postop, were equivalent in the two groups [41]. Lee et al. also demonstrated that cSDH patients aged 90+ benefited from surgical drainage compared to conservative treatment with better mortality rates, improvement in neurological function, and discharge disposition [42]. They also note that conservative management is actually less likely to be successful in the very elderly, because their brain atrophy means that only large cSDH will produce symptoms in the first place.

It is important to note that the most common surgical intervention for cSDH, burr hole craniostomy, is relatively noninvasive. An alternative procedure, twist-drill craniostomy, can even be done at bedside without any general anesthesia. Even patients of this advanced age should be considered for surgical intervention given that nonagenarians do better with evacuation compared to conservative treatment [42].

Aneurysm

The literature regarding cerebral aneurysm management in elderly patients primarily focuses on comparing outcomes between endovascular coiling and open neurosurgical aneurysm clipping. While rates of good functional outcomes vary between studies, generally, there is a consensus by most clinicians that endovascular techniques are less invasive and may be a safer and more effective treatment alternative to clipping in elderly aneurysm patients [43–45]. This is particularly true in elderly patients with multiple comorbidities, who do better with less invasive interventions across all surgical disciplines. Gonzalez et al. saw that after endovascular coiling of unruptured or ruptured aneurysms, 65% of elderly patients had a good functional outcome (mRS ≤2) [46].

Unruptured Aneurysms

Although there is still controversy on which asymptomatic unruptured aneurysms should receive therapeutic intervention, especially in elderly patients where their shortened life expectancy significantly reduces the cumulative aneurysm rupture risk, treatment outcomes have been reported in multiple studies. Brijiniki et al. observed that while increasing age was associated with greater mortality and worse discharge location after any treatment for unruptured aneurysms, endovascularly coiled patients fared better than surgically clipped patients [43]. These patients had decreased length of stay, lower rates of discharge to a long-term care facility, and decreased mortality rates. The authors noted that this difference was more pronounced in patients over 80 years old. Barker et al. also found that endovascular coiling for unruptured aneurysms was associated with reduced mortality compared to surgical clipping [47]. Gonzalez et al. saw that 91% of patients aged 70 years and older with unruptured aneurysms had good functional outcome (modified Rankin score ≥2) after endovascular embolization [46]. Finally, Cai et al. found that 91% of patients over age 70 with symptomatic unruptured aneurysm treated endovascularly achieved excellent outcomes (modified Rankin score of 0–1) [48].

Aneurysmal SAH (Ruptured Aneurysms)

Patients with ruptured aneurysmal subarachnoid hemorrhage have worse outcomes than patients with unruptured aneurysm [46]. However, coiling ruptured aneurysms still produces good outcomes in the elderly population, despite their advanced age. In a series by Zhang et al., the efficacy of endovascular coiling versus clipping was compared in 198 Chinese patients over age 60 with ruptured aneurysms [45]. While there was no difference in complication rates between techniques, coil embolization was associated with decreased length of stay and decreased procedural time. Additionally, coiling was associated with a favorable outcome, defined by a Glasgow Outcome Scale (GOS) score of 4–5, in 88.2% of patients. Similarly, a good or excellent outcome (GOS 4–5) was found in 59% of patients aged 65–80 with SAH secondary to aneurysm rupture treated in a series by Lubicz et al. [44] and 48% of patients aged 65 and above in a series published by Sedat et al. [49]. The International Subarachnoid Aneurysm Trial (ISAT) found that endovascular coiling was associated with better outcomes than surgical clipping in the general population. Of note, a substudy of the ISAT on elderly patients found that, to optimize outcomes, endovascular coiling should be the treatment of choice for ruptured ICA and PCA aneurysms while surgical treatment should be considered for patients with MCA aneurysms.

Aneurysm Treatment and Considerations for Elderly Patients

There are specific considerations to treating aneurysms in the elderly population. First, intracranial aneurysms are more common in an aging population as the prevalence in some series is doubled in elderly patients [45, 50]. Also, the Hunt and Hess (HH) grades tend to be higher in elderly patients [49], while the vasospasm risk is lower [51]. Sedat et al. noted that the rate of high grade aneurysmal SAH (Hunt-Hess 4–5) was 27.3% in young patients but 36.6% in patients over age 64 [49]. These considerations highlight the need to determine the best approach to managing ruptured aneurysms in this population.

The technical endovascular challenges unique to elderly patients are that the increased tortuosity and stenosis of the elderly vasculature may lead to navigation difficulties during the procedure and make complete embolization more challenging. Additionally, due to the atheromatous nature of vessels in the elderly, there is an increased risk of thromboembolic events during embolization [49]. In a series published by Sedat et al., elderly patients had an increased rate of thromboembolic events compared to younger patients (13% vs. 4.2%) [49]. These significant increases in complication rate warrant extra consideration for this patient population.

Conclusions

As the population continues to age and with the increase in the frequency, and the technological advances, in neuroimaging, aneurysm incidence will continue to rise. While the superiority of endovascular coiling versus microsurgical clipping remains controversial for all adult patients, particularly in the very young, there is an increasingly large and growing body of literature to support the use of endovascular treatment in elderly patients with unruptured or ruptured aneurysms. Treatment that is noninvasive and associated with less morbidity and mortality is likely best in these patients who may have multiple comorbidities.

Frailty

The contradictory evidence on the management of elderly neurosurgery patients across subspecialties may be due to the heterogeneous nature of the 65+-year-old population. A constantly growing body of literature suggests that age alone is not the best method of stratifying risk. This concept is well illustrated by Farhat et al.'s statement that "surgeons routinely use phrases such as a 'young 85-year-old' or the converse '50 going on 90'" [52]. In place of age, a patient's likelihood to tolerate surgery can be better defined by his or her level of frailty.

Broadly defined as a "a biologic syndrome of decreased reserve and resistance to stressors, resulting from cumulative declines across multiple physiologic systems" [53], frailty is a measure of biological age, rather than chronological. Although frailty increases with age [53] and is higher in the elderly surgical population than the nonsurgical population [54], up to 75% of people over the age of 85 are not frail [55].

The medical literature has long demonstrated frailty's effect on outcomes in the elderly population, usually defining frailty by "some combination of history, physical examination, and determination of physical capability, such as walking speed and grip strength" [56]. Surgical fields have also analyzed the effect of frailty on outcomes and complications, and since 2015 many neurosurgical studies have been published on the topic.

Between 2015 and mid-2019, 25 studies have been published on frailty in neurosurgical subspecialties including spinal deformity, degenerative spine, spinal tumor, intracranial hemorrhage, and intracranial tumor (Table 9.1). Although frailty was initially described as a way to discern the "biological age" specifically of the elderly population, the vast majority of these studies include all adult patients, so that frailty acts more like a traditional comorbidity index than a measure of physiologic reserve.

There are a variety of different frailty indices made up of a combination of functional status and comorbidities. The modified frailty index (mFI), an 11-factor index extrapolated from the Canadian Study of Health and Aging, is the most commonly used index. The neurosurgical literature consists of eight other frailty indices, and many are specific to pathology, such as the Adult Spinal Deformity-Frailty Index, Cervical Deformity-FI, and the Metastatic Spinal Tumor-FI. Each of these indices was created specifically to be predictive for patients undergoing procedures specific to these pathologies. The 9 indices combined include over 40 factors, but most commonly include functional status, congestive heart failure, hypertension, anemia, chronic kidney disease, and COPD or recent pneumonia. The use of so many different frailty indices can be confusing initially. However, increasing frailty will affect outcomes differently for neurosurgery patients depending on the extent of the surgical procedure. Frailty will play a much smaller role in a patient undergoing a bedside burr hole chronic subdural hematoma evacuation, or a muscle biopsy procedure, when compared to an all-day spinal deformity correction surgery. Studies comparing the predictive value of the mFI or the simplified 5i-mFI to the more complicated pathology-specific FIs are lacking. Still, the mFI has demonstrated predictive value across a range of neurosurgical procedures including kyphoplasty [57], lumbar [58] and cervical fusion [59], spinal deformity surgery [60], oncologic neurosurgery [61], GBM

Table 9.1 25 studies published on frailty in neurosurgery by mid-2019

Author	Year	Category of procedure	Sample size	Data source	Age
Cranial					
Tomlinson	2017	Mixed	27,098	NSQIP	All
Cloney	2015	Glioblastoma	243	One hospital (US)	**>65**
Youngerman	2017	Tumor	9149	NSQIP	>18
Imaoka	2018	Spontaneous ICH	156	2 hospitals (Japan)	All
Shimizu	2018	Chronic subdural hematoma	211	One hospital (Japan)	**>65**
Spine					
Ali	2016	Mixed spinal surgery	18,294	NSQIP	>18
Deformity					
Leven	2016	Spinal deformity	1001	NSQIP (2005–2012)	>18
Miller	2018	Spinal deformity	266	ESSG	>18
Miller	2018	Cervical deformity	61	ISSG	>18
Miller	2017	Spinal deformity	417	ISSG	>18
Miller	2018	Spinal deformity	267	SCOLI-RISK-1 database	>18
Reid	2018	Spinal deformity	332	Multicenter	>18
Yagi	2018	Spinal deformity and degenerative spine**	481	2 high volume spine centers	**>50**
Degenerative					
Charest-Morin	2018	Degenerative lumbar spine disease	102	One hospital (Canada)	**>65**
Flexman	2016	Degenerative spine disease	52,671	NSQIP (2006–2012)	All
Kessler	2018	Thoracolumbar spinal fracture	303	NSQIP (2007–2012)	>18
Leven	2017	Lumbar fusion	6094	NSQIP (2005–2012)	>18
Phan	2017	Anterior lumbar interbody fusion	3920	NSQIP (2010–2014)	>18
Rothrock	2018	Spine – degenerative	87	One hospital (US)	**>65**
Segal	2018	Kyphoplasty vertebral augmentation	2399	NSQIP	>18
Shin	2017	Cervical spinal fusion	6965	NSQIP (2005–2012)	>18
Weaver	2019	Elective posterior lumbar fusion	23,516	NSQIP	All
Tumor					
Ahmed	2017	Primary spinal tumor	1589	NIS (2002–2011); NSQIP*	All
De la Garza Ramos	2016	Metastatic spinal tumor	4583	NIS (2002–2011); NSQIP*	>18
Lakomkin	2018	Spinal tumor surgery	2170	NSQIP (2008–2014)	All

ICH intracerebral hemorrhage, *NIS* nationwide inpatient sample, *NSQIP* national surgical quality improvement project
*NSQIP used for external validation
**Adult spinal deformity, degenerative lumbar
Bold values: When the study is specifically focusing on older adults (>65 or one study was >50).

resection [62], and surgery for intracranial hemorrhage [63].

The lack of consensus in the neurosurgical literature is also reflected in the cutoffs used to define “non-frail,” “pre-frail,” “frail,” or “severely frail” (Table 9.2). To allow for comparison, each cutoff can be converted to a score between 0 and 1 by dividing the number by the total number of factors in the index. Using the mFI, for example, a mFI of 3 out of a possible total of 11 is equivalent to a frailty score of 0.27. Comparing definitions of frailty between studies shows vast variability. As Fig. 9.1 demonstrates, a score of about 0.3 would be considered non-frail, pre-frail, frail,

Table 9.2 Literature published between 2016 and mid-2019 on frailty in neurosurgery demonstrating association between frailty and complications across many neurosurgical procedures

Author	Category of procedure	Frailty measure	Frailty cutoffs	Outcomes associated with frailty	Predictive value of frailty in comparison to other risk factors
Cranial					
Tomlinson	Mixed	Novel Pre-op Frailty Scale	Non-frail: <0.19 Frail: ≥0.19	↑Mortality ↑Complications	Frailty predictive across age stratifications
Cloney	Glioblastoma	mFI	Least frail: 0 Moderately frail: 0.09–0.18 Frailest: I≥0.27	↑Mortality ↑Complications ↑Length of stay	Predictive value independent of age, KPS, CCI
Youngerman	Tumor	mFI	No frailty: 0 Low: 0.01–0.19 Intermediate: 0.2–0.29 High frailty: ≥0.3	↑Mortality ↑Complications ↑Length of stay ↑Discharge to higher care	mFI better predictor than age *ASA equally predictive as mFI*
Imaoka	Spontaneous ICH	mFI	Non-frail: <0.18 Frail: ≥0.18	↑Mortality ↑Poor outcome	ICH score + mFI best predictor
Shimizu	Chronic subdural hematoma	Clinical Frailty Score	Non-frail: ≤4 out of 9 Frail: ≥5 out of 9	↑Discharge to higher care	*Worse predictor of poor outcome than age*
Spine					
Ali	Mixed spinal surgery	mFI	Low vs. high mFI: 0 vs. 0.27	↑Complications ↑CD-G4 complications ↑Mortality	
Deformity					
Leven	Spinal deformity	mFI	Frail: ≥0.18 used for multivariable analysis	↑Complications ↑Reoperation	mFI better predictor than age >60 of reoperation but not complications
Miller	Cervical deformity	CD-FI	Not frail: <0.2 Frail: 0.2–0.4 Severely frail: >0.4	↑Complications	
$Miller_1$	Spinal deformity	ASD-FI	Non-frail: < 0.3 Frail: 0.3–0.5 Severely frail: > 0.5	↑Complications ↑Length of stay ↑Reoperation ↑Poor outcome	Increase in complications independent of age
$Miller_2$	Spinal deformity	ASD-FI	Non-frail: < 0.3 Frail: 0.3–0.5 Severely frail: > 0.5	↑Complications ↑Reoperation ↑Length of stay ↑Poor outcome	Significant on multivariate analysis (did not include age)
$Miller_3$	Spinal deformity	ASD-FI	Not frail: <0.3 Frail: 0.3–0.5 Severely frail: >0.5	↑Complications ↑LOS	
Reid	Spinal deformity	ASD-FI	Non-frail: < 0.3 Frail: 0.3–0.5 Severely frail: > 0.5	*More clinical benefit in frail* vs. *significantly frail OR non-frail*	

Table 9.2 (continued)

Author	Category of procedure	Frailty measure	Frailty cutoffs	Outcomes associated with frailty	Predictive value of frailty in comparison to other risk factors
Yagi	Spinal deformity and degenerative spine	mFI	No frail: 0 Pre-frail: >0, < 0.21 Frail: >0.21	Deformity: ↑Poor Outcomes Degenerative*: No significant association*	
Degenerative					
Charest-Morin	Degenerative lumbar spine disease	mFI	Not frail: 0 Pre-frail: >0 and <0.21 Frail: ≥0.21	↑Mortality	
Flexman	Degenerative spine disease	mFI	Not frail: 0 Pre-frail: 0–0.21 Frail: ≥0.21	↑Mortality ↑Complications ↑Length of stay ↑Discharge disposition	Predictive on multivariate analysis
Kessler	Thoracolumbar spinal fracture	mFI	Non-frail: ≤0.27 Frail: ≥0.27	↑Complications	
Leven	Lumbar fusion	mFI	Stepwise analysis Frail: ≥0.36 used for multivariate analysis	↑Complications ↑Readmission ↑Reoperation ↑Length of stay	mFI only better predictor of reoperation
Phan	Anterior lumbar interbody fusion	mFI	Low vs. high mFI: 0 vs. 0.27	↑Complications	
Rothrock	Degenerative spine disease	FRAIL scale	0: robust 1–2: pre-frail 3–5: frail	***No significant difference in return to cognitive function***	
Segal	Kyphoplasty vertebral augmentation	5i – mFI	1) mFI-5 = 0 2) mFI-5 = 1 3) mFI-5 ≥ 2	↑Complications ↑Readmission ↑Length of stay ↑Discharge disposition	Better predictor of complications than age
Shin	Cervical spinal fusion	mFI	ACDF group: 0 vs. ≥0.27 PCF group: 0 vs. ≥0.36	Both groups: ↑Mortality ↑Complications ↑CDG4 complications	ACDF: mFI better predictor of CDG4 complications than age>75, ASA>3 ------------- *PCF: Age>75 and ASA>3 better predictors than mFI*
Weaver	Elective posterior lumbar fusion	mFI-5	1. mFI-5 = 0 2. mFI-5 = 1 3. mFI-5 ≥ 2	↑Complications ↑Readmission ↑Discharge disposition	Predictive value independent of age and ASA
Tumor					
Ahmed	Primary spinal tumor	Spinal Frailty Index	Not frail: 0 Mildly frail: 0.11 Moderately frail: 0.22 Severely frail: ≥0.33	↑Complications ↑Length of stay	

(continued)

Table 9.2 (continued)

Author	Category of procedure	Frailty measure	Frailty cutoffs	Outcomes associated with frailty	Predictive value of frailty in comparison to other risk factors
De la Garza Ramos	Metastatic spinal tumor	Metastatic Spinal Tumor-FI	Not frail: 0 Mildly frail: 0.11 Moderately frail: 0.22 Severely frail: ≥0.33	↑Mortality ↑Complications ↑Length of stay	
Lakomkin	Spinal tumor surgery	mFI,	Stepwise analysis	↑Mortality ↑Length of stay	*High CCI better predictor than mFI*

mFI 11-factor modified frailty index
ASD-FI adult spinal deformity frailty index
5i-mFI 5-factor mFI
mCD-FI modified cervical deformity frailty index
∗Poor outcome from bleed but associated with less deterioration after surgery
Wide variation in cutoffs used to demonstrate frailty in these studies. Many different frailty indices used

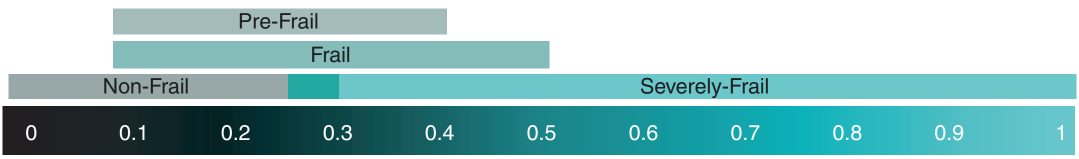

Fig. 9.1 Frailty cutoffs

or significantly frail by different studies. Even within one study analyzing different approaches to cervical fusion, different cutoffs were used to analyze frailty for the anterior vs. posterior approaches [58].

While it must be noted that the studies define frailty using different indices and cutoffs, the vast majority demonstrate an association between frailty and complication rates, including infection, reoperation, pneumonia, UTI, DVT, PE, and sepsis. Most importantly, 13 studies demonstrated that various frailty measurements are better predictors of outcomes and complication rates than age alone. This highlights that age alone must not be used as a treatment cutoff and why further study is needed across the spectrum of neurosurgical pathologies.

Case Reports

We present two recent cases that demonstrate that outcomes and complications are better predicted by comorbidities than by age (Table 9.3).

Case Illustrations

Patient A (Fig. 9.2) is a 76-year-old woman who presented to an outside hospital after syncopizing and was found to have a left temporal mass. Her past medical history was significant only for hyperlipidemia and remote seizure disorder (mFI of 0, non-frail or robust). Upon transfer she underwent left-sided craniotomy and temporal lobectomy for resection of an intracranial mass, which was later revealed to be glioblastoma. Postoperatively the patient had mild word-finding difficulties and lower extremity weakness, both of which improved significantly by discharge on POD6. She was discharged to acute rehab without any significant postoperative complications.

Patient B (Fig. 9.3) is a 65-year-old woman who was found to have a large right cerebellopontine angle mass on imaging after a fall. At the time she also complained of 1 year of gait instability and right-sided hearing loss. Her PMH was significant for HTN on medication, DM2, CHF, morbid obesity, previous TIAs, and a large abdominal hernia that had caused bowel ischemia status post

Table 9.3 Case illustrations of complications and outcomes in neurosurgery patients

	Patient A	Patient B
Pathology	Intracranial temporal mass – GBM	Intracranial CP angle mass – acoustic neuroma
Age	76	65
Presentation	Syncope	1-year gait instability and hearing loss, mass found on imaging after fall
Comorbidities	Seizures, HLD (mFI = 0)	HTN, DM2, CHF, TIA, abdominal hernia with bowel ischemia requiring ostomy formation (mFI = 4)
mFI	0.00	0.36
Medications at time of admission	Acidophilus, atorvastatin, levetiracetam, metoprolol succinate	Metformin, lisinopril, terbinafine, ventolin prn
BMI	20.9	46.0
Surgery	Left craniotomy and temporal lobectomy for mass resection	Left retrosigmoid craniotomy for resection of schwannoma with placement of lumbar drain
Outcome	Recovered well. At discharge had mild word-finding difficulties. Post-op mild weakness improved before discharge. Moving all extremities with full strength at discharge	Required intubation overnight postoperatively. Recovered well but had 3/6 right-sided facial paralysis Discharged to acute rehab on POD 11 but was readmitted 2 weeks later with wound dehiscence requiring reoperation
Complications	None	Readmission and reoperation for surgical site infection
Length of stay	6 days	11 days, 24 days after readmission
Discharge disposition	Acute rehab	Acute rehab, readmitted and then discharged to subacute rehab

Age is often not predictive of complications or outcomes in neurosurgery patients, such as with these two patients

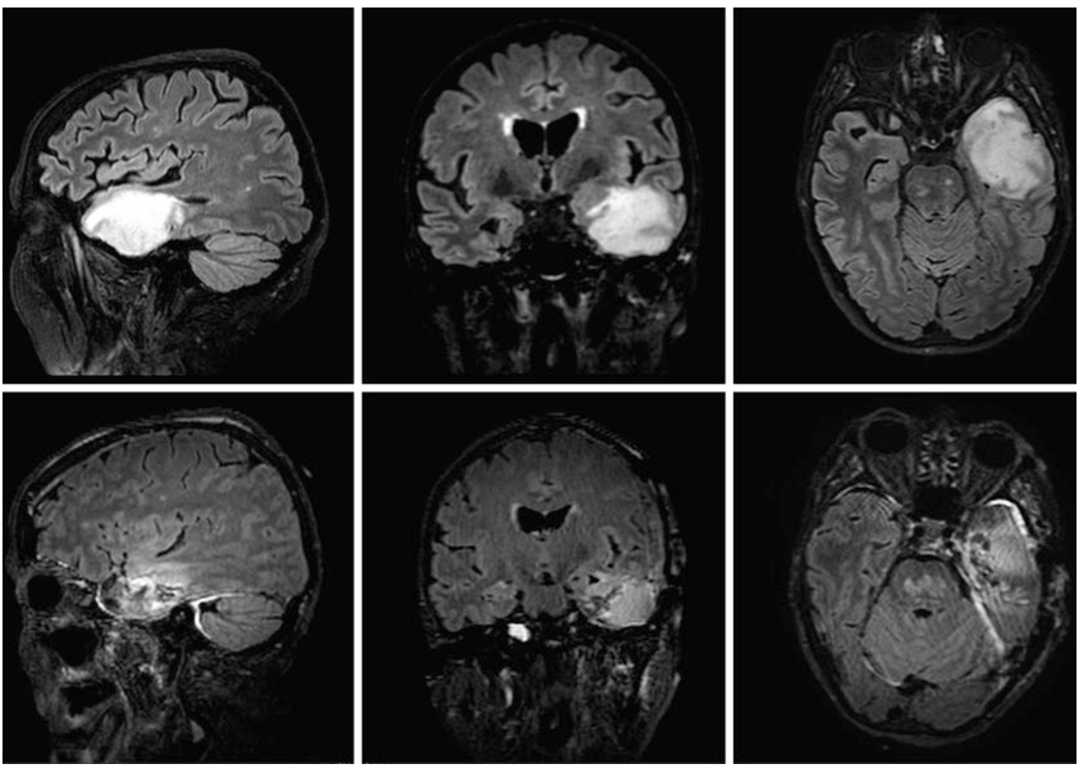

Fig. 9.2 Patient A, a 76-year-old woman. Preoperative (left row) and postoperative imaging (middle row) demonstrating resection of a large temporal GBM

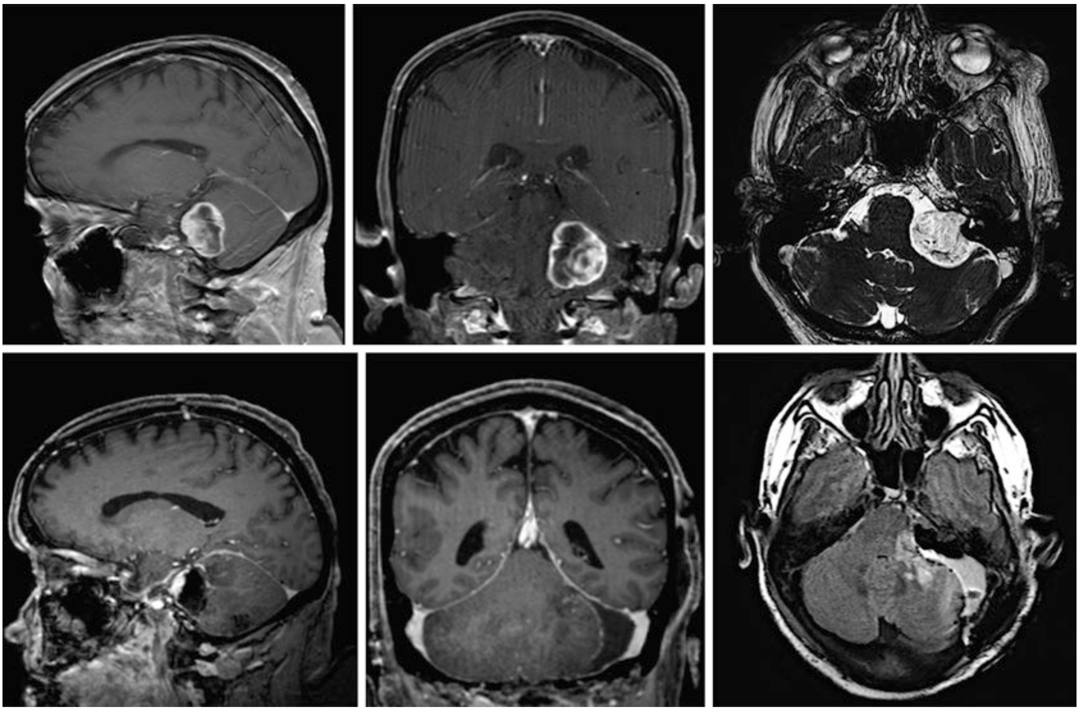

Fig. 9.3 Patient B, a 65-year-old woman. Preoperative (left row) and postoperative imaging (middle row) demonstrating near total resection of a vestibular schwannoma at the cerebellar-pontine angle

permanent ostomy diversion (mFI of 4, severe frailty). She was admitted for elective craniotomy and tumor resection. Her surgery went well with good resection of the mass. She remained intubated overnight and had transient 3/6 facial paralysis postoperatively, which eventually returned to normal. On postoperative day 11, she was discharged to acute rehab. Two weeks later she was readmitted with fevers, leukocytosis, and purulent discharge from her surgical site. She underwent reoperation for wound exploration and washout. She was treated with prolonged courses of vancomycin and aztreonam and was discharged to subacute rehab 24 days later.

Centenarian Case Reports

There are three case reports in the literature of centenarians undergoing neurosurgical procedures with good outcomes: a 101-year-old with an intraspinal meningioma, a 102-year-old with an acute subdural hematoma, and a 103-year-old with a thoracic compression fracture. These reports support our assertion that there should not be any absolute limit for neurosurgical intervention based on age alone.

101-Year-Old: Resection of Intraspinal Meningioma

In 2008, Cavanaugh et al. [64] published their case of a 101-year-old woman with an intraspinal meningioma found after presenting with leg spasms, bilateral leg weakness, stocking-type sensory loss distal to the knee bilaterally, and loss of ankle jerk reflexes. She had no other focal neurologic deficits. Imaging demonstrated an enhancing mass anterolateral to the spinal cord spanning from C7 to T1 that was compressing the spinal cord into a crescent shape. Surgery was offered due to the high risk of developing paraplegia without treatment. She then underwent laminectomy and resection of intradural mass that was adherent to the spinal cord. Her postoperative course was uneventful with recovery of strength in bilateral legs and no new neurologic deficits. On postoperative day 4, MRI confirmed no residual tumor and re-expansion of the compressed spinal cord.

At the time of presentation, this patient was living independently, and her only medical illness was mild congestive heart failure, which was well-compensated on medication (mFI = 1). Her low preoperative frailty likely contributed to her good outcome despite undergoing an invasive procedure.

103-Year-Old: Vertebroplasty for Thoracic Compression Fracture

In 2012 Kale et al. [65] published a case out of Turkey of a 103-year-old woman who successfully underwent vertebroplasty for a thoracic compression fracture. She presented with severe back pain refractory to conservative treatment 2 months after falling on her back. She had no focal neurologic deficits and exam only significant for tenderness to palpation at mid-thoracic spine. CT and MRI demonstrated T7 compression fracture. She underwent cement vertebroplasty with continuous fluoroscopic guidance under general anesthesia and was discharged on postoperative day 2 with significant improvement in her pain. Preoperative Visual Analogue Scale score was 9 and had decreased to 3 immediately postoperatively. On postoperative day 10, her VAS score was 1, and at 9-month follow-up, the patient reported no complications and required no medications for pain control.

Importantly, this patient was reportedly completely healthy preoperatively (mFI = 0). She was living independently without help and was taking no medications. Her injury was limited to one vertebral body and was not associated with any neurologic deficits. The procedure she underwent, percutaneous transpedicular vertebroplasty, can be performed with low complication rates in most patients. If any surgeon was presented this pathology unaware of the patient's age, they would offer treatment, but if the same set of clinicians were first presented the case knowing the age, then very few would offer treatment.

102-Year-Old: 2× Craniotomy and Evacuation of Subdural Hematoma

In 2007, Vyas et al. [66] presented the case of a 102-year-old woman who underwent two craniotomies for evacuation of two distinct acute subdural hemorrhages and who recovered all premorbid neurologic function and continued to do well through 7-year follow-up to the age of 110. This patient presented with mild drowsiness and right-sided hemiparesis after a fall. Head CT demonstrated acute SDH 2 cm in thickness. After being observed her neurologic condition deteriorated and her family opted for surgical intervention. She underwent left frontotemporal-parietal craniotomy and evacuation of subdural hematoma and was discharged to a rehabilitation after 11 days in the hospital and to home 2 weeks later. She recovered all premorbid neurologic function. Six months later, at the age of 103, she presented again after a fall with a GCS of 11. Head CT again demonstrated a large acute SDH, and the family again opted for surgery. After right-sided craniotomy and evacuation of SDH, the patient recovered to her baseline state of health and neurologically continued to do well through 7 years of follow-up.

This patient was in good premorbid condition relative to her age. Her past medical history at the time of presentation was significant only for impaired vision, difficulty walking, recurrent UTIs, and mild memory problems (mFI = 1). Her frailty level would likely be mild or prefail, depending on which scale was used to evaluate. This level of frailty is lower than would be expected when compared to her peers and even patients decades younger. Nonsurgical treatment would have likely resulted in severe neurological deficits or mortality. This patient continued to have good quality of life and no prolonged effects of surgery through 7 years of follow-up. There should be no neurosurgical treatment cutoff based solely on age.

Conclusions

The older neurosurgical literature regarding outcomes in elderly patients was extremely heterogeneous, and the results were conflicting. However, the baseline patient characteristics (frailty, comorbidities, etc.) were frequently not used to differentiate the patients, and clinicians were not as aggressive in treating these older patients sometimes. Furthermore, elderly patients from previous eras may not be representative of today's elderly patients as the baseline health of older patients continues to improve each decade. A Danish study analyzed how two cohorts of nonagenarians born 10 years apart scored in activities of daily living and cognitive tests [67]. The cohort born later scored significantly higher, suggesting that today's elderly population may not be equivalent to the elderly that were studied in the past.

Future prospective research needs to be performed that separates elderly neurosurgical patients by their baseline frailty or comorbidity status and by their specific pathology. This way "apples" can be compared to "apples" instead of "oranges" like the older literature when all patients >65 were lumped into one "elderly" category irrespective of their vastly different states of health that would lead to obvious and dramatic differences in outcomes with any potential treatments. Elderly non-frail patients can do great with certain neurosurgical procedures, while extremely frail elderly patients will often do poorly with significant invasive surgeries. The literature is replete with examples of non-frail elderly patients achieving excellent outcomes, and further research should continue trying to identify and then predict which patients will do well for each neurosurgical pathology subtype.

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10 Caring for the Geriatrics Trauma Patient: The Challenges and the Opportunities

Abbas Smiley and Rifat Latifi

It is expected that by 2050, almost 40% of trauma hospital admissions will be older adults [1]. Well-established and well-coordinated efforts in proper triage, preoperative, operative, and postoperative care of elderly trauma patients are crucial to decreasing preventable morbidity and mortality. While prevention is the most important component to reducing trauma in the elderly, this chapter will focus on general principles of management of trauma in elderly based on the physiology and mechanism of injury [2]. Additionally, creating the infrastructure for caring for elderly trauma patients such as geriatric consult service has proven critical. Preoperative considerations, such as time to surgery and nutritional status of the patient, are described in this chapter. Implementation of standardized perioperative assessment regimens has been shown to reduce poor outcomes and is discussed in this chapter as well. Consideration of anesthetic agents as part of the strategy to optimize care for elderly trauma patients is very important. Palliative care while in the ICU has received increased attention and acceptance in recent years since many elderly patients prefer this form of care over life-extending therapies. Finally, implementation of a discharge process that effectively addresses follow-up care solutions is the final component to proper care of elderly geriatric patients.

A. Smiley
Department of Surgery, Westchester Medical Center and New York Medical College, School of Medicine, Valhalla, NY, USA

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: Rifat.Latifi@wmchealth.org

The Burden of Trauma in Elderly

Currently, trauma is the fifth leading cause of death in people aged ≥65 years [3, 4]. Within the next 15 years, elderly trauma will consume about $34 billion dollars annually [5]. Falls are recognized as the leading cause of trauma-related mortality and morbidity in elderly [6], which occurs in about 30–35% of elders annually [7–9]. Road traffic accidents comprised about one-fourth of elderly trauma [10], and its average fatality rate is about 9% [10]. Elders have 16% higher chance of road traffic accidents compared to those 25- to 64-year-old drivers [11]. The burden of elderly trauma on the healthcare system and national resources is enormous [12–16]. By 2050, almost 40% of trauma admissions will be older adults [1].

Trends and Risk Factors

In the United States, trauma is the leading cause of death for people up to the age of 45 [17] and fifth leading cause of death in people aged

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≥65 years as mentioned above. After age 65, the characteristics of trauma change dramatically. While elderly people are still involved in motor vehicle accidents, falls are the leading cause of injury. Outcomes from injuries such as in hip fractures can be devastating, because they further reduce the quality of life for a patient who may already be frail. As people get older, the risk of falling increases because of frailty, weakness, chronic disorders and long-term use of medications, and cognitive, vision, and hearing problems. Moreover, living in the homes where they grew up (stairs and sleeping room on the second or third floor) and not modified for their age poses a major problem that should be addressed.

Several other factors for higher incidence of trauma among elders and their higher rates of morbidity and mortality exist; however, the mere aging process is the strongest one [18]. Constant declines in function of different organs predispose the elderly to various injuries even by low-energy level trauma. Osteoporosis, muscle atrophy, decreased subcutaneous tissue, osteoarthritis, renal, respiratory, and cardiovascular dysfunction, neurologic deficits, polypharmacy, and chronic medications are all parts of the aging process especially when combined with inappropriate lifestyle [1, 16]. History of fall is number one predictor for the increased risk of falls [19]. Females fall more, but males have worse outcome [20].

Other major mechanisms of injuries are road traffic accidents, elder abuse, and blunt/penetrating trauma [21]. Elder drivers with chronic disorders such as obesity, depression, or anxiety have higher risk of road traffic accidents [22, 23] and also higher mortality and morbidity following trauma [24]. Age distribution of pedestrian accidents in all age groups below 60 years usually follows the age distribution of the whole population. But the probability of pedestrian accidents in elders is double to triple of that in younger population [25, 26], and the risk of mortality is also 2–5 times higher [27, 28]. Pedestrian accidents are the worst mechanism of elderly trauma in terms of final outcome [29].

Elderly people constitute significant proportion of drivers on the road and have distinctive risk patterns as drivers. Chronic disorders, take multiple medications, fatigue, and sleep insufficiency are the main factors leading to reduced concentration and lower performance in elders [25, 30, 31]. In a long-term study, males had fewer falls and more road traffic accidents, whereas females had higher risk of more severe injuries. The latter could be explained by more frequent and more severe osteoporosis in elderly women [32, 33]. Elder men had significantly higher chance of being run over [34]. Marriage and education were protective factors against road traffic accidents and falls [32, 35]. Road traffic accidents were more frequent during weekends, mornings, and evening [36]. Fatal accidents were three times greater at night [37]. Driving in the country roads and rural areas had higher risk of road traffic accidents than in highways [32, 33, 38]. Road traffic accidents associated with elders occurred more frequently at intersections [25]. Alcohol was also associated with higher chance of road traffic accidents and falls [32].

Primary Prevention

Continuous weakening in various cellular functions in aging limits the response capacity to trauma. Demineralization and osteoporosis lead to weak bone which predisposes to insufficiency fractures and more severe fractures compared to the young population by minor trauma. Older adults are further predisposed to severe fractures by poorer mobility due to degenerative joint disease and stiffness of the spinal column [39]. Fall-related all extremity fractures, pelvic fractures and its major subtype, lateral compression injuries, and the related complications such as bleeding are more common in older adults than in younger ones. Traffic-associated limb injuries are also more common in elderly [40–42]. Poorer mobility also delays healing and increases the chance of venous thromboembolism [43]. Injuries in elderly victims are more severe and fatal [44–46] especially in those ≥75 years [29, 47]. So, age is the strongest predictor of mortality and morbidity in elderly trauma [29]; the older the victim, the higher the risk of mortality and morbidity. This age-related pattern was observed for both motorcyclists and pedestrians [48]. Measures that can potentially reduce or prevent harm include maintaining or strengthening the functions of musculoskeletal, cardiovascular, respiratory, renal, gastrointestinal, and neurological systems as well as ensuring proper levels of vitamin D, proper nutrition, physical activity, and enough sleep because they all prevent osteoporosis. Osteoporosis is often underdiagnosed. Screening for osteoporosis is a must, and education plays a key role [49].

Smart homes combined with remote health system monitoring can provide important health information and preventive measures for elderly population. Many required medical services could also be delivered to elderly patient in the comfort of their homes. Smart cloths, smart cameras, smart watches, and the associated health apps are the major components of smart homes [50]. More than 95% of falls could be accurately detected and promptly managed through smart homes and remote health system monitoring [51]. Smart homes provide the faster medical response, which can significantly reduce the mortality rate. In fact, the mortality rate of elderly trauma can be reduced significantly by just 10-minute faster medical response [52].

Secondary Prevention, Timely Diagnosis, and Proper Care

The aims of secondary prevention are timely and correct diagnosis of trauma and prompt surgical/non-surgical treatment. Early and correct diagnosis of the severity of elderly trauma patient is difficult, and, consequently, proper treatment could be delayed or incomplete. Lack of ability to demonstrate tachycardia due to beta-blocker medications, or simply inability to mount response to pain, could be detrimental in delaying the diagnosing major injuries. Incidence of fever in elderly patients is lower, and they are more often hyperglycemic and azotemic [53]. Decreases in renal, respiratory, and cardiovascular function further limit the response to trauma in hemodynamically compromised patients [1, 16]. These factors are especially important in internal bleeding following pelvic fracture, chest trauma, rib fractures, abdominal trauma, epidural/subdural hematoma, and cervical spinal cord injuries [54–56]. Other comorbid conditions may be hidden at the time of presentation. No awareness of comorbid conditions such as heart failure by healthcare providers may further complicate the management of patients [57].

Age >60 years, by itself, is a significant risk factor for bleeding [58]. Neurologic deficits such as reduced pain sensation, visual/hearing loss, and cognitive declines add more limits to the picture of hemodynamic response to trauma. Occult presentations of intracranial hemorrhage are more common in older adults [59]. Moreover, older adults take long-term medications such as anticoagulants, antihypertensives, antipsychotics, and corticosteroids. This polypharmacy may further complicate trauma care in aged population and change or limit their response to administered treatments. A clear examples are beta-blockers which decrease the proper response of sympathetic nervous system to trauma [60–62]. Therefore, the outcome in elderly trauma is multifactorial and more complex than the outcome of trauma in other age groups.

Given all the abovementioned issues, triage in elderly trauma to identify high-risk victims is difficult, but one should err on over-triage. Under-triage significantly increases the mortality in elderly trauma [41, 63]. Neither traditional severity scores such as the injury severity score and revised trauma score nor alternative outcome scores such as geriatric trauma outcome score and shock indices provide optimum measurement of triage in elderly trauma [5, 64–67]. Similarly, although CT scan is the primary imaging measure in geriatric trauma [41], the utility of repeated head CT scan in traumatic brain injuries has not proven useful. Repeated head CT scan is mainly valuable in unexaminable victims or those with neurologic deterioration [68]. Elder victims with head injury have higher risk of mortality specially within the first-day post-trauma. Age and Glasgow Coma Scale are the most important prognostic factors in these patients [69].

Given the complexity of elderly trauma, there are five keys that should be applied in practice in order to help with the management of geriatric trauma.

1. *Age alone as an indicator for trauma activation*. Many centers use vital signs and trauma mechanism as a venue for trauma team activation, whereas none of them could be a good indicator of severity of trauma. Many old patients with trauma have normal vital signs [70]. The mortality rate of elderly patients with mild, moderate, and severe trauma (injury severity score <15, 15–29, and >29, respectively) is more than triple of that in younger population [71]. Similarly, the mortality rate of elderly patients with mild, moderate, and severe traumatic brain injury (Glasgow Coma Scale <9, 9–12, and >12, respectively) is sextuple, triple, and double of that in younger population, respectively [72]. Health outcomes and cost-effectiveness will be improved if we treat trauma patients aged ≥70-year old at trauma centers, irrespective of their vital signs or trauma mechanism [73]. Then, a fully active and experienced trauma team will evaluate their frailty. Consequently, mortality will decrease dramatically compared to the non-trauma centers [74].
2. *Identification of frailty*: Evidence shows that identification of frailty and quantifying the frailty score are an important factor in trauma management in elders [47, 55, 75–77]. Frailty indices have been discussed extensively in Chap. 7, but one that has shown promising results in elderly trauma is Trauma-Specific Frailty Index. Its validity and reliability have been superior to the abovementioned scores. Frailty indices may also be able to predict the poor outcomes in elderly trauma [47, 55, 75–77]. Proper frailty estimate leads also the healthcare professional to decide whether the elder should be managed in a trauma center or not. In an interesting study conducted at American College Level I trauma center, starting on a specific date, all elderly patients aged ≥70 years were managed by the highest-level trauma activation system upon ER admission regardless of injury mechanism (933 patients). Patients admitted and managed for the last 2 years before the specific date were considered as the control group (1271 patients). The intervention group had 60% higher chance of staying in ER for 2 hours and shorter and also had 30% less mortality compared to the control group [78]. We know the importance of time in elderly trauma management. For example, fat embolism following long bone fractures may happen within the first 72 hours after long bone fractures. Definitive fixation of fractures within the first 48 hours after trauma is associated with uncomplicated hospital course [79]. Referral to Level I trauma centers or centers that treat a high proportion of older adults can significantly reduce the mortality rate in elderly trauma [5, 28, 64, 80]. In a recent cohort study, the mortality rates of elderly trauma patients admitted to trauma centers were compared with those admitted to non-trauma centers in seven counties in Oregon and Washington in 2011 and followed up for a year. More than 80% of all deaths occurred in patients managed by non-trauma centers [74]. Improving the qualities of medical and surgical care and using more advanced technologies in hospitals will enhance the efficiency of secondary prevention. The higher the quality of trauma center, the lower the years of lost life and the years lived with disability. Overall, the proper frailty assessment and management in a trauma center is the first important key in elderly trauma.
3. *Identification and evaluation of coagulation profile*: The third key in elderly trauma management is to know the coagulation profile of the patient at the time of injury and whether patient was taking anticoagulants before trauma or not [81–86]. The coagulation profile should be assessed in all elderly trauma victims especially those who were taking anticoagulation medications before injury. Since pre-trauma anticoagulants and antiplatelets significantly increase the rate of mortality following elderly trauma [81], quick reversal of anticoagulation is essential in preventing the progress of traumatic brain

injury and further internal bleeding [63]. Shock in elderly trauma is an ominous sign, and hypotension increases the odds of in-hospital death, especially in brain injuries [87]. Elderly trauma victims with bleeding, hypotension, or shock should be treated aggressively and monitored invasively [88–90]. If the elders were receiving warfarin before trauma, INR-correcting treatments should be started in less than 2 hours, and their INR should be fully corrected (<1.6 of normal) within 4 hours using fresh frozen plasma and intravenous vitamin K [81–86]. Also, patients on anticoagulants with suspected head injuries when there is headache, nausea and vomiting, reduced Glasgow Coma Scale, or external trauma should have CT scan to assess their possible head injury. Bleeding is also part of the picture in most patients with pelvic fracture. MRI can identify 99% of insufficiency fractures in pelvis and proximal femur [91] whereas CT scan better identifies periprosthetic fractures [92]. The amount of bleeding, severity of fracture, mental status change, and mechanical ventilation can predict the mortality of pelvic fractures in elderly [42, 93, 94]. Sarcopenia and osteopenia can also predict 1-year mortality in elderly trauma patients [95]. In those with Abbreviated Injury Scale (AIS) less than 3, masseter sarcopenia and brain atrophy may accurately predict 1-year mortality [96]. Finally, in elderly trauma with Glasgow Coma Scale<8 and no improvement within 3 days of injury, more aggressive treatments are better to be limited [78].

4. *ICU monitoring and management*: Should every elder trauma patient be transferred to ICU for close monitoring and management? The answer to this question provides the fourth key in elderly trauma care management. In a systematic review conducted by Eastern Association for the Surgery of Trauma (EAST) which covered 90 related references, it was revealed that the elderly patients with AIS ≥3 in one body system or a base deficit of −6 mEq/L or less must be managed at ICU [78]. Correction of acid-base balance (pH to more than 7.25) within the first 8 hours after trauma is associated with fewer pulmonary complications [79]. Compared to pH, initial lactate could be a stronger predictor of pneumonia [79]. Also, blunt thoracic trauma in elderly patients is a reasonable indication for admission to ICU because it will significantly decrease complications, length of stay, and mortality rate [97].

   Persistent and systematic monitoring of ICU patients, in terms of vital signs and physical exam, is crucial. Other adjuncts of monitoring include urinary output, central venous pressure, stroke volume variation, ECG, RASS score, CAM score, CBC, BMP, magnesium, phosphate and ionized calcium, and, in some patients, EEG. Patients with special signs and symptoms such as fever, cough, diarrhea, and rash need extra measures of monitoring such as LFT, CXR, and *Clostridium difficile* testing. Systematic assessment of drug interactions before prescribing any new medication is extremely important [98–101].

   Several studies have evaluated the advantages and disadvantages of early vs. late tracheostomy in trauma patients admitted to ICU. Although few studies have shown no significant difference between them, most investigations have been in favor of early tracheostomy. It seems early tracheostomy improves the health outcomes in terms of nosocomial pneumonia, duration of mechanical ventilation, ICU length of stay, and hospital length of stay [102–122]. No study has shown a significant difference in terms of mortality rate between early and late tracheostomy in elderly trauma patients admitted to ICU.

   The factors associated with poorer outcomes in victims of road traffic accidents admitted to ICU were old age, development of secondary systemic problems such as respiratory, circulatory, hepatic, and metabolic impairments, Glasgow Coma Scale less than 8, and subdural hematoma [123, 124]. Severe traumatic brain injury (Glasgow Coma Scale less than 9) in elderly patients is accompanied with more than 80% mortality rate or long-term placement facilities.

5. *Geriatric emergency service*: The fourth key in optimal management of elderly trauma patients includes participation of geriatric practitioners in their care as soon as the patient is admitted. This protocol may consist of standardized perioperative assessment regimens by both surgeons and geriatricians, expeditious surgical treatment, and continued surgical/geriatric care postoperatively, which will result in reductions in lengths of stay, ICU admissions, and hospital costs per patient [125–130]. In an interesting interventional study on older adults with hip fracture, 210 patients were assigned into two groups, orthogeriatric co-management group vs. orthopedic care with geriatric consultation group. In orthogeriatric co-management group, both orthopedic surgeons and geriatricians shared the responsibility of patient management in an integrated model of care. Patients in orthogeriatric co-management group showed significantly lower 1-year mortality, shorter hospital length of stay, and higher probability of having surgery within 2 days after admission [131]. Delay of the surgical intervention occurs due to arrhythmia, severe anemia, electrolyte disturbance, coagulopathy, uncontrolled hyperglycemia, uncontrolled heart failure, pneumonia, and sepsis [132]. Similar findings were reported by other centers from different countries using orthogeriatric co-management by conducting retrospective cohort studies [125–130].

Integration of Other Services in the Healthcare System

Emergency medical services: The faster the victim transports to trauma center, the better the prognosis of the victims. The closer the trauma care center, the lower the rates of mortality and morbidity. Transportation improvement and accessibility of more ambulance services for elder trauma victims are critical steps in improving trauma care [80, 123]. Ten-minute faster medical response can reduce the mortality rate by one-third in elderly trauma [52].

Pharmacy services: Development of more efficient and safer medications can save victims lives. For example, it has been estimated that if all trauma victims with significant bleeding around the world receive tranexamic acid on time, at least 100,000 premature deaths will be prevented annually [133]. This could be more lifesaving for elderly who has limited hemodynamic response. On the other hand, polypharmacy significantly increases the risk of falls, trauma, and fractures [134, 135]. Cardiovascular, psychotropic, and nonsteroidal anti-inflammatory drugs increase the risk of falls through dizziness, confusion, sedation, orthostatic hypotension, and sleep disturbance [135]. A population-based study showed more than 8 times increase in the risk of hip fracture in older adults who used ≥10 medications vs. those who used ≤1 medication. Elders aged ≥85 years who took ≥10 medications had 23 times higher risk of hip fracture compared to 65- to 74-year-old elders who took ≤1 medication [136]. Then, careful monitoring of medications and their side effects is an essential element of preventive measures in elderly trauma.

Rehabilitation services: Inpatient and outpatient rehabilitation facilities play important roles in recovery of elderly patients after trauma and retrieval of the pre-trauma quality of life. It is important to compare the following indices in every patient before and after injury in order to prepare the best rehabilitation plan: functional independence, vision, and memory status. It is further discussed in detail below.

Preoperative Considerations

Optimization of preoperative abnormalities is essential as long as it is possible. Elderly trauma patients have significantly more nutritional deficits than the younger patients after operations, and prolonged hospitalization worsens the nutritional deficits [137]. Measurements of initial and follow-up prealbumin level may provide important prognostic information about the risk of malnutrition and inflammation and the response to treatment in critically sick elderly trauma patients. Correction of prealbumin within 4 days after admission lowers injury severity score, shortens length of stay and ventilator days, and improves the survival [138]. Preparing a proper diet which covers essential nutrients for recovery has a vital role. Nutritional support should be initiated, if possible, in malnourished patient. Nutritional requirements of elderly population are further discussed in other chapters of this book (see Chap. 8 on nutritional support).

The sensitivity of elders to anesthetic medications is higher due to less functional reserve and limited renal, respiratory, and cardiovascular function response to stress (see Chap. 7 on anesthesia). Serum albumin level as the main protein binding to acidic drugs decreases in elderly. Total body water and hepatorenal metabolism decrease which leads to higher serum concentrations of medications. Total body fat increases which provide the higher volume of drug distribution and consequently, the longer drug action. Overall, elders need less medications, and they experience prolonged effects of medications.

Comorbid disorders and conditions such as diabetes mellitus, cardiovascular disease, depression, malnutrition, immobility, dehydration, and cognitive dysfunctions are more common in elders and associated with higher perioperative morbidity and poorer outcomes. Faster recovery and avoiding functional decline are essential objectives in elderly patients [139].

Postoperative Care

A recent study showed that 86% of patients with orthopedic trauma had sleep disturbance, and in about 55%, the sleep disturbance was very severe, similar to the level observed in major depression [140]. Similar findings of sleep disturbance have been observed in eye trauma in elderly [141]. Sleep disturbance not only postpones recovery, it also intensifies depression [142]. In order to reduce sleep disturbance, special attention should be paid to body pain and mental health since they are the main predictors of sleep quality in patients with orthopedic trauma [140, 143]. Depression also increases the morbidity and mortality and reduces the efficacy of rehabilitation [144]. Depression is not only common after trauma [145], it is also under-detected and under-treated in elderly population [146]. Counseling has a very positive impact on quality of life in elderly trauma patients [143].

Sleep insufficiency and depression are both predisposing factors for development of postoperative delirium [147–149]. Up to a third of elderly patients with trauma experience delirium postoperatively [150]. Delirium increases the mortality rate, the length of hospital stay, cognitive impairment at the time of discharge, and the probability of discharging to rehabilitation institutes or nursing home [150, 151]. In addition to age, other associated risk factors are length of surgery, American Society of Anesthesiologists classification >2 level, opioid use, and history of alcohol excess. Precipitating factors are polypharmacy, infections (meningitis, pneumonia, and UTI) systemic illnesses (hepatic failure, malignancy, pulmonary disease, CHF, and anemia), metabolic derangements (volume depletion, diabetes, serum albumin level, and vitamin B_{12} deficiency), and electrolyte disturbances (hyponatremia and hypercalcemia). Multicomponent interventions are necessary to tackle postoperative delirium in older adults [152–155]. Several systematic reviews have shown that improving sleep hygiene through measures such as bright light exposure, earplugs, and melatonin has huge positive effects on preventing delirium, whether postoperatively or in ICU [149, 156–160]. Other preventive measures of postoperative delirium are adequate pain management, dietary modification, exercise training, and hearing and visual aid [161]. Several medications have also shown promising effects such as dexmedetomidine, analgosedatives, rivastigmine, olanzapine, risperidone, and droperidol [162–165].

On the other hand, prolonged immobility triggers serious complications. Pressure ulcers, urinary tract infection, pneumonia, and venous thromboembolism are among the most important ones. Immobility-induced hypercalcemia and the associated complications could potentiate a worse outcome [166]. Orthostatic hypotension after prolonged immobility and the resultant falls and secondary trauma are other concerning risks [166]. Overall, functional mobility and the ability to conduct daily living activities are among the main predictors of long-term outcome [145]. Therefore, early mobility and early involvement of physical therapy are crucial for almost all cases [63]. Before the implementation of stroke center certification program, elderly trauma patients were more likely to discharge to skilled nursing facilities than to inpatient rehabilitation facilities. But, after the implementation of stroke center certification program, the trend has shifted toward more discharge to rehabilitation facilities rather than to nursing facilities. One of the eight domains of this program is focused on assessing and monitoring the mobility and the rehabilitation after surgeries [167].

Follow-up bone mineral density is a must, but it has not been always practiced properly [168]. In some instances, such as hip fracture, the risk of second hip fracture will persist for more than 10 years among the survivors. This means secondary prevention must be continued beyond the early postoperative care [169]. Dedicated fracture prevention service and clinic will reduce further fracture 2 years after the first incident [170, 171]. Elderly patients are more susceptible to postoperative complications such as stroke, low cardiac output, respiratory failure, and renal failure [172].

On the other hand, elderly patients with severe traumatic brain injury who are not improving in 72 hours and not responding to treatment should have limited aggressive treatments. Many elderly patients near the end of life select palliative intervention vs. life-extending therapies. Goals of end-of-life care and decision-making should be further discussed with families [173–175]. End-of-life care has been discussed in other chapters of this book. Palliative care is an important topic for elderly trauma but sometimes is not paid enough attention. In a recent study, 118 trauma surgeons were compared with 244 palliative care specialists. Trauma surgeons were less familiar with goals of end-of-life care, less likely reported high-quality training in perfuming conversations, and showed less interest in conducting related conversations. But they rated themselves better than the palliative care specialists in performing goals of care discussions with patients [174].

Trauma care in the elderly is in its primary stages of development. Specialized research projects dedicated to trauma and trauma care in the elderly are needed to provide evidence-based medicine on the table.

Post-Traumatic Quality of Life and Tertiary Prevention

The goal of tertiary prevention is to prevent or reduce post-injury and postoperative complications and progress the quality of life after discharge from hospital. Resuming the pre-trauma quality of life among elderly trauma patients might be difficult. Quality of life is significantly reduced after the trauma and even 3 months later [176]. Higher percentage of elderly trauma patients are eventually discharged to rehabilitation care or assisted living facilities compared to younger people [145, 167]. Age, severity of injury, number of comorbidities, fracture, length of stay in ICU, having Medicare, and ambulation status were significant predictors of discharging to rehabilitation care or assisted living facilities [177]. Furthermore, longer length of stay and discharge to rehabilitation care and assisted living facilities were the main predictors for hospital readmissions in elderly trauma [178, 179]. A recent meta-analysis showed that comprehensive geriatric care significantly improves the percentage of older adults who regained the same level of walking and daily living activities as before fracture [180]. Comorbid conditions and frailty play major roles in long-term quality of life [181]. For example, diabetic patients who experience traumatic brain injury have more than 3 times higher risk of dementia [182]. Multidimensional interventions in different aspects of lifestyle such as sleep, exercise, nutrition, recreation, and cognition are necessary to improve their quality of life [183]. Advanced follow-up studies are needed to reveal the pattern of quality of life and the areas that need more attention in rehabilitation in elderly trauma.

Summary

Trauma is the fifth leading cause of death in elders, and fall is the leading cause of trauma in this population. Osteoporosis, musculoskeletal weakness, osteoarthritis, renal, respiratory and cardiovascular dysfunction, neurologic deficits, chronic medications, and polypharmacy are all parts of the aging process. Prevention by vitamin D, proper nutrition, physical activity, and enough sleep is essential. Smart homes and remote healthcare monitoring carry further preventive and therapeutic benefits. When trauma occurred, the fast transport of elderly victim to the trauma center and proper triage become crucial. Employment of the following five keys will upgrade the patient management:

1. Age 70 is an indication for activation of trauma team.
2. Application of Trauma-Specific Frailty Index and admission in a trauma center to recognize the severity of frailty improve the health outcomes.
3. Assessment of the current coagulation profile, rapid reversal of anticoagulation effects, and aggressive management of shock are essential.
4. Transfer to ICU in case of AIS ≥ 3, blunt thoracic trauma, or a base deficit of -6 mEq/L or less is critical. Persistent and systematic monitoring of ICU patient is extremely important. Early tracheostomy shortens nosocomial pneumonia, duration of mechanical ventilation, and hospital/ICU length of stay.
5. Inclusion of geriatric practitioners to consult as soon as the patient is admitted is beneficial.

Minimizing anesthesia, medications, and increasing the mobility as much as possible following injury are most important factors. Faster recovery and avoiding functional decline are essential objectives in elderly operations. Resuming the pre-trauma quality of life among elderly trauma patients can be difficult. Higher percentage of victims of elderly trauma patients will be eventually discharged to rehabilitation care or assisted living facilities if early mobility and rehabilitation therapy are not implemented. Rehabilitation and physical therapy are critical parts of postoperative management, even in the ICU settings. Also, early involvements of counseling to treat sleep and depression are crucial. Multidimensional interventions in different aspects of lifestyle such as social life, nutrition, recreation, and cognition are necessary for long-term management. Many elderly patients near the end of life select palliative intervention vs. life-extending therapies. Goals of end-of-life care and decision-making should be further discussed with patients and families.

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ENT Surgery in the Elderly

11

Jaclyn Klimczak, Augustine L. Moscatello, and J. K. Rasamny

The geriatric age group is defined as individuals over the age of 65 and is one of the United States' fastest expanding populations. With the continuous expansion of medical technology, we have seen an increase in life expectancy occurring in congruence with the decline in birth rates. If the current trend continues, the expected census of people over the age of 65 by 2050 will be in excess of 83 million [1]. The change in demographic trends in the United States has an immense impact on the field of medicine and, more specifically, the practice of otolaryngology. Older individuals not only harbor acute and chronic medical problems specific to the geriatric population, but even their common problems need to be treated differently than their younger counterparts. Medical and surgical care for the geriatric population is also more complex because of the higher rate of comorbidities that must be considered. The aging process is burdened with deficits specific to the field of ENT that include but are not limited to hearing impairment, balance impairment, an increased risk of head and neck cancer, swallowing disorders, and voice concerns. These problems in turn contribute to a lack of independence and often social isolation as quality of life becomes compromised due to functional disability. It has been found that up to one-third of all health-related visits are related to complaints managed by otolaryngologists [2]. In response to the demands of this newly expanding population, it is imperative to understand the otolaryngologic disorders specific to this aging population and with that how to deliver an individualized treatment plan specific to their needs.

J. Klimczak
Department of Otolaryngology Head and Neck Surgery, Icahn School of Medicine at Mount Sinai, New York, NY, USA

A. L. Moscatello (✉)
Department of Otolaryngology/Head and Neck Surgery, New York Medical College, Valhalla, NY, USA

Department of Otolaryngology/Head and Neck Surgery, Westchester Medical Center, Valhalla, NY, USA
e-mail: Augustine.Moscatello@wmchealth.org

J. K. Rasamny
Department of Otolaryngology, Head and Neck Surgery, ENT Faculty Practice, Ardsley, NY, USA

Head and Neck Surgery in the Geriatric Population

Thyroid and Parathyroid Disease

Recently, the prevalence of both benign and malignant tumors of the thyroid has increased in concordance with increased utilization of diagnostic imaging. Statistics estimate about 50% of patients over the age of 65 years demonstrate nodules on ultrasound examination and about 90% of women present with thyroid nodules after

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the age of 60 years, and 60% of men after the age of 80 years [3, 4]. Although the American Thyroid Association (ATA) continuously update their management guidelines on thyroid disorders, there are none that are specific to the geriatric population. However, the staging system of papillary thyroid cancer is stratified by age less than or over 55 to account for the less aggressive nature of these tumors in younger individuals [5]. That carries over to the literature on thyroid disease and surgery in the geriatric population with there being a paucity in literature regarding specific management.

In general, it has been noted that increasing age has been an independent factor associated with postoperative morbidity and mortality [6]. Thyroid and parathyroid surgery is considered an intermediate-risk surgical procedure, and data is conflicting regarding its risk in the geriatric population [7]. Although smaller single institution–based studies have demonstrated similar outcomes among patients regardless of age, larger population–based research has shown that the elderly are at a higher risk for longer hospitalization stays, higher readmission rates, and major systemic complications following thyroid and parathyroid surgery [3, 8–12]. Tuggle et al. reviewed readmission rates in geriatric patients using the Surveillance, Epidemiology, and End Results (SEER)–Medicare-linked database to identify patients 65 years with thyroid cancer who underwent thyroidectomy over a 5-year period. Rehospitalization rates were found to be at 8% in their population and associated with increased comorbidity, advanced stage, the number of lymph nodes, increased length of stay, and small hospital size. Unplanned readmission cost was greater than $5000 for a mean length of stay of 3.5 days and significantly associated with death at 1 year [8]. Readmission rates after thyroidectomy and/or parathyroidectomy are found to be lower in larger hospitals with postoperative discharge follow-ups to outpatient providers and among high-volume surgeons who perform greater than 30 thyroidectomies per year [8, 13].

The elderly are at increased risk of malignancy and harbor more aggressive thyroid tumors [4, 10, 11, 14]. Thyroidectomy is used to treat both benign and malignant disease. With increasing incidence due to better diagnostic tools, diagnosis and treatment become more important. Risks and benefits need to be carefully reviewed despite the increased safety profile of anesthesia and surgical procedures. For thyroid and parathyroid surgery, injury to the recurrent laryngeal nerve (RLN) is one of the most serious complications and intraoperative monitoring has become mainstay to avoid postoperative morbidity. In a patient population where nodules tend to be larger and more aggressive, and comorbidities are more prevalent, injury to the RLN are increased [15]. Calcified vessels and scar tissue can often be disorienting; therefore, intraoperative nerve monitoring is of great value when performing thyroid or parathyroid surgery in elderly patients. Postoperative RLN injury which can lead to symptoms of hoarseness, difficulty breathing, and dysphagia is often more difficult to overcome in the geriatric population and can lead to devastating morbidity and prolonged hospitalizations. As such, the weight of the benefits of surgery has to be carefully weighed against the risks.

Individual risk–benefit analyses must be performed and are even more important in the geriatric patient. Current guidelines stress the importance of surveillance in nodular thyroid disease and recommend against fine-needle aspiration (FNA) unless they meet criteria for size and suspicious characteristics on ultrasound. Those that do meet criteria and are found to be benign on FNA should also undergo routine imaging surveillance in 6–24 months depending on sonogram characteristics [5]. Studies have shown that although the incidence of papillary thyroid carcinoma increases with time, the incidence of nonpapillary thyroid carcinoma remains relatively constant, and increase in incidence of thyroid cancer during the last decades without concomitant rise in mortality may reflect the growing detection of indolent forms of thyroid cancer [16]. In a prospective study stratified by age that looked at disease progression in patients with papillary thyroid microcarcinoma, it was found that less than 2% of patients greater than 60 years of age had progression to clinical disease. These findings suggest that observation may play a large role in older patients with low-risk papillary microcarcinoma, thereby minimizing the risks of surgical interventions in the geriatric patient [17].

Parathyroid surgery has become more streamlined and effectively a safer procedure over the years due to the improvement in preoperative localization studies. Primary hyperparathyroidism has a peak incidence between 55 and 70 years of age and is associated with being a direct cause of osteoporosis, constipation, and mental fogging. In geriatric patients, complications from primary hyperparathyroidism such as osteoporosis and increased risk of fracture are devastating and appropriate treatment of the disease by surgical removal is imperative [18]. Because parathyroid surgery has become a fast, outpatient procedure with immediate cure and benefit, it is recommended even in older individuals after appropriate preoperative clearance.

With the increase in the prevalence of thyroid and parathyroid disease, there has been an increase in surgical procedures as a means of first-line treatment. In the geriatric population, surgical thyroid and parathyroidectomy can be safely and appropriately performed after careful risk–benefit assessments and preoperative counseling has been performed with the ultimate benefit of improving or prolonging each patient's life.

Head and Neck Oncology

Head and neck cancers represent 6% of all cancer diagnoses worldwide and account for 650,000 new cases and 350,000 deaths yearly [19]. That number accounts for 52,000 new cases diagnosed in the United States each year with the median age being 60 years old at the time of diagnosis. Head and neck cancers encompass a broad group of epithelial malignancies that can arise from the nasal cavity, ears, oral cavity, pharynx, larynx, and paranasal sinuses. Squamous cell carcinoma represents the most common histological presentation with tobacco and alcohol use and prior infection with the human papillomavirus (HPV) being the greatest risk factors [20]. As the population increases and lifespans continue to lengthen, head and neck cancer in the geriatric population will continue to grow. Current estimates suggest that 20–25% of patients with head neck cancers are over the age of 65 with over 50% of new diagnoses occurring in this age group [21–23]. Despite being a predominantly male-dominated disease with ratios ranging from 8:1 to 15:1, the proportion narrows with age as more females become diagnosed in patients over 65 years of age [24–26].

Management of head and neck cancers requires a multimodality treatment regimen targeted by surgery, radiotherapy, systemic chemotherapy, or a combination of the three depending on tumor stage, location, regional disease, distant disease, and intent of treatment. Approximately two-thirds of patients with head and neck cancer present with locoregionally advanced disease commonly involving the cervical lymph nodes (stage III or IV), where distant metastatic spread at initial presentation is found in about 10% of patients [27, 28]. Treatment of head and neck cancer is complex with an extensive perioperative period and long-term close follow-up appointments with often multiple physicians involved as part of the treatment team. It does not follow a one-size-fits-all model. Its careful diagnosis and management in the geriatric population is necessarily much more specific to the individual needs of the patient.

Although the biological age is more telling in the geriatric patient than the chronological age, with age there are particular physiologic organ-specific changes as well as a decline in the integrity of certain anatomical functions. Functional ability and comorbidities are important to assess as complex medical histories are more common in elderly patients. Elderly patients with poor physiologic reserve and complex medical problems are vulnerable to an increased burden of symptoms and have reduced tolerance for medical interventions, thereby necessitating a comprehensive geriatric assessment as the first and essential step prior to selecting the most appropriate treatment options [20]. Age-specific problems include functional decline, impaired cognition, decreased psychological well-being, reduced nutritional status, and the absence of social support. All of these should be vigilantly evaluated and perform an important role in determining the appropriate treatment. Presenting a comprehensive plan for the patient that illustrates its fluidity as the treatment process is implemented is crucial in the geriatric. Treatment of head and neck cancer is often a long and arduous path toward cure and prolongment of lifespan, so it is imperative that understanding the risks and potential complications that can arise throughout the course is thoroughly discussed with the patient. Informed decision by the patient should include knowledge of all the potential complications that can arise from each of the treatment options that can have adverse effects on their quality of life. These should be frequently revisited throughout their treatment course to reevaluate goals of care.

Early-state head and neck cancer is typically treated with a single-modality regimen including either surgical resection or radiotherapy and is determined based on the anatomical site. Prognostic factors well studied in head and neck cancer patients are disease specific such as tumor size, staging, lymph node involvement, margin status, perineural or vascular invasion, and extra lymphatic extension. Age as a prognostic factor is less understood but gains more attention in recent years as the population has increased. A Surveillance, Epidemiology and End Results (SEER) Program in 9386 subjects found comorbidities to be an independent predictor of survival for patients older than 65 years with head and neck cancer [28]. Multiple prospective and retrospective studies in head and neck cancer survival outcomes have not shown any differences when stratified by chronological age [25, 28, 29]. Over 2500 cases of squamous cell carcinoma of the glottic larynx, oral tongue, and tonsil were extracted from the SEERS program over a 10-year period and stratified by chronological age. Overall survival and disease-specific survival were compared among younger and elderly patients and found no statistically or practically significant differences [30]. Sarini et al. assessed outcomes in patients 74 years of age and older compared to younger patients undergoing head and neck cancer treatment and found no differences when it came to tolerance to treatments and survival outcomes [24]. Although older patients with head and neck cancer are more likely to harbor comorbidities, the chronological age in this heterogeneous geriatric population is not an independent predictor of response to therapy or survival. Therefore, the biological age becomes a crucial parameter that may have a large impact on prognosis when considering treatment plans. Those patients who are more frail or harbor multiple comorbidities which increase with age may be unable to tolerate treatment or its toxicities, putting them at higher risk for receiving suboptimal care and less aggressive treatment options needed to achieve complete remedy of their disease [27].

As head and neck oncology has evolved, so have treatments, which have led toward the development of less-invasive modalities such as transoral laser and robotic surgery, endoscopic surgery, and intensity-modulated radiotherapy which are better tolerated while minimizing the side effect profile. The use of transoral robotic surgery for early-stage oropharyngeal carcinoma offers a function sparing surgery that is less intrusive than prior open techniques. With complete resection and lymph node dissection, these newer methods allow delivery of lower doses of adjuvant radiation therapy, sparing critical structures such as the pharyngeal constrictors, brachial plexus, and carotid artery from high-dose radiation damage and functional impairment, disabilities that can be devastating to overcome in an elderly patient [31, 32]. Due to the expanding evidence in the literature that geriatric patients have similar head and neck cancer treatment outcomes when compared to control matched younger individuals, primary treatment plans for these patients do not need to stray from the gold standard to compensate for age.

However, because comorbidities and symptom incidence, prevalence, and severity are known to increase with age, it is imperative to be meticulous in the overall management of elderly head and neck cancer patients [22, 33, 34]. Developments in oncologic practices have put forth standardized quality of life, symptom assessment, and comorbidity tools to best determine prognosis and response to treatment modalities which should be incorporated into initial pretreatment assessments [33–35]. One of the most important assessments that need to be done at the initial evaluation is the determination of frailty in the elderly. Elderly patients once stratified based on their biological age or level of frailty can be appropriately intervened prior to treatment to improve outcomes. Head and neck patients are even more at risk for functional declines because the location of their tumors impact many important functions of daily living such as swallowing, speaking, hearing, and breathing. Dysfunction in any of these can lead to dysphagia, malnutrition, aspiration, infection, and even death. Due to the nature of these tumors, patients who are functionally viable and independent can decompensate as they lose these basic functions that greatly impact quality of life. This may only be exacerbated with treatment modalities as surgical resections violate this functional anatomy. Alternatively, radiation therapy is not without side effects. In patients that may have difficulty swallowing post-surgical intervention or radiotherapy treatment for instance may benefit with early intervention enteral feeding to prevent malnutrition throughout their cancer therapy. Comprehensive geriatric assessment's (CGA) is a multifactorial measurement that can be used in the geriatric population to determine one's frailty by measuring their functional status, medical conditions, cognition, mental health, social support, nutritional status, and polypharmacy. The evaluation takes into account functional status through the means of completing activities of daily living and objective measurements of functional status, such as the 'Get up and Go' test [36]. Promptly creating a plan, using preoperative assessment tools, and mapping out the proposed long-term treatment plan in patients can identify those at risk for complications.

Primary surgical treatment is a well-established modality for the treatment of most head and neck cancers but is not without its complications. Many studies in the literature that have looked at patients with comorbidities have found they are in fact at a higher risk for postoperative complications [37, 38]. In head and neck cancer and reconstructive surgeries where the patient undergoes anesthesia for a prolonged period of time, these comorbidities become more important in the preoperative evaluation. Pedicle and free flap reconstructions have improved immensely over the years with success rates ranging from 95.4 to 100% for free flaps and 87.7 to 100% for pedicle flaps [39–41]. These statistics have not been shown to vary based on elderly patients, but concurrent comorbidities regardless of age have been shown to play a large role [42, 43]. Zhang et al. analyzed the treatment outcomes including the type of flap, the length of the intervention, and the outcomes of over 600 elderly head and neck cancer patients who underwent surgical treatment and reconstruction with either a pedicle flap or a free flap. They found outcomes in surgical intervention and reconstruction with a pedicle or free flap tissue were not significantly affected by age. This has been consistently shown in the literature to suggest head and neck cancer surgeries with reconstruction can be performed safely in patients regardless their age, but comorbidities need to be preoperatively assessed and monitored [39, 44].

Radiotherapy is a means of treatment for head and neck cancers that are either early stage and not suitable for surgery, inoperable, locally advanced, or used for adjuvant treatment after surgical resection. Treatment can be difficult for the cancer patient because of the time commitment dedicated to completing its course. The average fractionations are 5 times a week for 7 weeks, necessitating the need for a reliable support system and consistent care. Furthermore, radiotherapy is known to induce acute morbidity due to the xerostomia and fibrosis induced by this therapy [45]. The responsibility of transportation to the appointments, dedication of time, and post-radiation complications all can be very overwhelming for any patient. In the geriatric population, this can lead to a loss of independence and depression. The use of concurrent chemotherapy, complications of ototoxicity, and nephrotoxicity can acutely impact the patient's quality of life and lead to negative physical, emotional, and social outcomes [46]. Close monitoring and frequent reevaluations by the head and neck surgeon and oncologist in this patient population are important to maintain goal-oriented expectations and be attentive to make adjustments as needed for intolerable morbidities that may arise.

Geriatric patients should be presented the best treatment plan for head and neck cancer regardless of age. Surgical treatment which can be disfiguring and long-term morbidity from radiation therapy can have considerable effects on their quality of life. Pretreatment evaluations with geriatric assessments to determine biological age and fragility are useful in initial pretreatment planning to unmask any foreseeable morbidities and identify patients who can or cannot tolerate standard of care treatment interventions.

Laryngology in the Geriatric Population

Aging Voice

Physiologic differences exist between not only males and females, but also exist among different age populations [47–49]. The prevalence of voice disorders in the United States is about 6.6 to 7.6% with nearly $300 million annually related to dysphonia-related disorders. In the elderly population of patients over the age of 65, hoarseness and dysphonia are common complaints that draw patients to see an otolaryngologist and are widely due to natural physiologic changes of senescence that take place with age. As we age, pitch and loudness diminish, and speech slows down with more pauses for air. The geriatric voice without aberrant pathologies is found to have [50]:

- Increased pitch in men
- Decreased pitch in women
- Reduced vocal endurance (pauses for breaths, fatigability increased)
- Reduced vocal volume
- Decreased vocal projection
- Vocal tremor

The structure and function of the geriatric larynx deteriorate with age as the laryngeal framework weakens and ossification takes place of the cricoid, thyroid, and arytenoid cartilages, leading to a more rigid structure and limiting the adduction ability of the inferior pharyngeal constrictors [51]. The composition of the extracellular matrix (ECM) of the vocal folds, laryngeal muscles, cartilage, and nerves all continue to change with age and lead to functional changes such as dysphonia and hoarseness. Structurally, a normal vocal fold is made up of five layers: the epithelium, the superficial, intermediate and deep layer of the lamina propria and the vocalis muscle. The three layers of the lamina propria have different viscoelastic properties and thereby differ in the composition of the ECM [52]. The ratio of hyaluronic acid to collagen is decreased as collagen fibrils increase and elastin fibers thin in the superficial layer of the lamina propria. This compromises the viscoelasticity and vibratory properties of the folds [53, 54].

Vocal fold bowing and atrophy are common anatomical changes that take place with age as connective tissue is lost in the superficial and intermediate lamina propria, making the ventricle and vocal process more prominent, sulci to develop, and atrophy to ensue. This is commonly seen as a glottic gap on flexible laryngoscopy examinations [55, 56]. Vocal fold bowing and thinning of the vocal process is more common in men than women and increases the pitch and fundamental frequency. Women, especially with the lack of hormonal signaling after menopause, experience an edematous thickening to the vocal cords that change the viscoelasticity of the mucosa and stiffening the vocal cord, thereby deepening the voice and decreasing the fundamental frequency [57]. Muscle mass in both men and women decreases and is replaced by fibro-fatty tissue; incoordination of muscle movement and timing becomes more prevalent and mucus membranes lose their lubricating properties [58]. Presbyphonia is categorized into synonymous disorders encompassed by terminology that includes vocal cord atrophy, vocal cord bowing, vocal fold thinning, vocal fold edema, or posterior glottic gap.

Voice changes in the elderly patient are a common complaint that can be a significant handicap in an elderly patient's quality of life. It leads to impairment in communication and can have detrimental social effects, leading to depression and isolation. Consequently, early recognition and intervention are crucial to maintaining quality of life. The causes of geriatric vocal dysfunction represent a broad diagnosis that can be divided into these subsets [59, 60]:

- Anatomical changes (vocal fold atrophy, glottic gap, bowing)
- Neurologic conditions (e.g., Parkinson's disease, cerebral vascular accident, tremor, spasmodic dysphonia)
- Impaired conditioning (e.g., decreased lung elasticity and compliance, reduced physical fitness)
- Malignant lesions (laryngeal carcinoma)
- Benign lesions (e.g., epithelial lesions, Reinke's edema, cysts, granulomas)
- Inflammatory disorders (e.g., reflux laryngitis)
- Infectious disorders (e.g., laryngitis)
- Vocal fold paralysis
- Autoimmune (e.g., Amyloidosis, Sarcoidosis)

In-office examination can be performed with simple flexible laryngoscopy to rule out pathological conditions in geriatric patients presenting with voice disorders. Complaints related to prebysphonia include a weak or breathy voice that easily fatigues. Patients may complain of pain as their phonation becomes stressed due to the application of hyperfunctinoal compensatory mechanisms [52]. It is important to understand normal age-related changes in the geriatric population to provide earlier intervention and avoid inaccurate diagnosis and unnecessary costly workups. In relatively benign examinations on flexible laryngoscopy, the first step is to obtain comprehensive information on the vocal folds themselves through videolaryngostroboscopy. This allows high-power interpretation of glottic closure and the mucosal wave. Acoustic parameters are used to analyze and measure the jitter, shimmer, noise to harmonic ratio (NHR), and fundamental frequency [61]. Once the cause can be attributed to organic anatomical age-related changes, treatment with goal-oriented voice therapy can be initiated. Voice therapy and its success are correlated directly with the effort the patient puts into the treatment, which includes removal of aberrant hyper-functional compensatory mechanisms and learning adaptive strategies that allow patients to voice appropriately with the anatomical changes [52, 62]. These adaptive strategies are focused on improving vocal cord adduction to improve phonatory duration and strength and reduce fatigability. Vocal therapy requires multiple visits before patients experience improvement. It may be difficult to organize a reliable treatment plan in some patients.

Geriatric patients who do not respond to conservative therapy can be considered for surgical management. Injection laryngoplasty or thyroplasty should only be considered in a particular subset of patients with anatomical characteristics that would benefit from intervention. Patients with glottic insufficiency and gaps are excellent candidates for injection laryngoplasty. In geriatric patients this is a favorable intervention because it can be performed during an in-office visit under local anesthesia [63]. Injection laryngoplasty does not recover laryngeal function, but only provides additional vocal fold bulk to minimize the glottic thinning and subsequent glottic gap, and allow for more complete adduction. There are many different substances used for injection ranging from temporary to permanent materials that are injected into the paraglottic space deep to the lamina propria to cause medialization of the vocal fold [64]. Often used to treat recurrent laryngeal nerve paralysis by improving glottic incompetence, injection laryngoplasty has gained popularity for improvement in voice for elderly patients with anatomic changes amenable to this procedure.

Permanent materials have fallen out of favor for injection laryngoplasty because of increased risk of complications if not injected accurately. However, the aging larynx that benefits from this temporary medialization may be an excellent candidate for a more permanent result that can be achieved with thyroplasty augmentation. In this procedure the neck is open while the patient is responsive to expose the thyroid cartilage and carve a window out of its framework, exposing the paraglottic space. There implant materials can be advanced through the paraglottic space until an optimal voice is changed through medialization, while avoiding glottic compromise [54]. In a select subset of elderly patients, thyroplasty procedures should be considered, but not before determining clinical benefit from prior injection laryngoplasty and completing a thorough workup to ensure a preoperative risk benefit.

Swallowing in the Geriatric Patient

Dysphagia is defined as difficulty in moving food through the oral cavity, pharynx, and esophagus that can be structural or functional in nature [65]. The ability to eat and drink is a basic human need and pleasure that when impaired can have significant physical, psychosocial, and financial implications. Eating not only provides a means of nutrition but interpersonal gatherings and rituals are typically centered around feasts and meals [66, 67]. Dysphagia can have devastating health-related complications such as dehydration, malnutrition, and aspiration that have significant effects on morbidity and mortality. In addition, it can also weigh on the patient's mental health, leading to decreased social interaction and depression. It has been noted in the literature that more than 40% of patients over the age of 60 experience symptoms of dysphagia [68]. Swallowing mechanisms become affected as we age due to normal physiologic changes. Presbyphagia refers to the natural changes in the swallowing mechanism in otherwise healthy adults that occur as we age and is associated more with biological age rather than chronologic. Dysphagia is associated with many age-related comorbidities and becomes more common in patients with multiple medical problems.

Swallowing is a complex function that can be affected at any point in one of the three phases: oral, pharyngeal, and esophageal (Table 11.1).

Alterations in the oral phase that take place lead to difficulties preparing the bolus and lifting it toward the pharynx. Bolus preparation in large part is successfully completed by retained dentition, providing the necessary force of mastication. Age is associated with alveolar bone loss and a decline in dental hygiene, leading to problems with eating and swallowing. Studies have shown that older patients who were edentulous were more likely to have laryngeal penetration than those with complete dentition [69]. The tongue is another crucial component of the oral cavity that aids in the propulsion of the food bolus into the pharynx. With normal aging, it has been found that the generation of lingual pressure needed for propulsion decreases in congruence with a decline in overall tongue strength contributing to prebysphagia [70]. The muscles of mastication that move in a coordinated fashion are known to deteriorate with age similar to the

Table 11.1 Causes of dysphagia at different levels of the swallowing phase

	Age-related changes	Effect
Oral phase	Dental compromise Decreased masticatory muscle strength Decreased tongue strength and pressure Sensory changes Xerostomia	Poor bolus preparation Poor propulsion toward pharynx
Pharyngeal phase	Delayed swallowing reflex Reduced pharyngeal muscle strength Reduced suprahyoid muscle strength Dilated upper esophageal sphincter opening	Increased pharyngeal swallow time Reduced hyoid elevation Aspiration Pooling in the pharynx
Esophageal phase	Dysfunction in upper/ lower esophageal sphincter Decreased peristalsis Uncoordinated contractions Dilation/ constriction	Laryngo-esophageal reflux Esophagitis Gastroesophageal reflux Bolus retention in the esophagus

atrophy and strength decrease seen in other aging muscle groups [71]. Salivation is stimulated with the onset of mastication and produced by the submandibular, parotid, sublingual, and minor salivary glands. It serves many important functions in the physiological homeostasis of the oral cavity that includes the digestion of carbohydrates, maintaining dental mineralization, providing immune support, and maintaining a lubricated environment to facilitate in the acts of swallowing and speaking. Xerostomia is common in the elderly population, not because of a global age-related decline in salivary production, but can be caused by several possible etiologies such as medical comorbidities (diabetes, Sjogren syndrome, rheumatoid arthritis), medication side effects, and even prior radiation to the head and neck region [72, 73]. Lastly, sensory changes and diminished tactile sensation especially in the oral cavity lead to a delayed response in swallowing. Since swallowing is a coordinated process, the diminished response can hinder the natural swallow pattern. Sensory, salivary, and muscular changes in the elderly are not inherent to the oral cavity but occur throughout the pharynx and esophagus as well.

Pharyngeal abnormalities that occur as a result of aging are of more clinical relevance. This is due to a risk of aspiration when protective mechanisms to secure the glottis are lost due to a decline in the pharyngeal strength and coordination. Both aspiration and penetration are adverse results of a misdirected bolus and swallowing dysfunction that can lead to significant morbidity and mortality [74]. Nasogastric tubes are commonly placed in head and neck patients during times when swallowing is compromised, or the patient is required to be kept nil per os (translated: nothing through the mouth) (NPO) for a prolonged period of time such as with the healing phase after a free flap microvascular reconstruction. One study found that swallowing function and liquid penetration were more pronounced in patients over 70 years of age where nasogastric tubes were placed. This suggests that elderly patients are unable to compensate or overcome even slight modifications to the swallowing process under stressful situations [74]. Otolaryngology patients are commonly faced with these changes because their aerodigestive tract is at the forefront of surgical procedures, and otolaryngologists commonly introduce foreign bodies such as nasogastric tubes and tracheostomy tubes. Consideration and early intervention should be taken in elderly patients that will undergo any form of alteration even if minor to prevent complications. These problems can lead to prolonged hospital stays and increased costs as the functional ability to obtain nutrition is compromised.

Lastly the esophageal phase of the swallow mechanism becomes less coordinated and fluid as we age, leading to decreased peristalsis and risk of stasis of the bolus while making its way to the lower digestive tract. Furthermore, the upper and lower esophageal sphincter that aids in being a gateway for the bolus from the pharynx to the stomach can become less functional, leading to reflux of food and acid and incomplete passage. Although these esophageal sphincter functions decrease with age, it is the decrease in the extent of its ability to open that varies in older individuals and can manifest into symptoms of dysphagia and frailty [75].

Diverticulum

Zenker's diverticulum is a pulsion diverticulum that occurs at Killian's triangle between the cricopharyngeus muscle and inferior aspect of the inferior pharyngeal constrictor. Typically, a disorder that is inherent to middle-aged and elderly patients with a predisposition for men in their seventh and eighth decade, studies have suggested that its pathology is due to reduced compliance and muscular contractility of the cricopharyngeus (contributing to the upper esophageal sphincter) [76, 77]. Histological findings from muscle biopsies of the cricopharyngeus suggest progressive denervation may contribute. Symptoms of intermittent dysphagia, regurgitation, and hoarseness are common in patients with esophageal diverticulum; and diagnosis is based on clinical suspicion of radiographic swallowing studies. Treatment of a

Zenker's diverticulum has evolved over the years from a transcervical open repair with cricopharyngeal myotomy to endoscopic repair with laser or stapling and subsequent cricopharyngeal myotomy [78]. These less-invasive techniques have gained popularity as a safe and effective treatment for a largely geriatric-centered patient population who have notoriously more comorbidities that put them at a risk for surgery. Asymptomatic lesions that are less than 2 centimeters can be monitored, while larger diverticulum or those that are symptomatic should undergo surgical resection and cricopharyngeal myotomy [79]. Howell et al. performed a meta-analysis and systematic review of over 800 patients undergoing an open vs endoscopic approach to Zenker's diverticulectomy and found no difference in patient-reported improved symptoms of dysphagia [80]. Endoscopic approaches, however, have been found to have statistically significantly shorter operating times and hospital stays, and time to resume oral feedings [81, 82]. In patients unfit for surgery, this less-invasive approach may be the most suitable. However multiple factors including the size of the diverticulum, the exposure of the diverticulum, surgeon ability, and the patient's tolerance to undergo surgery and withstand its complications are all important considerations that must be evaluated.

The differential diagnosis of dysphagia in the elderly patient is broad with causes ranging from neurologic, autoimmune, infectious, traumatic, neoplastic, anatomic, medication-induced and iatrogenic. In the otolaryngology patient, more common causes of dysphagia are related to head and neck tumors, radiation therapy, esophageal diverticulum, strictures/webs, and cricopharyngeal bars [83]. Elderly patients should be thoroughly screened for swallowing disorders as these conditions are more common in their population. Complications from dysphagia can be devastating if not diagnosed and treated in a timely manner. It has been found that over 60% geriatric patients with oropharyngeal dysphagia are initially misdiagnosed and over 66% do not receive timely treatment once a diagnosis has been achieved [84]. A multidisciplinary team of nurses, therapists, and physicians all play critical roles in diagnosing and treating dysphagia in the elderly. First and foremost, a thorough history and physical exam can promptly identify the cause of dysphagia. Screening questionnaires such as the Gugging Swallowing Screen (GUSS), the repetitive saliva-swallowing test (RSST), and the 3-oz water swallowing test [85, 86] have shown promise in being early intervention tools to diagnose and treat dysphagia. Palli et al. trained nurses in a stoke unit to perform dysphagia screening using the GUSS and found dysphagia was significantly reduced in the intervention group and had lower rates of pneumonia and a reduced length of hospital stay [87]. More comprehensive studies to diagnose dysphagia include those that quantify swallowing dysfunction such as the barium swallow radiography, videofluoroscopic swallowing study (VFSS), fiberoptic endoscopic evaluation of swallowing (FEES), upper endoscopy, and esophageal manometry. Depending on the underlying pathology, treatment can vary from compensatory management to surgical intervention.

Otologic Problems in the Geriatric Population

Hearing Loss

One of the most common reasons elderly patients seek out an otolaryngologist is for hearing and otologic-based complaints. A large retrospective review concluded the most common chief complaints in patients who visited an otolaryngologist over the age of 65 and among 418 patients were ear and hearing disorders (24.2%). Age-related hearing loss also known as presbycusis is a common phenomenon that is estimated to impact 25–30% in the United States between the ages of 65 and 74, and nearly 80% of individuals over the age of 75 [88]. It carries a large economic burden with about $3 billion annually spent on its diagnosis and treatment in the United States [89]. Hearing impairment is a serious health threat in the geriatric population as it contributes to impaired balance, deterioration in mobility, an increased risk of falls and traumatic injuries, and cognitive impairment. The functional disability that ensues as a consequence of hearing loss can therefore lead to depression, anxiety, loss of independence, social isolation, and an overall impaired quality of life [90, 91]. Lin et al. conducted a cross-sectional analysis of the association of hearing loss with self-reported falls in patients in the United States participating in the National Health and Nutritional Examination Survey (NHANES) and found hearing loss to be independently associated with an increased risk of falls [90].

Presbycusis is the most common form of hearing loss in the geriatric population. It is classically diagnosed by its pattern of bilateral symmetric high frequency sensorineural hearing loss with difficulty in central auditory processing and speech discrimination. In its earliest stages, patients notice a slow decline in their ability to understand high-frequency speech which is most pronounced in noisy environments [92]. As it progresses, the ability to localize and detect sounds becomes increasingly more difficulty, creating situations where failure to hear warning signals is exceedingly dangerous. Advanced hearing loss affects the lower frequencies, making speech detection and understanding difficult [91, 93]. The cause of presbycusis is multifactorial with studies citing intrinsic causes to include genetic disorders, metabolic disease, and systemic disease such as hypertension and diabetes. Extrinsic factors include ototoxic medications, loud noise exposure, and diet [94]. Historically, presbycusis was categorized into four different categories based on audiometric tests and temporal bone pathology to include sensory, neural, strial (metabolic), and cochlear conductive. Two additional categories, mixed and indeterminate, were added over 20 years after [95, 96].

Sensory presbycusis affects the organ of Corti in the cochlea that contains the outer hair cells vulnerable to intrinsic and extrinsic factors. Damage begins at the basal turn of the cochlea which is responsible for high-frequency hearing in this subset of presbycusis. It has been found that sensory presbycusis demonstrates a pattern, much like noise induced, with outer hair cell loss and steeply sloping high frequency sensorineural hearing loss on audiograms. Age itself is not a direct cause of outer hair cell loss, but more so than environmental factors [93].

In *Neural presbycusis* there is a loss of 50% (or more than 35,500) spiral ganglion auditory nerve fibers seen on histopathology. Audiograms show a gradual downward sloping pure tone threshold toward high-frequency with diminished speech discrimination out of proportion to pure tone thresholds [95, 96].

Strial (metabolic) presbycusis is characterized by atrophy (30% or more) of the stria vascularis in all turns of the cochlea. The stria vascularis provides the inner ear blood supply and balances the chemical and bioelectric potential across the cochlea. Atrophy of strial tissue causes a decrease in endolymphatic sac potential through potassium recycling [97]. Audiograms in patients with strial presbycusis have diminished pure tone thresholds and hearing loss across all frequencies with the preservation of speech discrimination [96].

Cochlear conductive presbycusis is believed to be caused by an age-related degenerative thickening and stiffening of the basilar membrane but has not yet been verified. Audiograms show a low-frequency sensorineural hearing loss with unaffected speech recognition [95, 96].

Mixed presbyscusis is a combination of the above forms of presbyscusis. It is characterized by a loss of outer hair cells at the basal turn of the cochlea, stria vascularis atrophy, and a severe loss of cochlear neurons. Audiograms show a down-slope high-frequency hearing loss.

Indeterminate presbycusis represents about 25% of cases and shows none of the patterns seen as described earlier. There are no visualized abnormalities in cochlear tissue under microscopy or correlation between audiometric or pathologic patterns [94].

There is currently no diagnostic test to predict which individuals will have hearing loss as a result of presbycusis. Furthermore, there is not a single treatment to reverse its effects. Screening geriatric patients as a routine part of their physical exam is important in recognizing and providing early intervention for hearing loss. Studies have found an independent association between hearing loss and cognitive decline [98–100]. Lin et al. completed a prospective study of over 600 patients undergoing audiometric testing who were dementia free at its initiation and found over an 11-year period a strong correlation between hearing loss and incident all-cause dementia. Patients with mild-to–severe hearing loss have a 2- to five-fold increased risk of developing dementia which increased linearly with the severity of hearing loss [99]. Neuroimaging is found to be congruent with these findings where temporal lobe and overall brain atrophy is more prevalent in patients with hearing impairment [101, 102]. Current treatment modalities for presbycusis fall under hearing amplification devices and cochlear implantation which should be introduced early in their disease process to prevent morbidity and mortality that have considerable socioeconomic impacts on patients.

Hearing aids can provide patients with substantial benefits, yet it is estimated that less than 20% of patients with hearing loss use hearing aids [103]. Limited resources, the absence of education of their benefit and usage, and expense are factors that affect a patient's reasoning for doubting this therapy modality. Patients who have severe to profound hearing loss without any benefit from traditional hearing aid amplification are strong candidates for cochlear implantation. Studies have shown that early intervention in these patients can be shown to improve cognitive skills and positively influence their social interactions and quality of life [104, 105].

When considering a cochlear implantation in an elderly individual, not only should their operative fitness and perceived benefit be taken into account, but more specifically, the integrity and thickness of the scalp. Cochlear implant survival relies on a substantial and healthy scalp to protect the implant from extrusion or exposure. The older individual is more at risk for extrusion because of the predictable senescent thinning of the scalp with the loss of collagen, which should be taken into consideration when operating on these patients [75]. Close surveillance with appropriate wound care is critical to ensure the implant remains in a good position. In individuals with significant comorbidities or at risk of general anesthesia, it has been found that cochlear implantation under local anesthesia and sedation via a suprameatal approach is a well-tolerated and safe alternative [104, 106]. Hearing aids and cochlear implants are both excellent treatment modalities for qualified elderly patients with hearing loss and should be introduced early in their treatment to maintain and prolong their quality of life. Age should not be a primary determining factor in surgical hearing aid placement as the benefits in the majority of patients far exceed the risks.

Vertigo/Balance

The physiological process of aging is associated with a steady decline in vestibular function. With a decline in muscle mass, strength, and agility, the range of motion becomes more limited and reaction time is delayed. Due to the progressive loss of peripheral and central vestibular system nerve cells, dizziness, imbalance, gait disturbances, and vertigo are commonly seen complaints in the elderly [107, 108]. Agrawal et al. found vestibular dysfunction in the United States affects 18% of adults aged 40 to 49, 49% of persons over 60, and 80% in individuals over the age of 80 [109]. As with hearing loss, an impaired vestibular system can also lead to reduced quality of life as mobility and independence become compromised. With the significantly increased risk of falls in patients with vestibular dysfunction, morbidity, mortality, and health care costs are enormous in this population. Therefore, the importance of screening is imperative to promptly diagnose and treat these patients to prevent potentially disastrous consequences.

The vestibular system is comprised of three semicircular canals (superior, posterior, and horizontal) and two otolith organs (utricle and saccule) housed within the inner ear. These structures transduce information to the central nervous system in regard to rotational and linear head movement along with spatial orientation relative to gravity. The integration of this tightly controlled system through a central pathway from the inner ear structures produces the necessary information to the cortex and controls the vestibulo-ocular reflex and vestibulospinal reflex which maintains gaze and postural stability [109, 110] Peripheral vestibular disorders warranting otolaryngology visits in the elderly typically include benign paroxysmal positional vertigo (BPPV) and Meniere's with vestibular migraines. Vestibular neuritis is less specific to this age population.

The most common vestibular disorder in the elderly population is BPPV, which is caused by the accumulation of dislodged otoconia in the endolymphtic duct of the semicircular canals [111]. Otoconia are calcium carbonate–based biocrystals found linked to the dense gelatinous maculae layer of the utricle and saccule by filaments and serve the purpose of sensing linear acceleration and gravity. As we age otoconia undergo a decrease in number, volume, and change in shape, facilitating crystal dislocation to the ampulla and causing disruption balance and equilibrium [111, 112]. Theories for degeneration of otoconia have been proposed, but no treatment targeting their compromise currently exists. BPPV can be easily diagnosed in the clinic with a thorough history and physical exam. Patients typically complain of short attacks of rotary vertigo that occur when changing position or moving their head without associated hearing loss. Diagnosis can be confirmed in the office with maneuvers such as such as the Dix Hallpike for the posterior semicircular canal which is affected in most cases (>90%) [113]. Although BPPV typically resolves spontaneously, treatment can also be completed with certain maneuvers such as the Epley, Semont, or Gans [114–116]. Care must be taken in elderly patients to consider their range of motion and neck extension as it does require some manipulation. Vestibular rehabilitation therapy for refractory cases may also prove to be useful in its treatment.

Meniere's disease is generally a disorder of the middle-age population but found to reported in up to 15% of patients over the age of 65 [117]. Typical symptoms include vertigo, aural fullness, hearing loss, and tinnitus with a unilateral presentation. Vertigo episodes last longer and are more variable in Meniere's disease, lasting from minutes to a few hours at a time. The condition is thought to be caused by an excess of endolymph in the semicircular canals, and no one therapy exists as a cure for the disease [118]. Patients often respond to a combination of a low-salt diet and diuretics medications with more invasive therapies including intratympanic injections of gentamicin and corticosteroids to cause ototoxicity, thereby alleviating the vestibular symptoms [117].

Surgery is rarely a means of treating BPPV-specific vertigo and a path when all other therapies have been exhausted. Newer techniques include those that occlude the posterior semicircular canal with argon lasers, or performing vestibular neurectomy [119]. Meniere's patients, because of the severity in some cases of their symptoms, can also undergo vestibular neurectomy, endolymphatic sac shunting, or labyrinthectomy [120, 121]. In elderly patients, the risk of surgery for a primarily medically managed disorder may propose to outweigh the benefits. In addition, complications such as hearing loss and incomplete resolution of symptoms may not be superior to medical management. Compensatory mechanisms in the elderly are often slowed or lacking, so surgical management may cause more complications if patient selection is not precise. All these factors need to be taken into consideration in determining the best patient population, especially in older individuals prior to surgical management for vertigo.

Conclusion

The elderly population over 65 years of age is becoming one of the most rapidly growing segments of the population and, with the rise in life expectancy in part because of medical advances, will continue to increase. The American Society of Geriatric Otolaryngology was established in 2006 recognizing the increase in demand in geriatric focused medicine with the goal to provide knowledge to practitioners on disorders of the ears, nose and throat in this population. While some otolaryngologic diseases are specific to the geriatric patient, management of even common disorders should take into consideration the needs of this subset of patients. Over one third of patients that visit an otolaryngologist are found to be over the age of 65, and care should be taken to recognize the specifics in treating and managing their presentation otolaryngologic diseases.

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12 Thoracic Surgery in the Elderly

Donna C. Koo, Francis X. Carroll, and Tracey L. Weigel

General thoracic surgery, i.e., non-cardiac thoracic surgery, is a broad field including relatively minor procedures such as tube thoracostomy, diagnostic video-assisted thoracoscopic surgery (VATS), and mediastinoscopy, as well as major operations primarily for resection of malignant or benign thoracic tumors. Operations such as lobectomy, esophagectomy, and thymectomy traditionally required large, painful incisions in the chest or upper abdomen. At high-volume academic centers, these surgeries are now being carried out by minimally invasive technique with VATS or robotic assistance (RATS) with improved patient outcomes (Fig. 12.1) [1, 2]. These procedures are still associated with significant morbidity and mortality. As the general population ages, so too does our patient population. As surgery, anesthesia, and perioperative care become less invasive and more advanced, major surgeries are increasingly considered in the care of elder patients. This has appropriately become an area of increased interest in research, such that the special challenges related to the surgical treatment of elder patients can be better understood and addressed. It is now recognized that there is a difference between chronologic age and biologic age, perhaps best understood and assessed by various frailty measurements. Similarly, with newer research and insight, it is recognized that in states of advanced age, physiology is altered. This may lead directly to enhanced care by targeting specific pathways. This chapter will attempt to address the preoperative assessment of older candidates for thoracic surgery, with a view toward optimizing patient selection for major thoracic operations and introducing the concept of prehabilitation when possible in preparation for major thoracic operations.

Perioperative Risk Assessment for the Geriatric Patient

With advancements in medicine and an aging population, physicians and surgeons are increasingly caring for a greater number of older patients [3]. By one study, greater than 50% of surgeries are now performed in patients older than 65 years. Although chronologic age is often associated with increased perioperative risk, increased age is only one variable in perioperative complications in the geriatric population [4]. Other causes of increased operative risk in elderly

D. C. Koo
New York Medical College, Valhalla, NY, USA

F. X. Carroll · T. L. Weigel (✉)
Division of Thoracic Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA
e-mail: Tracey.Weigel@wmchealth.org

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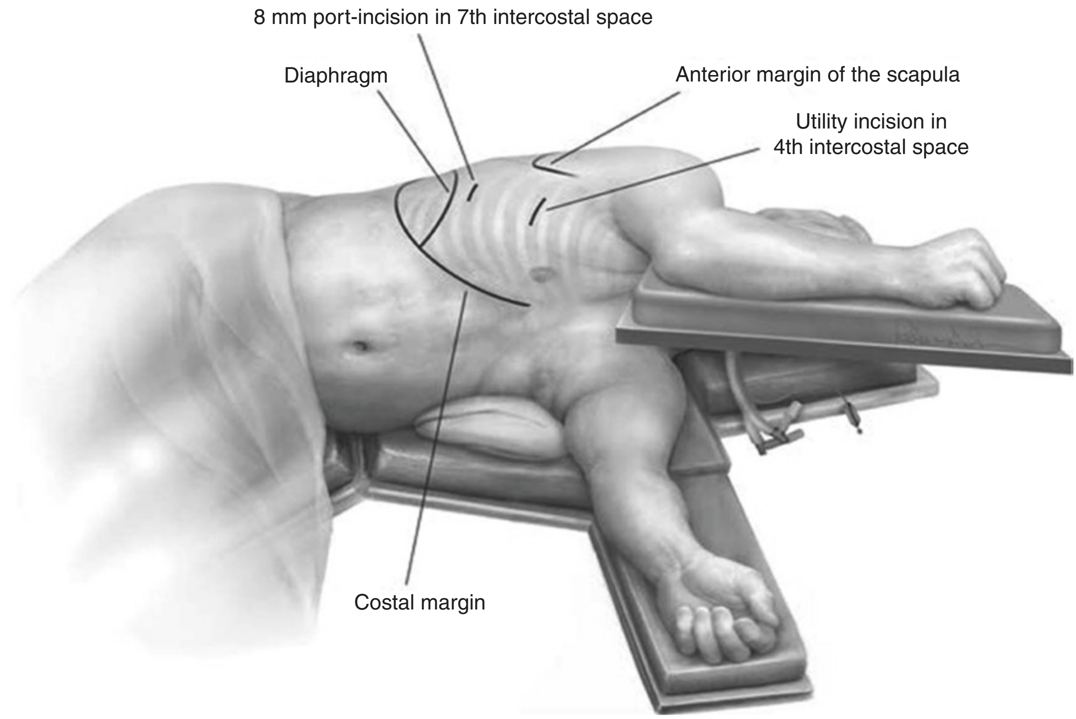

Fig. 12.1 Video-assisted thoracoscopic surgery (VATS). Minimally invasive techniques such as video-assisted thoracoscopic surgery (VATS) employed at high-volume academic centers minimize the need for large, painful incisions during procedures such as lobectomies that were traditionally performed as open procedures. VATS are typically associated with improved patient outcomes. (From Veronesi et al. [1], with permission)

patients include higher number of comorbidities, incidence of geriatric syndromes, higher levels of disability, and increased frailty.

Perioperative Risk Factors for the Geriatric Patient

Comorbidity

Comorbidity is defined as the concurrent presence of more than one medical condition in the same individual. While only 35.3% of adults ages 65–79 in the USA have medical comorbidities, they are present in 70.2% of adults older than 80 years [5]. Geriatric patients typically have higher number of comorbidities when compared to their younger counterparts [4]. Such comorbidities include higher rates of anemia, cardiac disease, COPD, heart failure, diabetes and its complications, peripheral vascular disease, and renal failure. Chronic comorbidities have been shown to increase perioperative complications in a variety of operations including orthopedic, urologic, and thoracic procedures [6–9].

Disability

Another area of operative risk for geriatric patients is associated disability, which is more prevalent in older populations. Disability is failure of independence in performing acts of daily living such as eating, bathing, dressing, transferring objects, toileting, and continence. Acts of daily living (ADL) include fundamental tasks in self-care, while instrumental acts of daily living (IADL) include additional tasks of household management [5]. As adults age, they become increasingly unable to live independently and rely on caregivers to manage daily tasks. A 2008 study by the SIOG surgical task force demonstrated that the likelihood of complications is increased by 50% when patients have dependency in IADL, abnormal performance status, or impaired scores by other various measures [10]. In fact, the presence of dependent ADL was the best predictor of extended length of stay in the hospital after surgery. Such studies have identified disability as a better predictor of postsurgical outcomes compared to presence of comorbidities. Unfortunately, up to 20–30% of adults living in communities have impairments in ADL or IADL [5].

Geriatric Syndromes

Other sources of increased operative risk in geriatric patients are geriatric syndromes [4]. These syndromes include preoperative cognitive impairment and preoperative malnutrition. Cognitive impairment is associated with postoperative delirium, while malnutrition can be associated with an increase in surgical complications and can be seen even in "healthy" geriatric patients. Malnutrition in geriatric patients confers a high risk of mortality with malnourished patients suffering from a mortality rate 55% greater than their adequately nourished peers [11]. Studies estimate that up to 60% of geriatric hospitalized patients are malnourished [11].

Frailty

Decreased physiologic reserve also contributes to increased perioperative risk. In particular, cardiorespiratory reserve can be affected by older patients who demonstrate difficulty walking on flat ground and up a flight of stairs. Across all age groups, lower anaerobic exercise threshold is predictive for adverse postoperative outcomes. The concept of "frailty" in recent literature is defined as a state of decreased physiological reserve and resiliency associated with age that causes patients to have decreased tolerance for handling stressors such as illness or surgery [12]. Increased frailty correlates with morbidity and mortality risk postoperatively in geriatric patients, and higher scores on various frailty scales are correlated with increased length of stay and increased functional decline.

Tools for Preoperative Assessment

Screening for factors contributing to increased perioperative risk in the geriatric patient can help identify areas of optimization prior to surgery. To date, several preoperative assessments exist for assessing such risk, including the Comprehensive Geriatric Assessment (CGA), Abbreviated CGA (aCGA), Preoperative Assessment in Elderly Cancer Patients (PACE), and various preoperative assessments using frailty, disability, and comorbidity [10, 13–16] (Table 12.1). Together, geriatric assessment markers for frailty, disability, and comorbidity have a high sensitivity and specificity when predicting 6-month mortality rates [15]. The use of preoperative assessments, such as CGA and aCGA in elderly patients, has been shown to improve surgical outcomes [4].

Table 12.1 Comprehensive Geriatric Assessment – domains of health

Physical medical conditions	Comorbid conditions and disease severity Medication list Nutritional status Past medical history
Mental health	Cognitive status Mood Fears and anxieties
Functional status	Gait, mobility, and balance Activities of daily living Instrumental acts of daily living Patient's priorities for independent living and functional status
Social health	Social network Support Socioeconomic status
Environment	Housing and facilities Ability to use technology Availability of transport Accessibility to local resources

Adapted from Welsh et al. [16], with permission

The Comprehensive Geriatric Assessment (CGA) describes domains of health that physicians should evaluate in geriatric patients [16]. This and other such scales can be used to assess surgical risk preoperatively

Comorbidity

The burden of comorbidity in geriatric patients can be assessed using various scales. One such scale is the Charlson Comorbidity Index (CCI) that contains 19 categories of comorbid conditions. These conditions are assigned weight values based on their independent 1-year mortality rates [15]. Other measures of comorbidity include American Society of Anesthesiologists (ASA) score and polypharmacy [15].

Disability

Disability and dependence can be measured using scales such as the Katz Index of Independence in Activities of Daily Living [15, 17]. In this scale, patients are given 1 point for ability to maintain independence in each of the six domains (eating, bathing, dressing, transferring objects, toileting, and continence). Higher scores are associated with higher levels of independence and improved postsurgical outcomes (Table 12.2).

Geriatric Syndromes

Preoperative cognitive impairment and malnutrition can be assessed by a variety of scales. Cognitive impairment can be measured using traditional tests such as the Montreal Cognitive Assessment (MoCA) or the Mini-Mental State Examination (MMSE). Clinical malnutrition can be assessed using scales such as the MNA-SF (Mini-Nutritional Assessment-Short Form) or using serum albumin levels [18].

Frailty

To date, frailty can be measured using two main scales. The Frailty Index (FI) is a comprehensive geriatric assessment that scores patients based on many factors including cognitive status, emotional well-being, motivation, communication, strength, mobility, balance, elimination, nutrition, ADL, IADL, quality of sleep, social support, and presence of comorbidities [19, 20] (Table 12.3). Patients with a FI score <0.10 are considered non-frail, while patients whose FI scores are between 0.1 and 0.2 are considered vulnerable. Patients with FI scores between 0.21 and 0.45 are considered frail, and FI scores >0.45 are considered the frailest. Although most of these variables are self-reported, this scale can be time-consuming due to potential cognitive deficits present in the elderly [12]. Despite the time investment, however, the Frailty Index identifies specific areas that can be optimized preoperatively due to its comprehensive nature. Several scales have attempted to improve on the Frailty Index, such as Edmonton Frail Scale, Modified Frailty Index (mFI), and Clinical Frail Scale.

Another main assessment used to determine frailty, the Frailty Phenotype, focuses more on the clinical manifestations of frailty. In this scale, points are assigned to various domains including unintentional weight loss >10 pounds in 1 year, self-reported exhaustion, weakness as determined by grip strength, slow walking speed

Table 12.2 Katz Index of Independence in Activities of Daily Living

Activities	Independence	Dependence
	(1 Point) Performed *without* supervision, direction, or assistance	(0 Points) Performed *with* supervision, direction, or assistance
Eating	Gets food from plate into mouth without help. Food may be prepared by another person	Needs partial or total help with feeding or requires parenteral feeding
Bathing	Bathes self completely or needs help bathing only a single part of the body (back, genital area, disabled extremity)	Needs help with bathing more than one part of the body and getting in or out of bathing area or requires total bathing
Dressing	Gets clothes from storage area and puts on clothes and outer garments with fasteners. May have help tying shoes	Needs help dressing self or needs to be completely dressed
Transferring	Moves in and out of bed or chair unassisted. May use mechanical transfer aids	Needs help moving from bed to chair or requires a complete transfer
Toileting	Goes to toilet, gets on and off, arranges clothes, and cleans genital area without help	Needs help transferring to the toilet and cleaning self or uses a bedpan or commode
Continence	Maintains complete control over urination and defecation	Is partially or totally incontinent of bladder or bowel

From Katz et al. [17], with permission

The Katz Index of Independence in Activities of Daily Living is a scale in which patients are given 1 point for ability to maintain independence in each of the six domains (eating, bathing, dressing, transferring objects, toileting, and continence). Higher scores are associated with higher levels of independence and improved postsurgical outcomes [17]

Table 12.3 Frailty Index

Variables			Deficit points		
Needs help bathing		Yes = 1	No = 0		
Needs help dressing		Yes = 1	No = 0		
Needs help transferring from chair		Yes = 1	No = 0		
Needs help walking around house		Yes = 1	No = 0		
Needs help eating		Yes = 1	No = 0		
Needs help grooming		Yes = 1	No = 0		
Needs help toileting		Yes = 1	No = 0		
Needs help using stairs		Yes = 1	No = 0		
Needs help lifting 10 lbs		Yes = 1	No = 0		
Needs help shopping		Yes = 1	No = 0		
Needs help with housework		Yes = 1	No = 0		
Needs help with meal preparation		Yes = 1	No = 0		
Needs help managing medications		Yes = 1	No = 0		
Needs help with finances		Yes = 1	No = 0		
Lost >10 lbs in the last year		Yes = 1	No = 0		
Self-rating of health	Poor = 1	Fair = 0.75	Good = 0.5	Very good = 0.25	Excellent = 0
How health has changed in last year	Worse = 1	Same = 0	Better = 0		
Stayed in bed > half the day in last month due to health reasons		Yes = 1	No = 0		
Cut down on usual activity in last month		Yes = 1	No = 0		
Walks outside		<3 days = 1	≤3 days = 0		
Feels everything requires a lot of effort		Most of the time = 1	Sometimes = 0.5	Rarely = 0	
Feels depressed		Most of the time = 1	Sometimes = 0.5	Rarely = 0	
Feels happy		Rarely = 1	Sometimes = 0.5	Most of the time = 0	
Feels lonely		Most of the time = 1	Sometimes = 0.5	Rarely = 0	
Has trouble getting going		Most of the time = 1	Sometimes = 0.5	Rarely = 0	
Has high blood pressure		Yes = 1	Suspect = 0.5	No = 0	
History of heart attack		Yes = 1	Suspect = 0.5	No = 0	
Has CHF		Yes = 1	Suspect = 0.5	No = 0	
History of stroke		Yes = 1	Suspect = 0.5	No = 0	
Has cancer		Yes = 1	Suspect = 0.5	No = 0	
Has diabetes		Yes = 1	Suspect = 0.5	No = 0	
Has arthritis		Yes = 1	Suspect = 0.5	No = 0	
Has chronic lung disease		Yes = 1	Suspect = 0.5	No = 0	
MMSE score	<10 = 1	11–17 = 0.75	18–20 = 0.5	20–24 = 0.25	>24 = 0
Peak flow		*Men:* ≤340 = 1	*Women:* ≤310 = 1		
Shoulder strength		*Men:* ≤12 = 1	*Women:* ≤9 = 1		
BMI		*Men:* <18.5 = 1 >30 = 1	*Women:* >25 and <30 = 0.5		

(continued)

Table 12.3 (continued)

Variables			Deficit points		
Grip strength	*Men:* BMI ≤24: BMI 24.1–28: BMI >28:	GS ≤29 = 1 GS ≤30 = 1 GS ≤32 = 1	*Women:* BMI ≤23: BMI 23.1–26: BMI 16.1–29: BMI >29	GS ≤17 = 1 GS ≤17.3 = 1 GS ≤18 = 1 GS ≤21 = 1	
Usual walking pace		>16 s = 1	<16 s = 0		
Rapid walking pace		>10 s = 1	<10 s = 0		

From Searle et al. [20], with permission.
The Frailty Index (FI) is a geriatric assessment that scores patients based on many the presence of deficits in many domains including cognitive status, emotional well-being, motivation, communication, strength, mobility, balance, elimination, nutrition, ADL, IADL, quality of sleep, social support, and presence of comorbidities [19, 20]. The total number of points is tallied and divided by 40 (the number of variables in the index). Patients with a FI score <0.10 are considered non-frail, while patients whose FI scores are between 0.1 and 0.2 are considered vulnerable. Patients with FI scores between 0.21 and 0.45 are considered frail, and FI scores >0.45 are considered most frail

(measured in seconds needed to walk 15 feet), and low physical activity (as measured by the Minnesota Leisure Time Activity Questionnaire). Patients with deficits in more than three domains are considered frail, while patients with deficits in 1–2 domains are considered pre-frail.

Perioperative Risk in Thoracic Surgery

Common postoperative complications for thoracic surgery include atrial fibrillation, allogenic blood transfusion, pneumonia, reintubation, delirium, acute renal failure, ARDS, sepsis, cerebral vascular accident, pulmonary embolism myocardial infarction, bronchopleural fistula, and empyema [21]. It is estimated that the risk of postoperative complications in thoracic non-cardiac procedures can be as high as 27%. Patients who require reintubation or develop pneumonia and delirium postoperatively have a higher risk of death 3–18 months after surgery, while patients who develop sepsis have higher risk of death after 18 months. Patients who require allogenic blood transfusions have higher risk of death in both time frames.

Fitness for surgery can be determined via functional capacity tests to stratify surgical risk in thoracic surgery candidates. The Shuttle Walk Test (SWT) can be used as an initial screening tool that does not require cardiopulmonary testing [22]. Patients walk at an incrementally increasing pace between two cones placed 10 m apart. A pre-recorded "beep" signals the allotted time that patients have to walk 10 m at each speed. Patients who are able to walk more than 400 m were found to have lower rates of complications after thoracic surgery. Other simple tests, such as stair climbing, can also be used. In general, patients with maximal oxygen consumption less than 15 mL/kg or with an anaerobic exercise threshold less than 10–11 mL/kg/min were defined to have poor functional status and at higher risk for postsurgical complications [21].

Additionally, preoperative pulmonary function tests can be used to determine appropriateness of thoracic surgery. In particular, predicted postoperative FEV1% (ppoFEV1%) can be used to predict pulmonary complications.

$$\text{ppoFEV1\%} = \text{preoperative FEV1\%} \bullet 1 - \frac{\text{\%functional lung tissue removed}}{100}$$

In general, a ppoFEV1% >40% is considered low-risk for respiratory complications, while a ppoFEV1% < 30% is considered high-risk [23]. A nuclear quantitative perfusion scan should be performed to determine the fraction of function that comes from each lobe to attempt to quantify post-op predicted FEV1 and FVC, i.e., after the affected lobe is removed.

Thoracic Surgery in Relation to the Geriatric Patient

The issue of perioperative risk in geriatrics is an especially relevant problem for thoracic surgery. Thoracic surgery patients are typically older and have comorbidities pertaining to pulmonary disease [24]. This causes them to have decreased performance on screening tests traditionally used for surgical risk stratification (shuttle walk and stair climbing). However, despite increased surgical risk, elderly patients with early-stage lung cancer still benefit from surgical treatment due to poor survival rates in unresected lung cancer [25].

Tools for Preoperative Assessment of Geriatric Patients in Thoracic Surgery

Several screening tools exist for determining perioperative risk for geriatric patients undergoing thoracic surgery. One such tool is the Thoracic Onco Geriatric Assessment (TOGA) which screens patients for functional status, nutrition, and mood via a combination of other scales [26, 27]. Functional status is assessed through independence with ADLs and IADLs [17, 28], while nutrition is assessed using the NSI Nutrition Health Checklist [29]; mood is assessed using the Geriatric Depression Scale [30]. The TOGA is quick to administer and allows physicians to identify areas of risk prior to surgery, as well as determine the effect of surgery on a patient's independence (Table 12.4).

Another tool used to predict postoperative complications for patients older than 75 years undergoing video-assisted thoracoscopic surgery (VATS) is the Simplified Comorbidity Scale (SCS) [31]. The SCS scores patients based on whether or not they have various comorbidities, including smoking status, diabetes, renal insufficiency, respiratory distress, cardiovascular disease, cancer, and alcoholism. Higher SCS scores are associated with more frequent postoperative complications.

Table 12.4 Thoracic Onco Geriatric Assessment (TOGA)

Screening test	Assesses	# of items	Estimated administration time
Activities of Daily Living (ADLs) [26]	Functional status	6	2–5 minutes
Instrumental Activities of Daily Living (IADLs) [27]	Functional status	8	2–5 minutes
NSI Nutrition Health Checklist [28]	Nutrition	10	3–6 minutes
Geriatric Depression Scale [29]	Mood	15	3–6 minutes

The Thoracic Onco Geriatric Assessment (TOGA) is a preoperative screening tool for thoracic general surgery that uses various pre-existing screening tools to assess functional status, nutrition, and mood. It is quick to administer and allows surgeons to identify areas of risk prior to surgery, as well as determine the effect of surgery on a patient's independence [26, 27]

Improving Surgical Outcomes for the Geriatric Patient

Ultimately, the goal of assessing perioperative risk in the geriatric patient is to determine how we can best mitigate such risks and prevent adverse outcomes. Several perioperative domains of intervention have been used with some success to improve prognosis for geriatric patients: shared decision-making, prehabilitation, and interdisciplinary geriatric co-management [12].

Shared Decision-Making

Shared decision-making refers to the practice of having in-depth conversations with patients and their families about goals of care [32]. These conversations allow physicians to determine decision-making capacity and allow patients to have realistic expectations regarding the outcomes of surgery and help them to make informed decisions prior to surgery [33]. Topics of discussion include personal goals, treatment preferences, as well as the importance of specific outcomes, such as the possibility of loss of independence. Additionally, it is important to ensure that patients undergoing surgery should have advance directives and a designated health care proxy in place prior to surgery. If applicable, palliative care should be consulted prior to surgery for high-risk geriatric patients with a particularly poor prognosis.

Prehabilitation

Prehabilitation and preoperative exercise therapy have been shown to improve postoperative outcomes and decrease postoperative complications and length of stay in geriatric patients undergoing surgery, especially thoracic surgery [34]. Prehabilitation, or the optimization of geriatric syndromes, is especially helpful for patients with high frailty scores. Interventions include exercise, nutritional support, and psychological interventions lasting greater than 4 weeks pre-op [12]. Poor exercise capacity and muscle weakness are predictors of poor surgical outcomes and high complication rates [35]; thus, prehabilitation to improve exercise tolerance and muscle strength can optimize patients for surgery and improve surgical outcomes. This is especially true in general thoracic surgery, where preoperative exercise capacity can be used to predict the length of stay after thoracic cancer surgeries [36].

Prehabilitation regimens can take place in prehabilitation centers or in patients' homes [37]. Patients receiving prehabilitation care at formalized centers are required to attend various supervised exercise sessions weekly for a minimum of 4 weeks. Exercises can include aerobic exercises at target heart rates, high-intensity interval training, and stretching [38]. Home-based exercise training programs can similarly include aerobic activities such as walking and cycling and/or muscle training exercises [35]. Home-based prehabilitation programs have been shown to be equally as effective as center-based prehabilitation programs [37]. Improved surgical outcomes after home-based prehabilitation have been noted for patients undergoing lung resection, as well as coronary artery bypass graft (CABG) and valve surgeries [35, 39]. Additionally, home-based regimens are more easily accessible to patients who are unable to travel or stay in care centers due to physical condition or other financial factors, thus increasing prehabilitation compliance.

Recent research has shown promising results in the use of biomarkers to predict the efficacy of certain components of prehabilitation. One molecule, surfactant protein-D (SP-D), has been proven to be a sensitive predictor [40]. SP-D, a lung-derived biomarker for inflammatory lung disease, was shown to decrease significantly after a week of preoperative pulmonary rehab for patients with lung cancer undergoing thoracic surgery. Lower serum levels of SP-D were also correlated with lower rates of postoperative pulmonary complications.

Other strategies used in prehabilitation programs include branched-chain amino acid and herbal medicine supplementation in addition to exercise, which have also shown improvement in postoperative complication rates after lobectomy [41, 42].

Interdisciplinary Geriatric Co-management

Perioperative outcomes improve when interdisciplinary teams work together toward preventing postoperative morbidity and mortality [43]. The Acute Care for Elders Program (ACE) is an inpatient interdisciplinary system that creates a team of a nurse coordinator, geriatrician, nurses, physical and occupational therapists, dietician, pharmacist, and social workers who communicate with the surgical and anesthesia teams to improve surgical outcomes. Currently, the Society of Perioperative Assessment and Quality Improvement (SPAQI) recommends creating interdisciplinary teams for frail patients undergoing high-risk (aortic and vascular) or intermediate (intraperitoneal/intrathoracic, head/neck, orthopedic, prostate, carotid) procedures [12].

General Perioperative Management Techniques for Reducing Surgical Risk

Perioperative management techniques for improving postoperative complications for general surgical patients hold true for geriatric thoracic surgical patients as well. Guidelines such as the Enhanced Recovery After Surgery (ERAS) and Enhanced Recovery After Thoracic Surgery (ERATS) recommend VTE prophylaxis and antibiotic prophylaxis in thoracic surgery patients to prevent the risk of pulmonary embolism and reduce the risk of postoperative infection [24]. Other techniques include early removal of chest tubes and Foley catheters, and discharging patients early, so they can sleep without the constant interruptions of the hospital. In particular, early removal of chest tubes after VATS has been shown to lower length of hospital stays, costs, and patient morbidities [44].

Postoperative Pain Control

Other recommendations by the ERATS include using multimodal non-opioid analgesics for postoperative pain control to circumvent the respiratory depressant effects of opioids [24]. The decision to use opioid and other systemic analgesics should be made cautiously in geriatric patients in particular [45]. Stress and pain reduction techniques such as guided imagery can also be useful techniques to reduce perioperative pain and anxiety. Guided imagery techniques direct patients to visualize and focus on calming scenes, such as walking along a beach, to invoke feelings of relaxation. Guided imagery has been associated with lower levels of distress in lung cancer patients and can also benefit caregivers [46]. Although guided imagery is typically associated with high levels of patient acceptance and satisfaction, they have not been shown to consistently improve pain and reduce postoperative analgesic requirements in the elderly [47]. Other studies argue that guided imagery techniques remain a cost-effective method of reducing perioperative anxiety [48] and can be a powerful non-pharmacologic tool that can be employed by patients to control pain [49].

Other non-narcotic pharmacologic regimens for postoperative pain control include usage of intraoperative intercostal nerve (ICN) blocks with liposomal bupivacaine (Exparel®) after thoracotomy [50]. Such techniques allow patients to have more long-term continuous pain relief (up to 48–72 hours) and decrease the need for additional needlesticks and IV drips. ICNs have also been associated with lower opioid usage in the first 24 hours after VATS [51]. They have also been associated with a significant decrease in pulmonary complications compared to patients receiving epidural analgesia [50]. This benefit may be due to the increased mobilization of patients postoperatively with sufficient analgesia, which has been shown to reduce postoperative complications [2].

Fluid Management

Fluid management provides another potential area for reducing postoperative risk. Although thoracic surgery patients are traditionally volume-restricted, recent ERAS/ERATS guidelines have advocated for preventing preoperative dehydration and hypoglycemia by allowing patients to drink clear liquids up to 2 hours prior to surgery [24]. Ultimately, the goal of fluid therapy is to maintain euvolemia intraoperatively and to resume enteral hydration as soon as possible during the postoperative period.

Incentive Spirometry

Finally, early use of incentive spirometry is thought to prevent atelectasis and improve lung re-expansion following major thoracic surgery [52] and can be used to assess lung function after surgery and reduce postoperative complications [53]. Despite the widespread use of incentive spirometry postoperatively, however, the literature does not indicate a significant reduction of length of stay or significantly improved pulmonary function for patients who use incentive spirometry compared to other postoperative breathing exercises and airway clearance techniques [54, 55]. However, preoperative instruction and practice with an incentive spirometer can optimize preoperative volumes and serve as a personal benchmark and realistic objectively quantifiable goal in the postoperative period.

Conclusion

All medical and surgical specialties are striving to serve our growing elder population better by studying and understanding of the alterations in physiology which occur in advanced age. In reference to thoracic surgery in general, rehabilitation with pulmonary rehab programs, medical optimization, and nutritional supplementation are long-standing and not new. Emphasis is now added to the elder population as their needs and disabilities are recognized as greater, with added perioperative risk due to their potential geriatric syndromes.

More accurate risk assessment in the elder or frail may also at times redirect therapies. Currently, medically inoperable patients with early-stage lung cancer may be offered stereotactic radiation therapy with good results in nonsurgical candidates. Sub-lobar resections, such as segmentectomy or wedge resection, may be offered to high-risk, elderly thoracic patients with subcentimeter lesions, instead of standard lobectomy. For patients with stage IIIa disease, who may be reasonably offered either induction chemotherapy followed by surgery or definitive chemotherapy/radiation therapy without surgery (as suggested by NCCN guidelines), more detailed preoperative assessment and shared decision-making may better inform our recommendations and patient choices. In instances when risk factors such as frailty, debilitation, and malnutrition can be favorably modified, patients may not need to be excluded from curative surgical options.

Researchers are continuing to investigate new measures of assessing and stratifying general thoracic surgical risk in older patients. Sarcopenia, which reflects wasting, malnutrition, debilitation, and frailty, is one potential direction. A recent study proposes a Psoas Index, calculated by measuring psoas muscle diameter on CT and dividing by BMI, as a risk assessment tool for patients considered for transcatheter aortic valve replacement (TAVR) versus surgical aortic valve replacement (SAVR) [56]. Another study suggests a link between sarcopenia and transforming growth factor beta, (TGF-B), satellite cell function, and impaired muscle repair [57]. It is further suggested that this pathway may be favorably affected by administration of angiotensin receptor antagonist. Ongoing research in the area of risk assessment and particularly risk modification by pharmacology, rehabilitation, nutritional support, or other means is vital, in particular as it pertains to the growing elder population.

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Cardiac Surgery in the Elderly

13

Joshua B. Goldberg

The United States Census Bureau estimates by 2030, 20% of the United States will be older than 65, accounting for over 78 million people [1]. Cardiovascular disease is a leading cause of morbidity and mortality among all adult patients. Independent of age, gender, or ethnicity, heart disease accounts for greater than 20% of deaths in the United States [2]. With advancing age, heart disease becomes far and away the leading cause of death, accounting for over 25% of all deaths. Furthermore, the proportion of deaths attributed to heart disease increases with age. According to the CDC, among people aged 45–64, heart disease accounts for 20.8% of deaths, 25.1% of deaths among patients greater than 65, and 28.6 of deaths among patients greater than 85 (Fig. 13.1). Furthermore, the incidence and prevalence of cardiovascular disease is only expected to increase as the population continues to age.

Cardiac surgery is a surgical subspecialty that focuses on the surgical management of diseases of the heart and great vessels. Given the aging population and the incidence, prevalence, and associated mortality of cardiovascualr disease among the patients of advancing age, cardiac surgery is a field largely focused on the care of the elderly population. For instance, the average age of patients undergoing coronary artery bypass grafting or aortic valve replacement, two of the most commonly performed cardiac surgical procedures, is 74 years [2, 3]. Furthermore, recent advances in the management of valvular heart disease has resulted in surgeries being routinely performed on octogenarians and nonagenarians. This chapter will focus on the surgical management of coronary artery disease, valvular disease, and aortic pathology in the elderly population. Each section will consist of a general overview of the disease process, its specific focus on older patients, procedural outcomes, and quality of life in the elderly.

Coronary Artery Disease in the Elderly

Coronary artery disease (CAD) is defined as flow limiting obstruction to one or more coronary artery(ies). CAD is the most common form of heart disease in the general population. It is present in 12% of the general population and 20% of people over 65 [4, 5].

CAD is not only common, but it is a source of considerable morbidity and mortality. CAD represents the leading cause of death among men and women of advancing age. Obstructive coronary artery disease (CAD) is defined as a greater

J. B. Goldberg (✉)
Department of Surgery, Division of Cradiothoracic Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA
e-mail: Joshua.Goldberg@wmchealth.org

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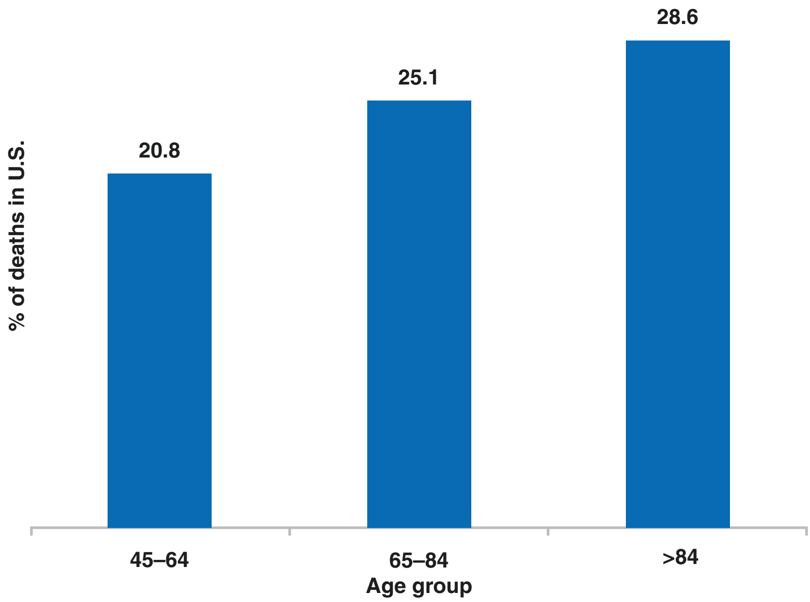

Fig. 13.1 Percentage of deaths in the United States due to heart disease increases with age. (From Centers for Disease Control and Prevention (CDC) [4])

than 50% obstruction of one or more coronary arteries. Obstructions are due to the accumulation of atherosclerotic plaques composed primarily of cholesterol and calcium that accumulate over many years. An atherosclerotic plaque can grow in size, resulting in limitations of downstream myocardial perfusion causing angina or myocardial infarction. Alternatively, atherosclerotic plaques can rupture showering atherosclerotic debris downstream while triggering platelet and coagulation factor activation which may also result in angina and myocardial infarction.

There are numerous genetic, comorbidity, and lifestyle components that contribute to the development of CAD, including diabetes, tobacco use, hypercholesterolemia, obesity, and diet. However, age has been thought to be the number-one associated condition linked with CAD as the deleterious effects of various chronic conditions and atherosclerosis accumulate over time. The incidence and prevalence of CAD increases with advancing age. Approximately 6% of patients between 45 and 65 are diagnosed with CAD, 14% between 65 and 75, and 24% greater than 75 (Fig. 13.2) [5]. The natural history of CAD culminates in decreased myocardial perfusion, resulting in angina or myocardial infarction. As expected, the incidence of MI and deaths from CAD increase with age (Figs. 13.1 and 13.3). There is an annual incidence of MI in patients <60 of approximately 3% which increases to 17% in patients over 80 [5].

There are 3 main treatment modalities for coronary artery disease: medical management, percutaneous therapies, and coronary artery bypass grafting. Medical management primarily consists of cholesterol-lowering therapies with lifestyle modification and medications such as statins, antihypertensives, and other preventive therapies. Percutaneous therapies and coronary artery bypass grafting are utilized when coronary artery disease progresses to a symptomatic level, resulting in angina or myocardial infarction. Percutaneous interventions (PCI) include: angioplasty or stent placement via a femoral or radial artery percutaneous puncture. In the setting of acute ST elevation MI, PCI is a preferred intervention as long as the patient's anatomy is sufficient. In addition, PCI is a preferred modality in patients with single or double vessel coronary artery disease with suitable anatomy for stent placement.

In the setting of multivessel coronary artery disease, left main coronary artery disease or left main equivalent coronary artery disease, diabetes, patients with heart failure

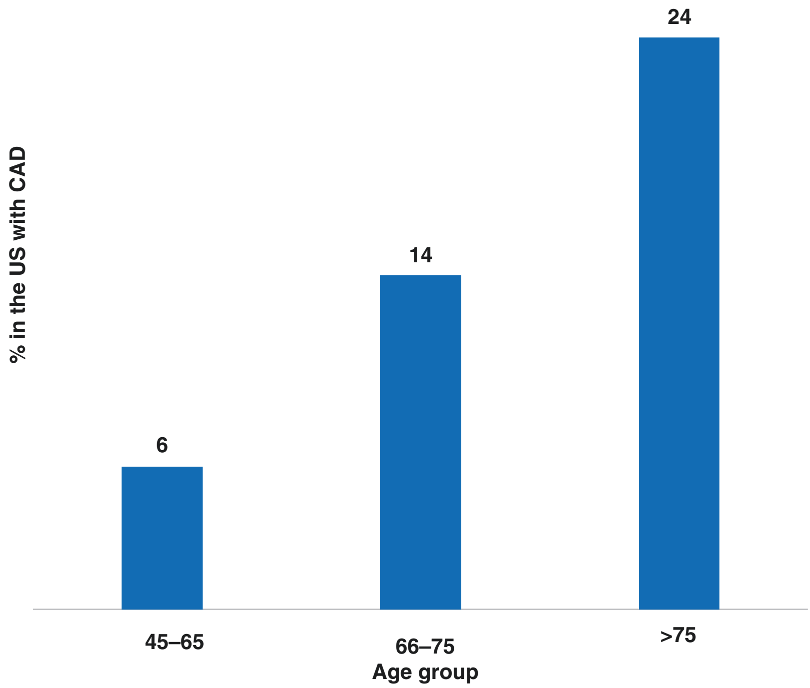

Fig. 13.2 Prevalence of CAD in the United States increases with age. (From Centers for Disease Control and Prevention (CDC) [4])

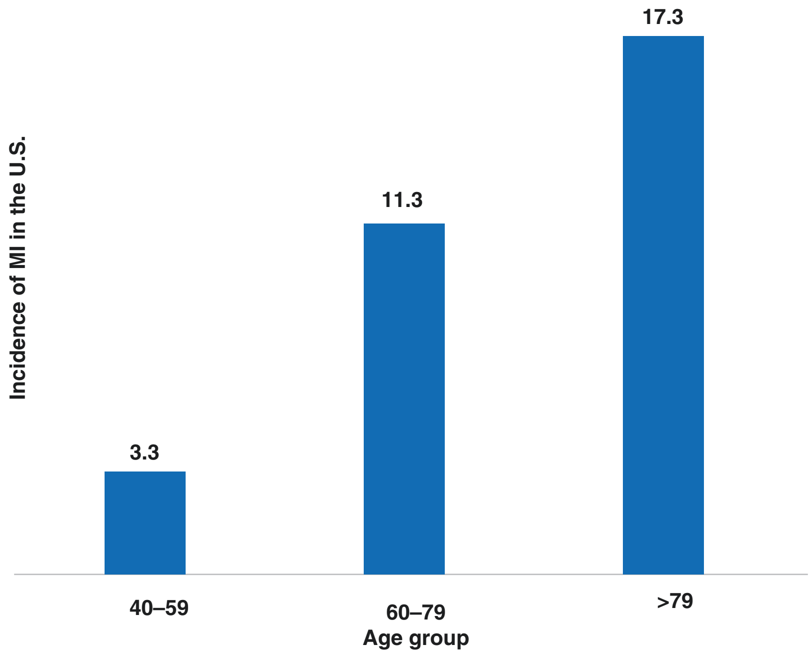

Fig. 13.3 Increasing prevalence of MI in United States with advancing age. (From Centers for Disease Control and Prevention (CDC) [4])

or reduced ejection fraction, coronary artery bypass grafting (CABG) is the recommended treatment modality as it has been shown to improve survival and freedom from future coronary events [2, 6].

Traditionally, CABG consists of a median sternotomy and bypassing significant coronary lesions utilizing a variety of arterial and venous conduits while on cardiopulmonary bypass. The left internal mammary artery (LIMA) is typically harvested from the chest wall, leaving its origin from the left subclavian artery intact. Due to its unique histologic and biochemical properties, the LIMA is typically anastomosed to the left anterior descending artery, the artery which perfuses the major portion of the left ventricle as well as the interventricular septum. A combination of saphenous vein grafts and/or other arterial grafts (right internal mammary artery or radial artery) are used to bypass the remaining diseased coronary arteries.

While a detailed discussion of bypass conduit choice is outside the scope of this chapter, it is important to understand that age and comorbid conditions influence the choice of bypass conduits. With rare exception, the disease of the LAD will be bypassed utilizing the LIMA. In general, the use of bilateral IMAs is reserved for younger patients (<65 years old) and those with few chronic conditions (no diabetes, smoking, immunosuppression, obesity) as bilateral IMA use is associated with sternal healing and infectious complications in older patients as well as those with significant comorbidities. It is important to mention that in the current era most saphenous veins are harvested in a minimally invasive, endoscopic technique that minimizes early mobility limitations compared with traditional, open saphenous vein harvest techniques which entailed an incision along the length of the saphenous vein. Lastly, radial artery harvest is typically performed with an open technique (incision from elbow to wrist) in most centers and can result in early mobility limitations, especially among patients who may be walker dependent. Thus, in older or polymorbid patients, bypass with LIMA and saphenous veins is preferred.

The safety and efficacy of CABG among all patients, independent of age, has been well established. Decades of large, multicenter series, national and international databases, and randomized controlled trials have concluded that, in the general population, CABG is a low morbidity and mortality procedure with an expected mortality of <1% [2, 6]. In comparison to PCI, multiple large randomized trials have concluded that CABG is superior to PCI in terms of survival as well as freedom from future coronary events. Long-term follow-up has demonstrated that CABG is cost effective with superior quality of life compared with PCI. The superiority of CABG has held true even with advances in stent technology as well as medical management.

The safety and efficacy of CABG observed in the general population also holds true with advancing age. In the not so distant past, a patient's age greater than 70 and definitely 80 was considered a relative contraindication for CABG and open heart surgery in general. However, numerous publications have demonstrated the safety of CABG performed in octogenarians as well as nonagenarians. While older patients undergoing CABG tend to have more acute presentations and more comorbidities than younger cohorts, short- and long-term survival are excellent. Overall CABG-associated mortality among octogenarians is around 2–4% with an approximate 5-year survival of 76%. Patients between 80 and 85 undergoing isolated CABG have a median survival of 7.4 years while patients ≥85 have a median survival of 5.4 years [7]. Thus, contemporary data concludes that CABG is a safe option for well-selected older patients.

When treating patients at extremes of age optimizing quality of life is often the prevailing goal of the patient and physician over increasing long-term survival. Exertional chest pain, dyspnea, and/or heart failure associated with CAD can be debilitating. Thus, in some patients of extreme age the goal of surgery may be symptomatic relief rather than long-term survival. Contemporary data has demonstrated that CABG among the elderly and debilitated results in improved quality of life and decrease in future cardiac events compared to medical management or PCI [8].

Innovations in cardiac surgery technique will likely positively impact the elderly population. Hybrid revascularization is a concept that is growing in popularity especially among higher risk surgical cohorts. Hybrid revascularization entails robotic LIMA dissection and LIMA to LAD anastomosis through a small right thoracotomy incision without the need for cardiopulmonary bypass with PCI revascularization of the remaining diseased vessels. This revascularization strategy takes advantage of the long-term patency of the LIMA to LAD anastomosis without the morbidity and mortality associated with a sternotomy and cardiopulmonary bypass. Preliminary data suggests the safety and efficacy of this strategy especially in higher risk and frail patients.

Thus, CABG can increase the longevity and quality of life of older patients including octogenarians and nonagenarians. As with other surgical procedures, patient selection is critical to a successful procedure and postoperative course. Age, in and of itself, should not deter a patient, or a patient's provider from the consideration of CABG in the setting of significant coronary disease.

Valvular Heart Disease

Valvular heart disease is a heterogenous assortment of independent and at times interdependent disease processes resulting from dysfunction of the aortic, mitral, pulmonic, and/or tricuspid valves. By far, aortic and mitral valvular diseases are the two most common valvular pathologies and will be the focus of this chapter [9]. While valvular heart disease is less prevalent than CAD (present in approximately 3% of the general population), it represents approximately 20% of open-heart surgical procedures. As with CAD, the incidence and prevalence of valvular heart disease increases with advancing age.

Aortic Valve Disease

The aortic valve represents the most common valve requiring surgery. The disease of the aortic valve can present in two, not mutually exclusive, forms: stenosis or regurgitation. Aortic insufficiency (AI) is the least common. It can be caused by a number of pathophysiologic processes including leaflet dysfunction, aneurysmal disease, connective tissue disorders, endocarditis, or aortic dissection. Primary AI is less common in older patients compared with younger patients due to a link with connective tissue disorders which tend to present at younger ages. There is a grading system based primarily on echocardiographic-derived hemodynamic parameters combined with clinical features which ranges from mild to severe. Surgery is indicated in the setting of severe symptomatic AI [10]. Most patients are able to tolerate gradual increasing severity with minimal symptoms until the AI becomes severe. While medical management can temporize the effects of AI, ultimately surgery with valve repair or replacement is the only definitive treatment.

Aortic stenosis is the most common valve pathology affecting the patients of advancing age. Classically there have been two categories of aortic stenoisis: congenital, which is usually associated with a bicuspid aortic valve and presents in the fifth to sixth decade of life, and degenerative aortic stenosis which results from calcific degeneration of the valve with aging. The vast majority of AS is secondary to a slowly progressing degenerative process of a trileaflet valve. Because of its increasing incidence and prevalence in progressively older patients, it was classically named "senile aortic stenosis." As with aortic insufficiency, there is a universally accepted AS severity grading system based primarily on echocardiographic or angiographic hemodynamic parameters and symptoms ranging from mild to critical [10].

Regardless of the etiology, the hemodynamic and mechanical effects are the same. As the valve becomes progressively stenotic, so does the LV afterload and work required by the LV to maintain perfusion pressure. Aortic stenosis progresses slowly over years if not decades. As such, the heart does an excellent job compensating for the increased afterload with increasing left ventricular hypertrophy. During this stage patients are usually asymptomatic. However, the heart reaches a "tipping point" when the AS is severe and the heart is no longer able to compensate; patients become symptomatic with evidence of diastolic heart failure which presents as increasing dyspnea on exertion, syncope, or angina. Classic studies that laid the foundation for the surgical management of aortic valve disease demonstrated that severe symptomatic AS is ominous without treatment as up to 50% will die with 1–3 years without valve replacement [11] (Fig. 13.4).

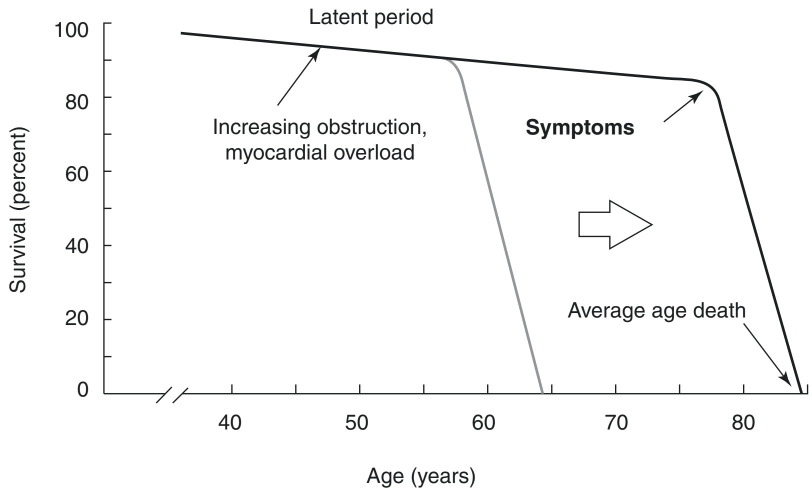

Fig. 13.4 The latent period of aortic stenosis occurs as the aortic valve becomes progressively stenoic with the absence of symptoms due to myocardial compensatory mechanisms. This occurs over many years to decades and has a low associated mortality rate. The development of symptoms with severs AS indicates a tipping point when compensatory mechanisms are exhausted and there is a drastic increase in mortality without surgical intervention. (From Ross Jr and Braunwald [11], with permission)

While the classic symptoms associated with aortic stenosis include dyspnea on exertion, syncope with exertion and/or angina, determining the presence of symptoms, especially, among elderly patients can be a challenge and requires an adept and quizzical practitioner. Because aortic stenosis develops gradually over many years, symptoms develop and evolve subtly and are often mistaken for "normal" signs of aging [12]. Older patients are more likely to have limited mobility due to osteoarthritic or musculoskeletal problems or other comorbidities which may limit the ability to illicit symptoms. Furthermore, as patients get to the more extremes of age (80s and 90s), patients, families, and even providers often ascribe their symptoms to being "old" rather than from aortic stenosis. Patients often comment that they are short of breath and fatigued because "I am 85" when in fact there is a potentially treatable condition causing their symptoms. In the setting of aortic stenosis, providers must be astute when taking a patient's history, especially when they are older and more frail.

For several decades, surgical aortic valve replacement (SAVR) was the only definitive treatment for aortic stenosis. SAVR, in most cases, requires a midline sternotomy, the use of cardiopulmonary bypass, and valve replacement with either a mechanical or tissue valve prosthesis. Patient age is one of the main considerations influencing valve choice (tissue versus mechanical). Younger patients (<65) are typically offered mechanical valves while older patients tissue valves. The younger the patient the shorter the expected lifespan of a tissue valve prothesis. For instance, a tissue valve prosthesis in a 35-year-old is expected to degenerate after 5–10 years. While a tissue valve in a 70-year-old is expected to degenerate after 15–20 years. Mechanical valves do not degenerate and can be fully functional for decades but have the disadvantage of requiring life-long anticoagulation which is not needed with tissue valves.

Outcomes after SAVR are excellent. In the general population, isolated aortic valve replacement is associated with low morbidity and mortality. In a large contemporary, multicenter series SAVR-associated in-hospital mortality was 1.3% [13]. Similar to CABG, SAVR performed in the elderly population is safe and effective with relatively low morbidity and mortality albeit slightly higher than younger cohorts. Published series report mortality rates ranging from 2% to 10% among octogenarians with much of the variability in mortality dependent on preoperative risk factors [13–16]. Similarly, small published series of SAVR in nonagenarians demonstrate reasonable survival in this high-risk patient population with a mortality rate of 5–10% [16–18]. Elderly patients who undergo SAVR enjoy good quality of life after initial recovery from surgery. Among octogenarians who undergo SAVR at 1-year quality of life is better than predicted by age and comorbidity status [19].

Up until this last decade, SAVR has been the only definitive treatment for AS until recently when transcatheter aortic valve replacement (TAVR) has revolutionized the treatment of aortic stenosis, especially among the elderly and frail. In the vast majority of patients, TAVR can be performed percutaneously through femoral arterial access. The native, stenotic valve is crossed with a wire over which the TAVR valve is placed with fluoroscopic guidance and expanded. Unlike SAVR, the native valve is not excised. Rather it is pushed to the side and replaced with a tissue prosthesis. TAVR avoids a sternotomy and cardiopulmonary bypass. Thus, recovery is relatively short with few limitations on a patient's mobility and pulmonary functional status. The permanent pacemaker rate with TAVR is high, around 10%, which is due to the radial force of the TAVR valve on the conduction system which resides close to the aortic valve annulus. In addition, because the technology is relatively new, longevity of the valve has not been proven.

TAVR was originally tested in extremely high-risk patients which included the elderly and extremely frail. The PARTNERS I trial, published in 2010, compared medical management to TAVR among patients with severe symptomatic aortic stenosis who were deemed too high risk for surgery. The results demonstrated clear improvement in survival and quality of life [20]. In a subsequent study of high-risk SAVR candidates, TAVR was shown to be superior in terms of survival and quality of life [21]. Since that time the study has been repeated in intermediate-risk and low-risk populations demonstrating its safety, efficacy, and equivalence or superiority to SAVR in appropriately selected patients [22–24]. Based on the aforesaid data, the only reason an elderly patient, especially with multiple comorbidities should undergo SAVR for severe AS is in the setting of anatomical features preventing the safe placement of a TAVR valve.

TAVR has revolutionized the treatment of AS in the elderly. With the adoption of TAVR, high-risk patients, including the extremely elderly, are routinely referred for TAVR with excellent outcomes. According to the Transcatheter Valve Registry (TVT) (US national registry of all TAVR patients), the median age undergoing TAVR is 84 with a mortality rate of 5% (Fig. 13.5) [25]. One must keep in mind that at the time these data were collected the only patients approved for TAVR were those considered high risk for surgery

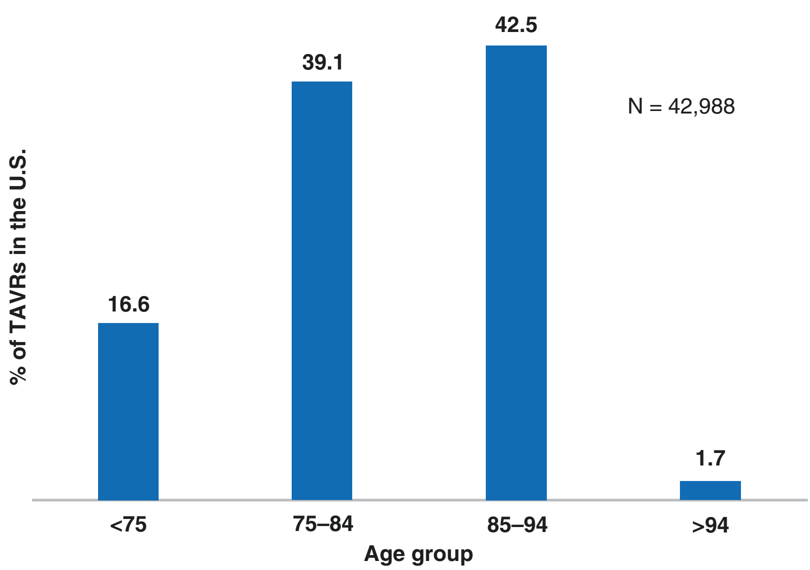

Fig. 13.5 Age distribution among the 42,988 TAVRs performed in the United States. (Adapted from Carroll et al. [25], with permission)

which was defined as a predicted risk of operative mortality of at least 8%. As of 2017 there were nearly 43,000 TAVRs performed in the United States and nearly 50% were performed in patients ≥85 years of age [25]. The subanalysis of TAVRs performed in nonagenarians has demonstrated its safety and efficacy with a 30-day mortality of 4% in a population with a mean age of 93 [26].

Mitral Valve Disease

Mitral regurgitation (MR) is the most common indication for mitral valve surgery. There are two types of MR: functional MR and degenerative MR. Degenerative MR is the least common and is caused by failure of one or more components of the valvular apparatus (valve leaflets and chordae tendineae) resulting in regurgitation. Functional MR is the most common cause of MR in the elderly. In functional MR the valvular apparatus is normal but becomes regurgitant due to annular dilation or leaflet restriction. The most common cause of functional MR is ventricular dilation from ischemic heart disease. As with aortic valve disease, MR is graded from mild to severe largely based on echocardiographic-derived hemodynamic and functional patterns [6]. Progression of MR is typically gradual, allowing for myocardial compensation. As MR becomes severe and myocardial compensatory mechanisms become exhausted, patients develop heart failure symptoms. Severe symptomatic MR is an indication for surgical repair or replacement. Mitral valve repair is preferred over replacement if a functional and lasting result can be achieved as tissue prosthetic valves are subject to limited functional lifespan and mechanical valves require lifelong anticoagulation.

Significant MR is common with aging. An estimated 10% of the patients greater than 75 have significant mitral regurgitation [27]. However, the vast majority of elderly patients who may benefit from surgery to treat their MR are denied surgery due to age and other risk factors [28]. Mitral surgery can be performed safely in older patients as demonstrated in a study investigating over 14,000 procedures which demonstrated a mortality rate of less than 3% among older patients. Furthermore, the long-term survival was equivalent to that of the general population matched for age and gender [29] (Fig. 13.6). Wide and varying outcomes have been reported among octogenarians undergoing mitral surgery with mortality rates ranging from 2% to 25%. The vast majority of reported morbidity and mortality is associated with preoperative comorbidities; and many elderly, higher-risk patients are referred for surgery later in the disease process. Modern series report superior survival of octogenarians after mitral surgery compared to predicted risk of mortality based on risk assessment models [30]. The analysis of mitral repair among octogenarians demonstrates excellent 30-day survival >97%. Replacement survival was less impres-

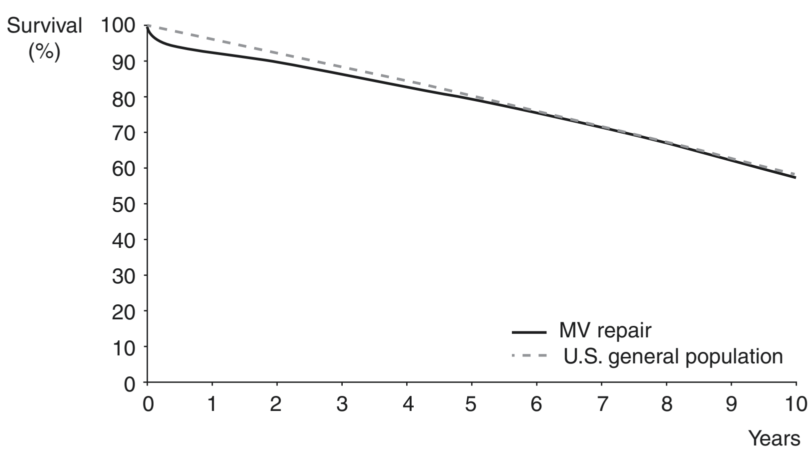

Fig. 13.6 Ten-year survival after mitral valve repair in patients aged 65 years or more. The Kaplan-Meier 10-year survival after valve repair (solid line) is equivalent to the age and sex-matched US population (dashed line). MV mitral valve. (From Ghoreishi et al. [44], with permission)

sive at 86%. However, there are important differences between the repair and replacement groups that have an impact on survival and confound survival analysis. Replacement patients tend to have more comorbid conditions, including a significant number with ischemic heart disease and significant number requiring concomitant procedures, such as CABG [31]. Elderly patients, including octogenarians experience improvement and freedom for heart failure as well as overall quality of life after mitral valve surgery. While mitral surgery among octogenarians is associated with adequate survival and improvement in cardiac-related symptoms, approximately 50% of patients >80 require some sort of assisted living at 1 year. Thus, mitral surgery can be performed safely and effectively in the elderly; patients need to be well selected for optimum outcomes.

There are multiple surgical approaches to the mitral valve that have an important impact on elderly patients. The traditional, and most common, surgical approach is via a median sternotomy. A minimally invasive approach through a right thoracotomy or robotically are increasingly being used. Data on right thoracotomy or robotic mitral surgery reports that it is associated with fewer postoperative mobility limitations and shorter lengths of stay with improved quality of life which may have a particular importance with elderly patients [32].

Just as TAVR has revolutionized aortic valve surgery for elderly and frail patients, Transcatheter Mitral Valve Repair (TMVR) is revolutionizing the treatment of MR. TMVR is an endovascular procedure during which a clip is advanced from the femoral vein into the right atrium and then left atrium through a transeptal puncture. Under TEE and fluoroscopic guidance, the clip is then passed through the mitral valve and the mitral leaflets are approximated. The concept is that the clip will improve leaflet coaptation and, therefore, reduce the MR.

TMVR has shown improvements in survival and quality of life in patients who are at high risk for surgical mitral valve repair or replacement. The EVEREST study randomized patients between surgery and clip for degenerative MR and concluded that, while the clip was less effective at reducing the MR than open surgery, it was associated with lower morbidity with equivalent mortality [33]. Subsequent long-term follow-up data demonstrates equivalent survival between the clip and surgery cohorts, with the clip cohort more likely to need subsequent mitral valve surgery. The COAPT trial investigated the high-risk, functional MR population who are traditionally denied surgery due to risk. The COAPT trial randomized high-risk patients to the clipping procedure or optimal medical therapy and discovered that the clip significantly improved survival as well as quality of life as measured by a decrease in admissions for heart failure. While the data is clear that the clip is not as effective at eliminating all of the MR compared to surgery, it is has less associated morbidity with equivalent risk-adjusted survival even among high-risk surgical patients, approximately 50–80% of whom are denied surgery [34, 35]. Other published series have demonstrated safety and efficacy of the transcatheter mitral repair with low procedural morbidity and mortality rates less than 4% and significant MR reduction in over 90% of patients [36–38].

Transcatheter mitral repair results in a significant improvement in patients' quality of life in the short and long term. While in the short term patients do not have to undergo the challenges of recovering from surgery, at 1 year the majority of patients have improvements from heart failure symptoms and improvements in functional status. This translates to fewer admissions for heart failure exacerbations which is a common problem among patients with severe MR. Furthermore, given the fact that TMVR is approved for patients with high and prohibitive predicted risk of mortality with mitral surgery patients, the vast majority of the patients undergoing the procedure are elderly with multiple comorbidities with median age in the mid-80s [37].

While mitral valve surgery can be performed safely in well-selected older patients, TMVR has changed the treatment paradigm of MR among high-risk patients including patients of advanced age.

Ascending Aortic Surgery

There are two main reasons to operate on the ascending aorta: aneurysm or acute aortic syndrome. Ascending aortic aneurysms are often associated with some form of connective tissue disorder and are asymptomatic until it reaches extremes of size and interacts with surrounding structures or develops acute aortic syndrome. Most aneurysms are detected incidentally during imaging for other reasons. Surgical indications for ascending aneurysms are based on size and growth rate with the intent of preventing dissection or rupture which is more likely to occur with increasing size. Acute aortic syndrome is defined as either aortic dissection or rupture and represents a life-threatening emergency. Aortic dissection has a 50% mortality rate at 48 hours without surgical repair [39]. Elective ascending aortic surgery is safe in the general population with a risk of mortality less than 2%. While the risk of morbidity and mortality of 8–10% is elevated among older patients, it more reflects the risk burden of comorbidities such as CAD and renal dysfunction rather than age alone [40].

Acute aortic syndrome is a lethal diagnosis and in the setting of ascending aorta pathology can only be definitively treated with open surgery. Two separate disease processes comprise acute aortic syndrome: aortic dissection and aortic rupture. Type A aortic dissections involve the ascending aorta and is associated with a 50% mortality within 48 hours of onset and 90% at 1 month without surgical repair [41]. The morbidity and mortality of surgical repair of acute type A AD is high and is largely associated with the preoperative state and comorbidities of the patient [42]. For instance, dissection patients who present to the operating room with evidence of coronary, cerebral, mesenteric, or extremity malperfusion have a significantly higher mortality (30–45%) versus those who do not (6–14%) [43].

Surgery has not been traditionally offered to elderly patients who present with acute type A aortic dissections given the high mortality associated with repair. However, with the aging of the population and increased experience and success with cardiac surgery in the elderly population, there is increasing experience with Type A aortic dissection repair in older patients. Current published experiences have reported mortality range among octogenarians ranging from 8–37% with mortality largely being associated with malperfusion syndromes and preoperative comorbidities. As with other areas of cardiac surgery, success is largely dependent on patient selection when considering aortic dissection repair in the elderly.

Conclusion

Cardiovascular disease is common in the elderly, and many may require surgery for definitive treatment. Current data suggests that age should not be a contraindication for surgical intervention on coronary artery disease, valvular heart disease, or ascending aortic disease as well-selected older patients, even those of very advanced age (90s), have good outcomes after surgery.

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Surgical Decisions on Breast Cancer in the Elderly

14

Maria Castaldi

A leaf in the fall susceptible, like fallen leaf, to be dragged to extinction by the smallest wind blow. –Mimnermus

Aging and Immune Response

Breast cancer is the most common cancer diagnosed in women [1, 2], and age is a major risk factor for breast cancer. Based on Surveillance, Epidemiology, and End Results (SEER) data that provides age-specific rates of breast cancer in the United States [3], the median age of diagnosis for women is 62 [3]. Over 40% of all breast cancers diagnosed are in women aged 65 years or older. It is anticipated that by the year 2030, approximately 20% of the population will be aged over 65 years, predicting a greater proportion of older women diagnosed with early breast cancer in the near future with an average of three co-morbidities [4]. This increasing number of comorbidities translates to reduced life expectancy. Healthy elderly patients diagnosed with breast cancer may have 11.6 years of remaining life expectancy. Life expectancy in the elderly is reduced to 9.4 when comorbidities that may lead to organ failure are present and further reduced to 7.3 years in a frail patient. A large-scale European study shows co-morbidities to be independent prognostic factors in breast cancer patients aged 50–79 years [4]. Older women with newly diagnosed breast cancer and the presence of three geriatric domain deficits in sociodemographic, clinical, physical function, or psychosocial measures experienced a near twofold higher breast cancer–specific death rate at 5 and 10 years [5]. Further, optimal treatment for older breast cancer patients is also not well established [6]. The treatment approach for elderly patients requires more than chronological age and includes comorbidities, social and economic circumstances, and life expectancy. As the majority of treatment recommendations are based on retrospective analyses and the extrapolation of study results from younger patients, resultant under treatment and poor survival outcomes in the older populations exists [6]. Undertreatment strongly decreases prognosis and survival of breast cancer in elderly women [7]. Large population databases from Europe show that even when patients over 70 years of age have early-stage tumors and favorable histologies, they still have lower disease-free survival than women diagnosed at less than 70 years of age [8]. Such a trend is possibly attributed to the fact that these patients are less likely to receive standard treatments of sur-

M. Castaldi (✉)
Department of Surgery, New York Medical College, School of Medicine, WMCHealthcare Network, Valhalla, NY, USA

Department of Surgery, Westchester Medical Center, Valhalla, NY, USA
e-mail: Maria.Castaldi@wmchealth.org

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gery, radiation and adjuvant therapy. There are a number of factors that contribute toward differential treatment. The majority of geriatric recommendations are based on analyses that utilized younger patients with study results being extrapolated for older patients [9–11]. As such, although there is research on various topics pertaining to breast cancer and treatment, often these results are not generalizable to breast cancer in the elderly. Other factors that contribute toward differences in treatment reflect that geriatric patients frequently present with multiple comorbidities and treatment may be perceived as less tolerated and thus less effective [12] due to poor performance status, limited social support, and lower life expectancy [9, 12]. Although clinical tools such as functional status aid in the identification of vulnerable patients from healthy patients and may avoid suboptimal treatments for fit, elderly patients, the biology of aging must be incorporated into treatment decision algorithms.

Inflammatory responses can be altered in the elderly as a consequence of the biology of aging. Aging is associated with chronic subclinical levels of systemic inflammation called inflammaging. Inflammaging is characterized by a state of chronic low-grade sterile inflammation and increased pro-inflammatory cytokines [13]. The most marked changes that occur with aging in the adaptive immune system determine the state of immunosenescence, the age-related dysfunction of the immune system. Immunosenescence and inflammaging involve changes in both the innate and adaptive immune system, which include the changes in function of a variety of immune cells aging of the immune system [14]. Several mechanisms involved in aging and cancer development lead us to believe that aging predisposes patients to cancer. Pathways of genomic instability, telomere attrition, epigenetic changes, loss of proteostasis, decreased nutrient sensing, altered metabolism, cellular senescence, and stem cell function link aging to cancer [15]. These changes of the immune system and indicators of senescence and progressive deterioration of the immune system may have clinical significance. Immunosenescence and inflammaging may predict the development of chronic diseases mostly considered age-related, such as cancer, and frailty [16]. Not all age-related immune changes however are detrimental, and cancer immunotherapies could have an advantageous response.

Frailty from an evolutionary point of view is the depletion of the physiological, biological, and molecular reserves of the aging organs, leading to less-efficient responses to stresses. However, interventions are not withheld in elderly patients based on opinions that aging-related immune changes are detrimental. If we consider immune changes related to gaining as an adaption or remodeling, interventions may be unpredictable. Interventions do depend on the level of inflammation, on interactions of the innate immune system with other systems, and on the appropriate inflammatory state of the individual. Treatment thus should be adapted for the elderly and frailty and should be different than that for young people [16].

For women younger than 40, the risk of developing breast cancer is 1 in 51, whereas the risk for women over the age of 70 is 1 in 15 [17]. The increased risk of developing cancer could be due to two biological processes: the gradual accumulation of DNA damage and the progressive decline of the human body to defend against tumor growth [4]. As both of these biologic processes are natural by-products of aging, it is clear that the incidence of cancer will increase with age. The incidence of breast cancer increases exponentially until menopause, and continues to rise after menopause, only at a slower rate [18]. While early-onset breast cancer is largely inherited, late-onset breast cancer is the result of growth of susceptible epithelium that fails to age normally. These cells are exposed to persistent growth stimuli from secreted products from senescent fibroblasts, although the degree of the influence is not known. Understanding the biology of breast cancer and its age dependency is crucial when one prognosticates breast cancer. Clinically, late-onset breast cancer grows more slowly than early-onset breast cancer and is less aggressive even when controlled for hormone receptors and growth factor receptors [18].

Older patients, especially those with cancer, are at risk of limited physiologic reserve of multiple organ systems and the ability to withstand stress. Geriatric assessment (GA) is currently the best way to assess the level of fitness in oncogeriatric patients in order to plan adequate therapeutic strategy. It allows detection of geriatric deconditioning in order to adapt treatment regimens accordingly. Several frailty models have been developed in general geriatrics (see Frailty Assessment as Measurement of Physiologic Reserves in the Elderly). GA alone is not sufficient to predict outcome and tolerance to treatment regimens for breast cancer [17]. In frail women with early-stage breast cancer, the predictors of 3-year overall survival included cognitive or functional impairment, limitations in instrumental activities of daily living, and the American Society of Anesthesiology grade [19]. Further, functional decline in the months preceding therapy resulted in an increased risk of death [20]. A combination of geriatric multimorbidities predicts overall survival in older patients with cancer. From a cellular stand point, frailty markers could be predictive and may even be used in the place of the extensive GA that is usually suggested.

Brouwers et al. studied the relationship of potential aging and frailty biomarkers with age and clinical frailty [21]. Plasma levels of interleukin-6 (IL-6) and other biomarkers were studied in non-metastatic young and old breast cancer patients. IL-6 levels correlated with chronological age in both groups and with clinical frailty in the older breast cancer group. Such a relationship was not found with other biomarkers such as telomere length, insulin-like growth factor (IGF-1), and Monocyte Chemoattractant Protein-1 (MCP-1), meaning there is no age correlate. This study indicated that plasma IL-6 levels should be further explored as a frailty biomarker in cancer patients [14]. Additionally, this group integrated GA in a single semi-continuous score and introduced a new instrument to document clinical frailty. The relationship between frailty biomarkers and clinical frailty should be sought.

Gene expression databases can identify genes regulated in aging and potential frailty biomarkers. Forty-four markers in aging pathways were evaluated for frailty [22]. Investigators grouped the biomarkers into seven categories (inflammation, mitochondria and apoptosis, calcium homeostasis, fibrosis, neuromuscular junctions and neurons, cytoskeleton and hormones, and other) and labeled them based on priority. They identified nineteen markers with high priority score, twenty-two markers with medium priority, and three markers with low priority. A panel of biomarkers should thus be utilized for assessing frailty rather than a single marker. They proposed a core panel of frailty biomarkers consisting of several signaling proteins, which includes IL6 [23].

In a large Polish Study, the PolSenior Study [23], the role of serum levels of two pro-inflammatory factors, interleukin-6 (IL-6) and C-reactive protein (CRP), was investigated in physical and cognitive performance to predict mortality in the successfully aging elderly. IL-6 and CRP levels were statistically lower in the successfully aging group rather than in the other participants in this study. The investigators found that higher IL-6 and CRP levels were statistically significant and associated with poor physical performance and cognitive performance. They noted the same association when they adjusted for age and other variables. Moreover, patients with lower concentrations of IL-6 and CRP survived longer [23]. IL-6 thus has been shown to be a promising marker in predicting frailty. Time aspect of aging however may not always correlate with clinical frailty or the possible functional consequences of the ageing process. Further, it is not clear if presumed clinically important biomarkes merely reflect chronological age, or rather the presence of clinical frailty [21]. Additionally, the oncogeriatric field is a specific subset and extrapolation of general findings from geriatric research and still requires validation. Conversely, the lack of correlation with frailty status at the time of diagnosis does not necessarily mean that these markers have no value in guiding treatment choices.

At the present time, research on biomarkers of frailty and ability to predict treatment toxicity may influence clinical decision making on the most appropriate management of geriatric cancer patients. Biomarker profiles could be incorporated into current geriatric assessment tools to enhance their ability in assessing the risk of adverse events in elderly cancer patients. Furthermore, identifying these biomarkers can elucidate the pathophysiology and contribute to better goal-directed therapies [24]. Elucidating the role of biomarkers in pathophysiology of cancer may detect unknown geriatric problems and allow adapting treatment regimens accordingly. Due to the importance of frailty as an underlying factor, frailty models, beyond the GA, must be utilized to guide treatment decision and tolerance to cancer treatments [21, 25].

Surgery

Although elderly women represent a large portion of breast cancer diagnoses, these women frequently experience undertreatment compared to their younger counterparts. Elderly cancer patients may experience differential survival due to consistent undertreatment [6].

Axillary Assessment

Axillary staging can have significant effects on decisions regarding the need for adjuvant treatment. The ACOSOG Z0011 study [26] and 10-year follow-up outcomes on disease-free survival and axillary events support the elimination of omitting axillary dissections in patients with early-stage breast cancer [8]. Sentinel lymph node biopsy is unlikely to be beneficial when the tumor is small, hormone receptor positive, and clinically negative axilla [27]. One study found that although omission of axillary staging in elderly patients may suggest an increased risk of regional recurrence, it leads to no difference in overall or breast cancer–specific mortality [28]. Other studies also support omitting axillary staging when elderly women have low-risk breast cancers [29, 30]. Guidelines from the Society of Surgical Oncology also suggest that routine use of sentinel lymph node biopsy would be avoided in a subset of elderly populations [31]. Some consider omitting sentinel lymph node biopsy in clinically lymph node negative, hormone positive invasive breast cancer in patients over the age of 70 [32]. In a study of 193,728 patients from the National Cancer Database, 79.8% had regional lymph node surgery, of which 15% were found to have positive lymph nodes. After multivariate analysis, luminal positivity in the cancer subtype was an independent factor positively correlated with the need for chemotherapy, hormone therapy, and/or radiation therapy [32]. Thus information obtained in the tumor alone may be sufficient to predict behavior and guide therapy regardless of lymph node status. Although pathological information from the axillary sentinel lymph node is important in directing the use of adjuvant therapy, oncologic surgeons generally perform axillary lymph node analysis for axillary staging and survival predictions rather than to guide treatment. Axillary lymph node manipulation in the form of sentinel lymph node excision or axillary dissection is associated with 7–20% rate of lymphedema and surrounding sensory and range of motion derangements. Two randomized controlled trials, the ALMANAC and NSABP B-32, demonstrated increased morbidity for patients who received sentinel lymph node biopsy [33, 34]. Added morbidity for elderly patients may have greater consequences than in younger counterparts, as many elderly patients already have preexisting comobordities [28] and do worse with extended surgery.

The involvement of axillary lymph nodes with cancer metastases strongly prognosticates early-stage breast cancer. In light of being minimally invasive, and highly sensitive, positive sentinel lymph node biopsy has not been shown to increase breast cancer–specific or all-cause mortality in women over 65 years of age. Surveillance, Epidemiology, and End Results (SEER) data research has not shown any 5-year all-cause survival benefit for performing axillary lymph node dissection in patients with positive sentinel lymph node. Additionally, SEER data research did not show a statistically significant difference in five-year breast cancer–specific survival (94.6% vs. 91.6%) [35] Hence, consideration could be given to omitting axillary lymph node analysis in a subset of elderly patients.

Breast Assessment

Surgery to the breast is the standard of care for any age for local control unless life expectancy is less than 2–3 years. In octogenarians with early-stage breast cancer, surgery improves breast cancer–specific survival and has a low postoperative mortality rate. However, this was not observed in 70-year-old patients and older with locally advanced disease defined by large tumor size and, or axillary metastases where there is no cancer-specific survival benefit [27]. In the elderly breast cancer patient, concerning breast conservation surgery and complete breast removal, studies have demonstrated variable use of breast conservation in the elderly. One study utilizing the SEER database demonstrated that approximately 66.55% of women over the age of 70 have improved cancer-specific survival compared with those who received mastectomy [36]. However, other studies have demonstrated how the addition of radiation with breast conservation in older populations does not improve survival and may lend to omission of radiation therapy when breast conservation surgery is performed [37–39]. Mastectomy is the preferred option for women with increased tumor size, wanting to omit radiotherapy or when patients prefer this option to others [40]. The clinical decision to undergo mastectomy using SEER data was based on disease-specific factors such as large tumor size, higher stage disease, and clinically positive lymph nodes [36].

Hormone receptor positive tumors in a patient that is not a candidate for surgery because of frailty with significant comorbidity, primary endocrine therapy is the preferred therapeutic option to halt progression and downsize tumor burden.

Frailty increases the risk of surgical complications. Based on phenotypic frailty criteria categorized as pre-frail (2–3 criteria) and frail (4–5 criteria), there is a step-wise increased risk of postoperative complications within 30 days. There is also longer length of stay to an institution among all, cancer and non-cancer, pre-frail and frail elective surgical patients. This phenotypic frailty is an additive to the increased risk estimation from popular surgical risk scores [41, 42].

There is a high incidence of ductal carcinoma in situ (DCIS) in patients at the age over 80 [43]. It has been shown that surgery does not improve overall survival benefit, but can be beneficial when there is a high-grade ductal carcinoma in situ as this most likely indicates disease aggressiveness. As surgical removal of DCIS is currently the standard of care, treatment with endocrine therapy and no surgery may be an option in low-risk DCIS [44]. The conclusions based on lead time between the development of DCIS and appearance of invasive breast cancer allow for active surveillance only in lieu of surgery in the elderly with comorbidities. For low-grade, small, nonpalpable in situ ductal carcinomas, there may be no benefit to surgery or radiation and a lesser approach such as active surveillance and endocrine therapy alone may suffice as treatment [44].

Adjuvant Therapy

Conventional treatment for breast cancer includes surgery (either breast conservation or total breast removal), radiotherapy, and chemotherapy. Surgery has been well established for local control. The supporting data on efficacy of chemotherapy in comparison to surgery is less robust [45]. Morbidity is largely due to subclinical metastatic disease at diagnosis. A recent 2019 study found that relative survival for elderly patients between the ages of 65–75 years increased over the last few decades. This increase in tandem with the increased use of systematic treatment in this same group. The authors reported that the in patients aged 65–75 years, the survival gain can most likely be attributed to the increased use of chemotherapy [46]. The authors report in another study that in the Netherlands only about 10% of patients with Stage III breast cancer over the age of 70 receive chemotherapy. This is compared to the 35.2% that receive chemotherapy in Belgium. This trend is important because survival outcomes are better in Belgium [47]. As such, it is clear that systemic therapy plays an important role in increased survival. However, the limitations of conventional breast cancer therapy are the low therapeutic index of a drug, side effects, therapy resistance, and heterogeneity of the drug concentration within the tissue. In the elderly, the availability of the drug in the bloodstream as well as pharmacokinetics is subject to the physiologic derangements that occur with aging.

When selecting a therapeutic regimen for an elderly patient, the physiological changes in the body of elder patients may increase the likelihood of toxicities. Aging causes a decrease in the total amount of water in the body, which leads to a decrease in the volume of distribution for water-soluble medications. Reciprocally, total body fat increases, which changes the distribution of fat-soluble medications. Apart from these physiologic changes, normal tissues are more susceptible to harmful effects of medications. Chemotherapy regimens in elderly patients lean toward being less aggressive, or may be excluded from the therapeutic protocol with resultant lower survival. One study found that regardless of a risk category (low, intermediate, high), patients ≥65 years were less likely to receive adjuvant chemotherapy [48]. These findings were consistent even when the population included fit older women. In this particular study, while elderly patients were more likely to experience toxicity, this did not correspond with increased mortality [49]. A systematic review conducted in 2011 also found an association between the increasing number of comorbidities and the decreased use of chemotherapy [50]. This trend is concerning for a number of reasons. First, there are studies that demonstrate that comorbidities in elderly breast cancer patients do not impact their disease-specific survival [51]. Second, some studies suggest that there is increased mortality for elderly patients with comorbidities undergoing chemotherapy. However, it is not elucidated whether this increased mortality is due to toxicity from treatment, or due to undertreatment. Modifications to standard treatments due to the patients being elderly could potentially explain the difference in survival. For example, withholding certain adjuvant therapies, or decreasing the dose of a chemotherapy regimen [52]. An alternative to excluding chemotherapy is enhancing therapy with prophylactic growth factors to offset toxicity, thus making it possible for elderly patients to benefit from full doses of the chemotherapy [53]. As toxicity must be managed, this should not result in undertreatment.

In the past few years, many new approaches have been developed for targeting drugs to breast cancer cells in ways that do not harm normal cells. Further, delivery of combination therapy approaches have been found to improve antiproliferative and anticlonogenetic effects on breast cancer cells due to their drug delivery systems. Nanotechnology could be further developed in elderly populations, and improved drug delivery systems can markedly improve drug absorption rates which are significant concerns in the elderly. Recent works with drug delivery systems in elderly groups are needed with targeted delivery systems customized to elderly and frail patients that could result in increased release, loading, and permeation of drugs tailored to elderly populations.

Treatment of breast cancer in the elder subpopulation is further challenged when elderly patients are subdivided based on their age. Extreme age (age >80) is often a barrier to participating in the clinical trials. Data about how to approach patients who age >80 years comes from the generalizations of the data obtained from studying younger patients. These patients are subject to overtreatment or undertreatment because treatment of this age category is adapted from the treatment of other age categories [27]. In the United States, the incidence of breast cancer in women older than age of 80 is approximately 400 cases in 100,000 women. Age alone is not a determining factor for tailoring the treatment. There are many healthy patients at the age of 80 or older that have life expectancy of 10–15 years and can tolerate treatment [27]. There are a number of online tools such as ePrognosis that help to estimate life expectancy and customize therapeutic plans. Research using SEER data has shown that most breast cancer characteristics in octogenarians are similar to younger patients [54]. Chatzidac et al. reviewed tumor characteristics in patients aged 80 and older. Data revealed 72% of the tumors were estrogen receptor positive and 56% progesterone receptor positive [55]. A high percentage of estrogen receptor positive tumors in the elderly treated with endocrine treatment may prolong survival even when the patient is not a candidate for surgery or chemotherapy. Most concerning in elderly patients is overall compliance to endocrine therapy. As it is well tolerated, completion of 5-year treatments at least should be encouraged [27].

Radiation therapy after breast conservation surgery is the standard of care. However, there is a high rate of non-compliance in octogenarians [56]. The main benefit of radiation therapy reduces the risk of local recurrence [27]. In women over the age of 70 with early-stage, estrogen receptor (ER) positive tumors [23] at 10.5 years, there was an increased rate of local recurrence with endocrine therapy alone compared to patients that had radiation therapy in addition to endocrine therapy treatment. However, a lack of radiation therapy did not change distant recurrence or overall survival. There was also a higher rate of morbidity in patients that received radiation [57]. The PRIME II trial showed the same lower recurrence rate with radiation therapy in patients over 65 years old [39].

However, Martelli et al., in a 15-year non-randomized trial with stage-one breast cancer, showed no statistical difference in mortality and distant metastasis [58]. Radiation therapy lends to problems with adherence, especially in the elderly. This could be due to any number of factors such as a lack of transportation or decreased mobility [2]. However, the inconsistent sessions could also decrease the benefits to these patients, while subjecting them to the negative side effects. Thus, in octogenarians when the tumor is early stage and hormone receptor positive, radiation therapy may be safely omitted [27]. As stated previously sentinel lymph node biopsy in this group may be omitted as well, as there is no survival benefit.

Web-based tools allow the calculation of 5- and 10-year survival and disease recurrence benefits of adjuvant therapies. However, these models do not predict survival and disease recurrence well in patients 80 years of age or older, and they might overestimate the benefit of adjuvant therapies [27].

Systemic treatment, adjuvant therapy, is typically reviewed with patients and their families during the geriatric assessment and discussion about life expectancy. Adjuvant therapy includes endocrine therapy, chemotherapy, and radiation. Edocrine therapy is a good option for patients who are frail with limited life expectancy, or those who are unwilling to undergo surgery [2]. The optimum duration of endocrine therapy in extreme ages is also uncertain. Studies have shown that severe side effects are most common after 2 years and as such a shorter duration of therapy could be wiser but overall effects of shorter time courses have not been proven [27]. While considering adjuvant therapy in patients aged 80 or older, although biological age is more important than chronological age. Side effects often overweigh the benefits in the elderly [27].

Breast Cancer Screening

Two main factors in the treatment of breast cancer are breast screening and adjuvant therapy after surgery as a mainstay for local control. However, the efficiency of breast cancer screening in patients who age >70 years is not certain as there is of insufficient data to assess benefits in this age group [59–62]. Currently the American Cancer Society (ACS) [63] and the US preventive Services Trask Froce (USPSTF) [64] offer guidelines for screening mammography in the elderly. Both the ACS and the USPSTF recommend regular screening for women between the ages of 65–74 years. The ACS recommending annual testing starting at age 40 [63] and the USPSTF recommending biennial screening from age 50 to 74 [64]. Beyond the age of 74, the ACS and the USPSTF vary in their recommendations. The ACS calls for the decision to screen being individualized [65], whereas the USPSTF notes that a patient over the age of 74 who does elect to undergo screening should do so biennially. However, both organization lack sufficient evidence-based guidelines due to the sparsity of randomized trials and observational studies utilizing women above the age of 74 [66].

Physiologic and precision breast imaging has markedly enhanced anatomic imaging. Precision imaging is used over standard imaging modalities the same way targeted adjuvant therapies are applied to tumor characteristics. Precision imaging with advanced software analysis of breast MRI (magnetic resonance imaging) and the like, novel molecular tracers, and intravenous contrast mammography could have the same potential benefits in being able to characterize cancers in a way that histology may not.

Precision imaging with MRI and physiologic imaging with contrast-enhanced spectral mammography may have significant benefit in elderly frail women with breast cancer.

Advanced software tools for texture analysis of tumors on contrast-enhanced MRI identify characteristics that are not seen by the eye alone and define tumor phenotypes and heterogeneity not appreciated on core biopsy. Spectral analysis of an MRI image allows the entire tumor to be assessed, rather than a core needle biopsy which is limited by sampling. Radiogenomics [67] can look at imaging analysis with underlying gene expression patterns. Radionomic phenotypes of tumor heterogeneity [68] is additive to radionomic software to obtain additional tumor information. These phenotypes predict tumor behavior patterns and allow morphology to be studied. Genotyping and phenotyping based on imaging characteristics is interesting in that the most heterogeneous phenotypes can be used to predict tumor behavior. Identifying heterogeneous natures of certain tumors might inform decisions on therapy or predict which tumors may fail to respond to treatment. Breast cancer tumor analysis with precision imaging modalities may potentially guide treatment based on MRI characteristics by texture imaging.

Contrast-Enhanced Spectral Mammography (CESM)

CESM may be comparable to MRI in the assessment of residual breast cancer following neoadjuvant therapy [69]. Prior work shows MRI is superior to clinical exam, mammography, and ultrasound and that there is very good correlation when looking for residual disease and tumor response after neoadjuvant chemotherapy in terms of positive and negative predictive values. Contrast-enhanced spectral mammography may be the same if not superior to breast MRI. IV contrast mammography is mammography with contrast infused. CESM is much easier and cheaper and could be preferable in the elderly. Studies have suggested for known breast cancer, CESM is extremely accurate in depicting tumor size, and in following tumor response to treatment. Regarding assessments on overall residual disease and complete response determination, MRI and CESM are comparable and performance is equal. Thus, response to therapy and determination for surgery if at all needed could be predicted by these advanced imaging modalities. A prospective study found that CESM may underestimate tumor size but specificity and sensitivity were adequate. CESM could be used to potentially replace MRI and even surgery [70]. A change in strategy based in imaging patterns could mean that a frail patient may avoid surgery as tumor burden is downstaged with neoadjuvant therapy.

Summary

Breast cancer in the elderly is common. Individual multidisciplinary and detailed discussions regarding the care and consensus of surgery, radiation, and adjuvant therapy in the elderly breast cancer must be performed. The treatment of breast cancer in the elderly and frail populations should encompass overall biological age as well as social and economic implications of treatment. The adoption of any practice changes in the treatment of the elderly with breast cancer requires consideration of multiple sources of information, but most importantly, more than chronologic age.

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15 Emergency General Surgery in the Elderly

Jorge Con, Shekhar Gogna, and Rifat Latifi

Definition of Emergency General Surgery

The term "acute care surgery" (ACS) seems to have been created following the realization that trauma surgeons at both academic and community hospitals were increasingly responsible for overall emergency surgical care that was extended way beyond trauma [1, 2]. The term "ACS" included three components: trauma, surgical critical care, and emergency general surgery [3]. The common characteristic shared between these three components is that an urgent treatment is required either in the form of surgery, the recovery from surgery or injury, or requiring surgical expertise.

The urgency in which hemorrhage control is needed in trauma parallels the urgency of certain non-traumatic conditions that care encompasses what constitutes EGS. Common examples include conditions such as viscus perforation, small and large intestinal obstruction, diverticulitis, fistulas, non-traumatic intra-abdominal bleeding, bowel infarction, intra-abdominal sepsis of any cause, and abdominal wall defects, particularly incarcerated and strangulated hernias, any acute pancreatico-hepato-biliary tract diseases but mainly cholecystitis, and acute pancreatitis. These conditions fall within the confines of the real of general surgery as defined by the American Board of Surgery [4] and as such are an integral part of surgical training. Furthermore, in 2013, in order to provide a common nomenclature for research on EGS, the American Association for the Surgery of Trauma (AAST) Committee on Severity Assessment and Patient Outcomes provides a list of ICD–9 diagnosis codes that further defines the scope of EGS based on the clinical practices of the time [5].

Outcomes of Emergency General Surgery in the Elderly

Elderly patients carry a higher risk of undergoing a major surgical procedure. A NSQIP study looking at a total of 7696 surgical procedures showed that surgical morbidity increased in a linear fashion across age groups [6]. This included postoperative wound occurrences, respiratory occurrences, renal occurrences, and cardiovascular occurrences. Morbidity for those patients

J. Con
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

S. Gogna
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: Rifat_Latifi@nymc.edu

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older than 80 years of age reached 51% versus 28%. Similarly, increasing age was associated with increasing mortality, with those greater than 80 years of age having a mortality of 7% versus 2.3%. Similarly, the odds ratio for mortality for undergoing emergency operations increased from OR = 3.0 in the 18–59 years age group, to OR = 5.2 in the 60–79 years age group, to OR = 11.4 in the 80 and above years old age group. Similar findings have been reported in low- to middle-income countries [7].

A study using the Healthcare Cost and Utilization Project – Nationwide Inpatient Sample comparing patient's ≥80 years of age vs. <80 years of age, looked at risk adjusted outcome measures found that although overall risk-adjusted odds of mortality were higher (OR1.67), the older group had lower risk–adjusted odds of morbidity, shorter length of stay, and lower total hospital costs [8]. Although the overall mortality was higher, the unexpected finding of these improved outcomes suggests that perhaps EGS in the elderly may be safer than we thought.

Demographics of Emergency General Surgery

Of all ACS patients, EGS patients tend to be older, more likely to be female, and more likely to be on Medicare or Medicaid [5]. Not only does the need for emergency surgery increase with age, but so does the rate of complications and mortality [9]. Many of the conditions requiring EGS involve re-operative surgery, which is inherently more complex. In another scenario, a non-emergent condition, such as a reducible hernia, may have become an emergent one, such as an incarcerated one, because of the patient's lack of health care access. In our experience, performing EGS in the elderly is particularly challenging because of the higher likelihood of encountering re-operative surgery, the possibility of a delayed or advanced stage presentation, sometimes due to the patient's lack of access to healthcare.

A study utilizing the National Surgical Quality Improvement Program (NSQIP) database published in 2012 describes the most common EGS operations performed in 35,334 patients older than 60, in which partial colon resection and small bowel resection topped the list [10] (Table 15.1). Another study the same year describes the conditions affecting 94 patients of age 80 or over who underwent emergency surgery for acute abdominal conditions [11] (Fig. 15.1). The most frequent surgical indication was acute cholecystitis (24.5%), yet only 3 of 24 cholecystectomies were performed laparoscopically, while the rest were done via a laparotomy. This series also supported the finding that intestinal resection was a more common procedure overall than cholecystectomy and appendectomy.

Table 15.1 Most common EGS operations in the elderly

Procedure type	Percentage
Colectomy	22.1%
Small bowel resection	10.1%
Laparoscopic appendectomy	9.5%
Exploratory laparotomy	5.9%
Cholecystectomy	6.4%
Appendectomy	5.4%
Lysis of adhesions	4.7%
Gastric perforation repair	2.5%
Ventral hernia repair	1.9%

From Farhat et al. [10] with permission

Chronological Age vs. Frailty

With demographic changes resulting in an increasing elderly population, and with the need of emergency surgery increasing with age, understanding the effects of physiological decline from age on surgical outcomes becomes important [1, 2]. Studies have shown that the odds of morbidity and mortality following emergency surgery increases with age [6, 7, 12]. The prevalence of comorbidities such as diabetes, hypertension, and coronary artery disease also increases with age, so does the need to be on medication such as antiplatelet agents and anticoagulation. Although it may not necessarily correlate with chronological age itself, other factors possibly affecting outcomes in the elderly are the nutritional status and activity level. Many factors associated with age affect the increased rate of morbidity and mortality in elderly patients undergoing EGS.

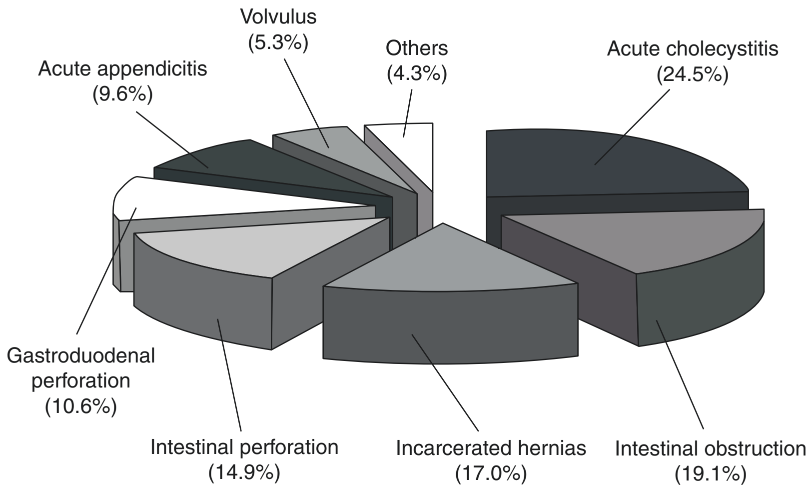

Fig. 15.1 Distribution of surgical conditions requiring emergency surgery in the elderly. (From Fukuda et al. [11] with permission)

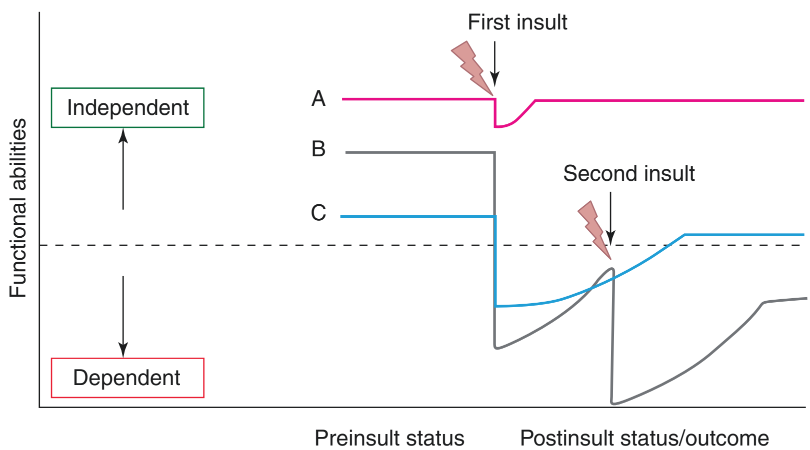

Fig. 15.2 Two-hit model in the frail elderly undergoing emergent general surgery. (From Desserud et al. [2] with permission)

Frailty syndrome results from physiological decline and in an increased vulnerability to adverse health outcomes. Frail patients are less able to adapt to acute illnesses or to recover their pre-illness level of function. A major insult (something requiring an emergency laparotomy) followed by a second insult (a complication) may result in the patient never regaining the pre-injury level of function or independence [2] (Fig. 15.2). The term "frailty" is usually employed to try to encompass several of these factors that are distinct from chronological age and that together are better predictors of outcome than chronological age alone.

Predictors of Outcome in the Elderly

Numerous frailty models have been proposed [13], yet the exact definition of frailty has remained evasive. Although the idea of frailty is that it is distinct from chronological age, age itself has been studied as a predictor. In a study by Marco in 1998, geriatric emergency patients aged 65 and older who came in with a complaint of abdominal pain were enrolled in the longitudinal case series, and it was found that surgical intervention was required for 22.1% of those patients. Advanced age and other more ominous signs such as hypotension, radiographic abnor-

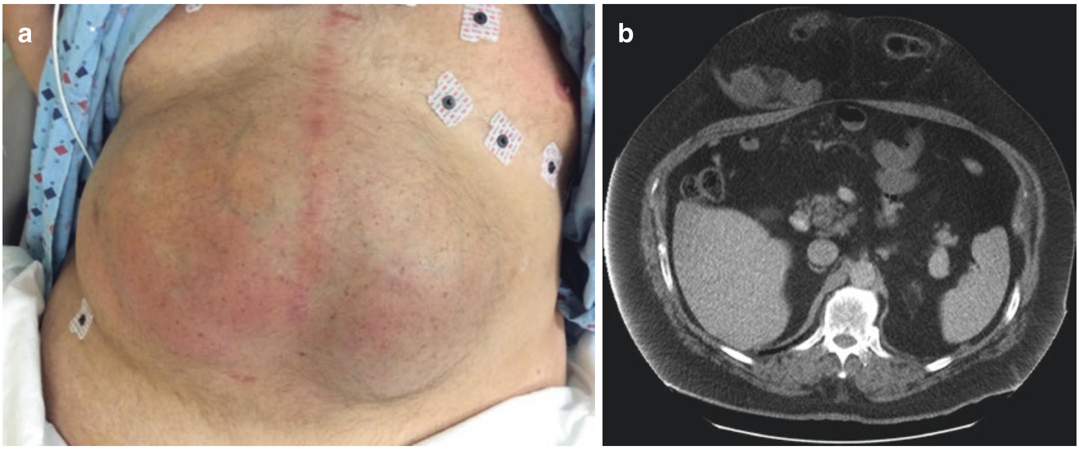

Fig. 15.3 A. 67-year-old gentleman with a large incarcerated ventral hernia with no significant signs of peritonitis and normal lactate. B. Necrotic small bowel of the same patient (∗). Please refer to Chap. 1 for intra-operative image. (Courtesy of Dr. Latifi)

malities, and leukocytosis are associated with adverse outcomes, the need for operation, and mortality [14]. Interestingly, physical examination, while mandatory, often is not a helpful predictor of significant pathology, making surgical decision making in the elderly very difficult. Other studies however have concluded that neither age [15, 16] nor the number of co-morbidities [16] was a mortality predictor. Often elderly patients do not manifest "classical" clinical picture of what is happening in the abdomen as demonstrated in Fig. 15.3.

The urgent nature of EGS condition suggests that any delay in treatment would lead to worse outcomes. This delay could be in the form of time from the onset of symptoms to hospital admission where having greater than 24 hours of symptoms was identified as an independent predictor for mortality in the multivariate analysis [11]. Delay could also present in the form of time from hospital admission to surgery where having greater than 72 hours was associated to mortality [15].

Other predictive models for mortality utilize slightly more complex calculations such as the American Society of Anesthesiologists (ASA) score [15, 16] and sarcopenia [17]. In this study, sarcopenia was assessed by measuring the total lumbar skeletal muscle cross-sectional area at the level of L3 using CT normalizing for height. It also found sarcopenia to be a predictor for morbidity.

Screening Tools

A recent review looking at 32 unique clinical assessment tools for frailty found that the tools usually followed one of two general approaches. The first approach defined frailty as when a certain threshold was reached out of five domains in the frailty phenotype paradigm [unintentional weight loss, self-reported exhaustion, weakness (grip strength), slow walking speed, and low physical activity]. The second approach defined frailty as some of impairments divided by the total number of items evaluated [13]. The number of components in these assessment tools ranged from 1 [18–20] to 141 [21]. These instruments were applied to various populations spanning orthopedic patients with hip fracture to elective vascular procedures to gynecologic cancer operations, with only one instrument addressing the emergency general surgery population specifically [10].

One review article looking into pre-operative scoring systems predicting outcomes specifically in elderly patients undergoing EGS did not find a single test with a negative predictive value sufficient to recommend against surgical intervention on its own [22]. Moreover, it found that many of the pre-operative scoring systems were disease specific: Glasgow Aneurysm Score [23] and Hardman Index [24] are specific to ruptured aortic aneurysm, and Boey Score [25] and Hacetteppe Score [26] are specific to perforated peptic ulcer.

Kenig in 2015 prospectively evaluated six screening instruments for frailty in 184 consecutive patients ≥65 years of age undergoing EGS, with questionnaires ranging from 4 to 15 items and a pre-defined cutoff score: Vulnerable Elderly Survey (VES–13), Triage Risk Screening Tool (TRST), Geriatric–8 (G8), Groningen Frailty Index (GFI), Rockwood, and Balducci. Of these, VES–13 was the best screening instrument because it had the highest sensitivity and negative predictive value (NPV) for both the postoperative mortality (Sensitivity 91%, NPV 93%) and morbidity (Sensitivity 85%, NPV 70%) [27].

Given that many of the questionnaire-type instruments published are lengthy, many studies have utilized modified versions that are shorter. Two of these studies utilizing modified frailty scores have been applied to the EGS population specifically. The first study used the modified Canadian Study of Health and Aging frailty index and showed that this instrument was the strongest predictor of mortality in multivariate logistic regression when compared to age alone, ASA class, and wound class [10]. The second study used a modified Rockwell frailty index found that the frailty index score and showed that it did not correlate with age and correlated poorly with the ASA score. Neither age nor ASA score was found to be predictive of postoperative or major complications. On the other hand, the modified frailty index by itself was an independent predictor for the development of major complications, with a sensitivity of 80% and the specificity of 72% [28].

Summary

Emergency general surgery outcomes, particularly overall mortality, are worse in the elderly. As outlined in the first chapter deciding what surgical approach to take in the elderly patient, when there are options available, is not an easy task. Should we perform definitive surgery in the elderly at the time of presentation, or should we try a "minimalistic approach" initially, and "give time for the patient to recuperate" and then perform the definitive surgery? Compared to the younger population who would undergo EGS for conditions such as acute appendicitis, the conditions for which the elderly undergo EGS appear to be more complex and require a more extensive operation. The most frequent procedure performed in elderly patients was bowel resection, including colon resection. The demographics of elderly EGS patients also tended to be female and on Medicaid and Medicare. Frailty as a syndrome is distinct from chronological age and seems to be a better predictor of surgical outcomes.

Other predictors for poor outcome include a delay in seeking attention or in getting an operation once admitted to the hospital. This highlights the challenging urgency of EGS in the elderly, a population that could face unique barriers in accessing care in a timely fashion. Although many frailty scoring tools have been studied, not all have been used for or designed for EGS. Yet present modifications to shorten lengthy questionnaires seem to maintain a certain predictive ability of these tools. Finally, certain adjusted metrics on other outcomes other than mortality suggest that favorable outcomes are possible for the elderly undergoing EGS. A better understanding of the factors that lead to favorable outcomes and future refinements in predictive models could lead to improved care for elderly EGS patients in the future.

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16 Inguinal Hernia Repair in the Elderly

Shekhar Gogna, James K. Choi, and Rifat Latifi

In 2050, the population aged 65 and over in the United States is projected to be 83.7 million, double its estimated number of 43.1 million in 2012 [1]. This demographic shift in the population will have its implications in terms of a higher proportion of the elderly undergoing surgery or other interventional procedures. Inguinal hernia repair is one of the most common surgical treatments performed worldwide [2]. Aging promotes physiological and pathological changes in the elderly that leads to increased prevalence of inguinal hernia (IH) in them as compared to the younger population. Decreased collagen synthesis, weak abdominal musculature, and increased intraabdominal pressures as a result of chronic prostate disorders or pelvic floor weakening are few of the common causes [3]. Surgical intervention is offered for inguinal pain and discomfort interfering with the quality of life (QOL) and to prevent emergency surgery in case of incarceration and/or strangulation, which is associated with very high rates of morbidity and mortality [4, 5]. The elderly population has a higher burden of comorbidities, and they tend to present late to seek medical care. Some studies have shown that 40% of inguinal and femoral hernia repairs in patients above 65 years of age are performed for incarceration or bowel obstruction [3, 6].

Inguinal Hernia in the Elderly Presents Differently from the Non-elderly

While considering the acuity of presentation, it is noteworthy that the elderly population is more likely to present with complicated inguinal hernia (incarceration or strangulation) as compared to young patients [7]. The overall risk of incarceration and strangulation approaches is up to 40% [3].

Studies have shown that time from diagnosis to inguinal hernia repair is usually higher in the elderly as compared to young patients [8]. This disparity is an active area of future research and intervention. The role of physicians practicing in the community is of paramount importance in early detection and post-operative care of the elderly undergoing IH repair [9].

Anatomically inguinal hernia is divided into two common types, indirect inguinal hernia when

S. Gogna
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

J. K. Choi
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: Rifat_Latifi@nymc.edu

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the hernial contents travel through the inguinal canal and exit via the superficial inguinal ring. Protrusion of the hernial contents through the weakened floor of the inguinal canal is known as direct inguinal hernia. An indirect hernia is more common in the young and direct hernia in the elderly [10].

The elderly generally present with larger indirect inguinal hernia than young adults. In the case of large indirect hernia, an acquired defect of the transversalis fascia is always present. Direct inguinal hernias are more often bilateral, and its occurrence is closely related to age [11]. These large hernias may contain large or small bowel (please refer to Figs. 1.3 and 1.5 in Chap. 1, as well as Fig. 16.1) and often are bilateral (Fig. 16.2), and are combined with umbilical hernia (Fig. 16.2).

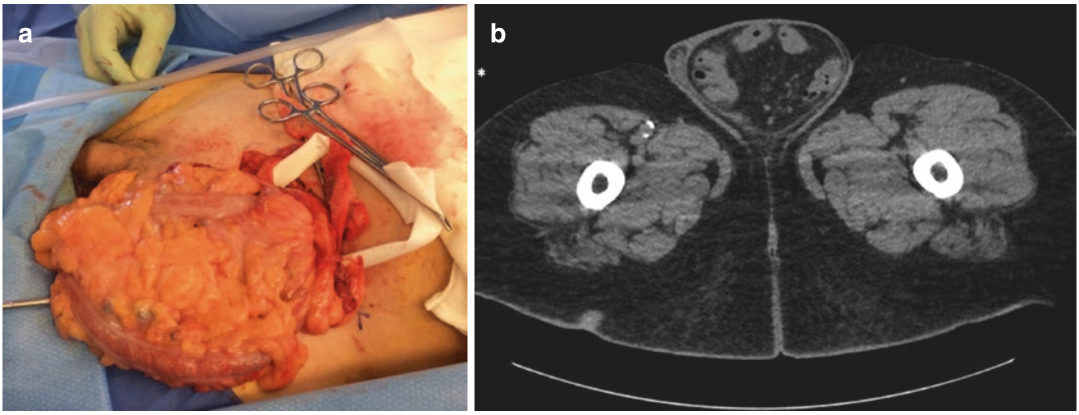

Fig. 16.1 (**a**) 73-year-old male with left incarcerated inguinal hernia containing sigmoid colon. (**b**) CT scan of the same patient with incarcerated sigmoid colon in scrotum (∗)

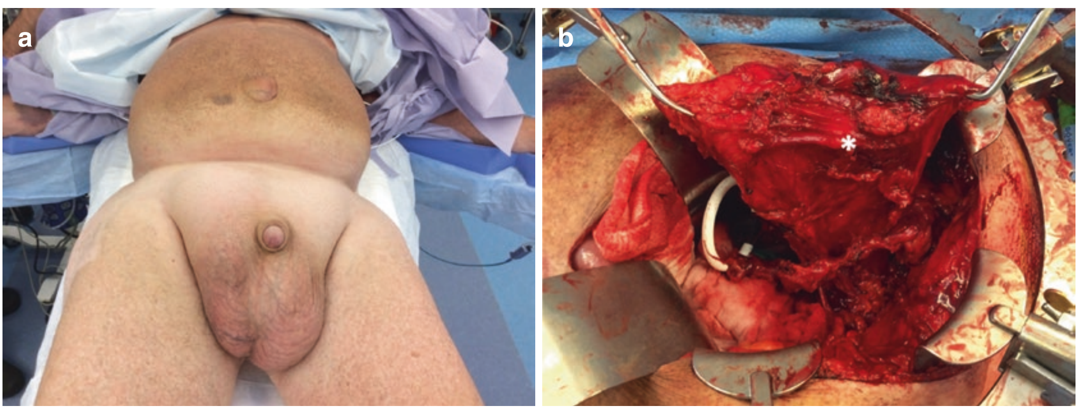

Fig. 16.2 (**a**) 61-year-old male with bilateral inguinal hernias and concurrent umbilical hernia. (**b**) Herniated bladder of the same patient with the left ureter (dilated) as it inserts into the herniated bladder (∗). (**c**) CT scan of the same patient illustrating bilateral inguinal hernias (∗)

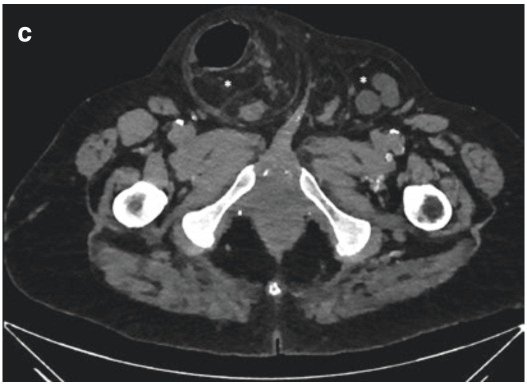

Fig. 16.2 (Continued)

A very practical issue that we surgeons face routinely in our day-to-day surgical practice of IH repair is the presence of a combined hernia in the elderly (Fig. 16.3). The pathogenesis of combined hernia stems from the fact that it is a progressive disease caused by chronic compressive structural damage due to long-term degenerative changes and hence more common in the elderly [12]. The simultaneous presence of hernial contents in different anatomic compartments of the inguinal area may lead to increased chances of early recurrence and morbidity if the surgical

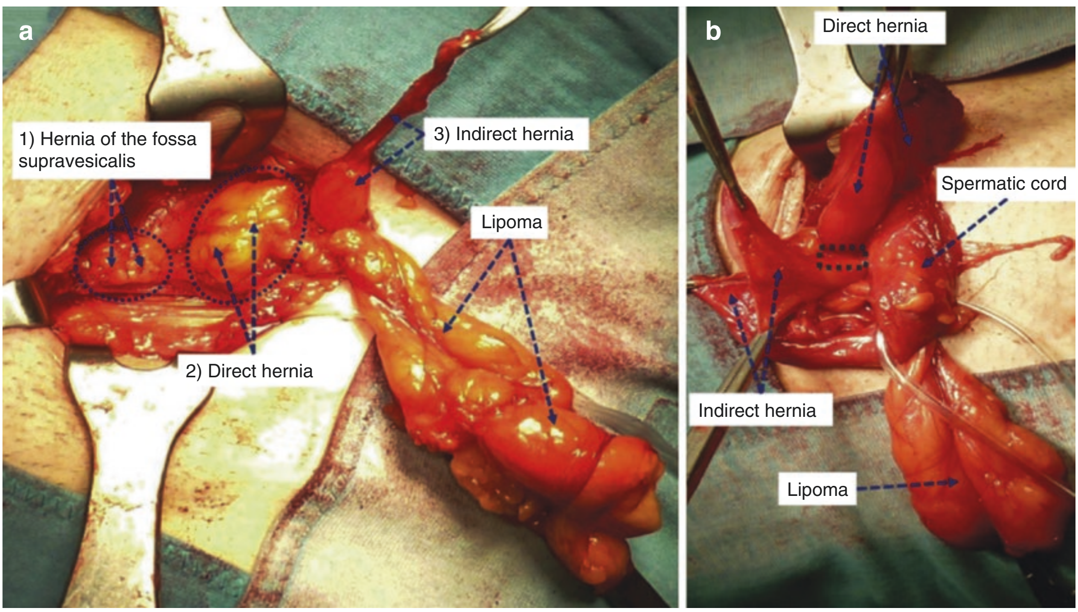

Fig. 16.3 (**a**) Tricomponent multiple ipsilateral herniae composed by a hernia of the fossa supravesicalis, a direct hernia and indirect hernia with a lipoma. (**b**) Double ipsilateral inguinal hernia composed by one direct and one indirect hernia (with opened sac). The medial aspect of the internal ring and the small portion of the back wall containing the inferior epigastric vessels (blue rectangle) divide the two protrusions. (From Amato et al. [12]. CC BY NC ND, license number: 4587921038730)

exposure is compromised due to faulty technique or lack of awareness.

Choice of Anesthesia and Setting of Inguinal Surgery

While there is an entire chapter dedicated to anesthesia in the elderly, in this chapter we briefly describe some of the techniques used for inguinal hernia surgery. Aging is linked to adverse postoperative outcomes affecting various organ systems and deterioration of cognitive function in elderly surgical patients [13]. The solution to prevent adverse postoperative outcomes is to have better integrated perioperative care. The aim of perioperative care is to improve the likelihood of very elderly surgical patients returning to their same pre-morbid status.

While considering the type of anesthesia, European Hernia Society (EHS) recommends that elective open (anterior) inguinal hernia surgery can be safely and effectively performed under local anesthesia (LA) in the elderly (Grade A recommendation, level of evidence Ib) [14]. All elderly patients should have long-acting local anesthetic infiltration preoperatively for better postoperative pain control. General anesthesia (GA) with short-acting agents along with local infiltration with long-acting LA anesthesia is a valid alternative to surgery under LA. The obvious indications for GA in the elderly are incarceration, obstruction, or strangulation.

In a three-arm multicenter randomized trial by Nordin et al., 616 patients at ten hospitals were randomly assigned to local, regional, or general anesthesia in patients undergoing groin hernia surgery. Patients in LA arm had substantial advantages in terms of shorter duration of admission, less postoperative pain, and fewer micturition difficulties [15]. Inguinal hernia repair with local anesthesia is quite safe and results in a good success rate in elderly patients despite a higher rate of comorbidity [16].

Multimodal analgesia combines different drugs with the aim of reducing doses and minimizing side effects of analgesics. Figure 16.4 depicts an effective way to control postoperative pain. All

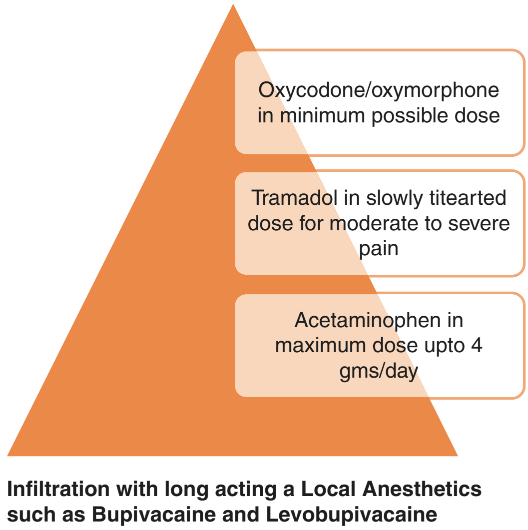

Fig. 16.4 Multimodal analgesia with escalation to more potent drugs

patients get long-acting LA and oral Tylenol to begin with. The slowly escalating doses of tramadol followed by opioids (in minimum possible concentration) are added. In a study by Seib et al., on the association between frailty in the elderly and outcomes after ambulatory surgery, the two important factors associated with decreased odds of complications were the use of local anesthesia and monitored anesthesia care [17]. With the shifting demographics of the aging population, the number of elderly patients requiring surgical procedures is increasing [18]. This has been a strong driving force in tilting the favor toward the ambulatory surgery centers performing the higher number of groin hernia repairs. Ambulatory surgery improves the quality of care and life with low morbidity [19]. A randomized control trial (RCT) comparing ambulatory care vs. inpatient care in elderly patients (excluding ASA IV and unstable ASA III) undergoing open inguinal hernia repair (Lichtenstein or repair with Proline hernia system) under local anesthesia showed no significant differences between both groups in the first 2 weeks postoperatively. Patients in the LA group had a high satisfaction rate and no readmissions [20]. Surgeons have pushed the boundaries little further; elective inguinal hernia repair in the elderly with significant comorbidities under LA has a good outcome [21].

Both open tension-free repairs and endoscopic techniques can be safely performed at daycare centers. The published series showed that other surgical and anesthesiologic techniques can also be effectively used as day surgery [14].

Is Surgical Technique Any Different in the Elderly?

Table 16.1 shows the various surgical techniques employed based on patient and surgeon's preference. The inherent steps in a particular surgical technique essentially remain the same in the elderly as well as the non-elderly. However, surgical intricacies might differ. As pointed earlier, the readers must keep in mind that "hernia is a progressive disease, which always continues to evolve" so the elderly have more propensity to present with a combined hernia, which has both direct and indirect components; this simply means that anatomy of the inguinal canal is distorted in the elderly [12]. Surgeons must be aware of the burden of comorbidity and frailty in elderly patients. The goal of IH surgery is a quick functional recovery after the operation using the "tension-free" technique and whenever possible under local anesthesia [22]. The mesh repair seems to be more prudent and strongly advocated in the elderly in elective cases than tissue repairs (Grade A recommendation) [14].

Table 16.1 Surgical technique of inguinal hernia repair

Tension-free prosthetic repairs	Technique
Anterior repair	Lichtenstein repair and its modifications
	Patch and plug repairs
	Double-layer devices (Proline Hernia system)
Posterior repair	(a) Open techniques via inguinal incision
	(b) Stoppa's repair
Laparoscopic repairs	Transabdominal preperitoneal (TAPP)
Endoscopic repairs	Total extraperitoneal (TEP)
Tissue-suture repairs	Bassini's repair
	Shouldice technique
	Desarda's technique
	Marcy repair

As mentioned in Table 16.1, anterior repair, also known as pre-muscular repair, strengthens the posterior wall of the inguinal canal. The primary goal of the posterior repair, also known as preperitoneal repair is to strengthen the entire myopectineal orifice [23]. Open anterior techniques are well established in the elderly; however, posterior repair necessitates general anesthesia (which might be unsuitable for the elderly with cardiopulmonary disorders).

The laparoscopic approach is safe in carefully selected elderly patients. In a retrospective analysis on 3203 cases (3847 hernias) by Zirui et al., who underwent LIHR, there were no significant differences in the recurrence rate and overall complication rate between the two arms ($P > 0.05$) [24]. The other two retrospective studies comparing laparoscopic approach vs. open approach in octogenarians concluded that laparoscopic inguinal hernia repair can be performed as a safe alternative to open repair with comparable rates of morbidity and mortality [25, 26]. In a prospective study by Vigneswaran et al. which aimed to analyze patient-centered outcomes for open and laparoscopic hernia repairs in the elderly concluded that laparoscopic inguinal hernia repair is safe and effective in the elderly with no major morbidities or mortalities. Although they are at greater risk for postoperative seroma, urinary retention, and octogenarians are at greater risk for readmission [27]. In essence, laparoscopic inguinal hernia repair can be safely performed in the elderly, but when it comes to safety, "open repair under local anesthesia" is still considered the gold standard in elective settings with which all techniques are compared. Emerging literature suggests that robotic inguinal hernia repairs are an option [28] and may be performed safely in the elderly [29]; however, the cost is still very prohibitive for most countries around the world.

It is well established that emergency hernia repair rates for incarceration, obstruction, and strangulation increase exponentially with the age in patients once they cross more than 50 years of their life [5]. Males predominate among the patients up to 75 years of age, while females prevail in the later age after 75 [30]. An emergency operation carries a substantial mortality risk. In the largest prospective study published in Sweden, the mortality was 7%, and it increased seven-fold after emergency operations and 20-fold if bowel resection was undertaken [31]. The mortality in the elderly population after emergency hernia repair is even higher. The surgical principles for the management of acute presentation in the elderly remain the same, but the delay in treatment has higher mortality and poor outcomes in the elderly as compared to a younger cohort.

Current Guidelines of Inguinal Hernia Management in the Elderly and Conclusions

There are no dedicated guidelines available for IH management in the elderly. There are three prominent guidelines on IH issued by hernia societies: the European Hernia Society guidelines (EHS), HerniaSurge Group (international guidelines for groin hernia management published by American Hernia Society, 2018), and International Endo Hernia Society guidelines (IEHS, published in 2011) covering laparo-endoscopic groin hernia repair [14, 32, 33]. The composite recommendations are presented here.

Indications for Treatment

Minimally symptomatic or asymptomatic inguinal hernia in men can be managed by the watchful waiting strategy (Grade A). It is recommended that symptomatic inguinal hernias be treated surgically (Grade D). The strangulated hernias should be operated on urgently (Grade D). In patients with a femoral hernia, early surgery should be performed, even if the symptoms are vague or absent. For recurrent IHs, use the opposite approach (e.g., for recurrence after anterior repair use a posterior technique, and vice versa is recommended [14].

Type of Anesthesia and Setting of Surgery

Most of the open inguinal hernia repairs can be done safely under local anesthesia at the daycare surgery center. Most of the laparo-endoscopic hernia repairs can also be safely performed at daycare centers (Level 2B, grade B).

The use of spinal anesthesia, especially, or long-acting anesthetic agents, should be avoided. General anesthesia with short-acting agents and with local infiltration anesthesia for prolonged pain control is strongly recommended (Grade B recommendation) [14].

Prophylactic Antibiotics

In open surgery, they are not recommended in low-risk patients. They are also not recommended in laparo-endoscopic surgery. In the presence of recurrence, advanced age, immunosuppressive conditions, expected long operating times and use of drains, antibiotic prophylaxis should be considered (Grade C recommendation).

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17 Abdominal Wall Reconstruction in the Elderly: Techniques, Outcomes, and Pitfalls

Rifat Latifi and Ansab Haider

Ventral hernias are defined as non-inguinal and non-hiatal defects in the fascia of the abdominal wall. Based on the etiology of the defect, they are either congenital or acquired. The vast majority of these hernias are acquired and result from previous abdominal surgeries or trauma. Incisional hernia repair is the most common complication after abdominal surgery. It is a consequence of failure of the abdominal wall fascia to heal after a previous surgery. Evidence-based guidelines have emerged to suggest optimal closure techniques for the fascia. However, despite the improvements in the surgical techniques, the incidence of abdominal wall hernias remains high anywhere from 2% to 50% [1–3]. Several factors contribute to this high incidence of incisional hernia which includes patient-related factors, native disease process, and the surgical technique. As a result of this high prevalence, ventral abdominal wall hernia repairs are one of the most commonly performed operations in the United States, and nearly 350,000 of these surgeries are performed every year with an estimated associated cost of $3.2 billion [4].

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: Rifat_Latifi@nymc.edu

A. Haider
Department of General Surgery, Westchester Medical Center, Valhalla, NY, USA

There has been a rapid growth in the aging population not only in the United States but in the entire world. Every single day 10,000 people turn 65 in the United States [5]. This is mostly a result of improved screening strategies, early diagnosis, and advancements in medical technology. The elderly population has several comorbidities associated with them, and they are well known to be associated with increased morbidity and mortality after surgery. Previously, the presence of these comorbidities was considered prohibitive for elective surgery. With the remarkable improvements in healthcare technology and outcomes and the advent of minimally invasive surgical techniques, many complex abdominal operations can now be safely performed in the elderly population which was previously not possible [6, 7]. This however poses a new set of challenges as well as opportunities for general surgeons. With increasing number of elderly patients undergoing major abdominal surgeries, the incidence of incisional hernia is expected to increase as well. Prevalence of incisional hernia is higher in the elderly compared to their young counter parts, and this is mostly due to the age-related weakness in collagen [8]. This weakness in collagen also puts these patients at higher risk for poor postoperative wound healing, fascial dehiscence, as well as recurrence of the hernia. The incidence of cardiac events and postoperative respiratory failure is also higher in the elderly population. Similarly, poor tolerance to opioids

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makes the postoperative pain control significantly more challenging in the elderly population and puts these patients with large hernia repairs at risk for postoperative respiratory failure and pneumonias.

Many of these abdominal wall hernias repairs are complex and may involve multiple fascial defects, presence of extensive underlying scarring to the bowel, associated stomas, concurrent malignant process, prior irradiation, previous hernia repair, malnutrition, and/or wound infection. With increasing geriatric trauma population and increasing number of trauma patients undergoing major abdominal procedures and the expanding utility of damage control surgery, the need for complex abdominal wall reconstruction in geriatric population for these complex defects is also expected to increase. The objective in the management of patients undergoing complex abdominal wall reconstruction is to restore the continuity of the gastrointestinal tract and the integrity of the abdominal wall by utilizing both native tissue approximation as well as reinforcement with biologic or synthetic mesh.

Anatomy of the Abdominal Wall

The boundaries of the abdomen are formed by the xiphoid process and the costal margins superiorly. Inferiorly the abdomen is defined by the pubic bones and the iliac bones. The integrity of the abdominal contents is maintained by the abdominal musculature and the associated ligaments and fasciae. Understanding these components is integral to abdominal wall reconstruction as weakness or defect in one or more of these components results in the ventral hernias. From superficial to deep, the abdominal wall is composed of skin, subcutaneous tissue, muscles and fasciae, extraperitoneal fat, and peritoneum. The subcutaneous tissue is composed of two layers. The superficial, more fatty layer is called the Camper's fascia, and the deeper more fibrous and membranous layer is called the Scarpa's fascia. The abdominal wall is comprised of a pair of strap muscles in the midline called the rectus abdominis which is attached to the xiphoid process and 5th–7th costal cartilages. Inferiorly it is attached to the pubic symphysis and the pubic crest. Laterally the abdominal wall is formed by the external oblique, internal oblique, and transversus abdominis muscles on each side. Fibrous aponeurosis of each of these muscles contributes to formation of the rectus sheath also known as the rectus fascia which is primarily responsible for the integrity of the abdominal wall. External oblique is most superficial of the abdominal wall muscles; its aponeurosis passes anterior to the rectus abdominis muscle and forms the anterior rectus sheath [9]. The internal oblique aponeurosis divides at the lateral edge of the rectus abdominis and passes anterior and posterior to the rectus muscle above the arcuate line forming the anterior and posterior rectus fasciae but passes only anterior to the rectus muscle below the arcuate line. Similarly, the aponeurosis of the transversus abdominis muscle contributes to both anterior and posterior rectus fasciae above the arcuate line but only to anterior rectus fascia below the arcuate line. Therefore, the abdomen is devoid of a posterior rectus sheath below the arcuate line, and rectus muscle lie directly on top of the fascia tranversalis and peritoneum [10]. Fascia transversalis is a thin layer of fibrous tissue that lines the inner surface of the transversus abdominis muscle. Beneath it lies the preperitoneal fat and the peritoneum. The abdominal wall receives its blood supply primarily by the superior and inferior epigastric arteries which run deep to the rectus abdominis muscle and anastomose which each other at the level of the umbilicus. Several perforating branches arise from both these vessels and supply both the superficial and deeper musculocutaneous tissues of the abdominal wall (Fig. 17.1). Laterally, the neurovascular bundle runs transversally between the internal oblique and the transversus abdominis layers of the abdominal wall. Therefore, vertical incisions that transect these nerves result in sensory deficits medial to the level of incision.

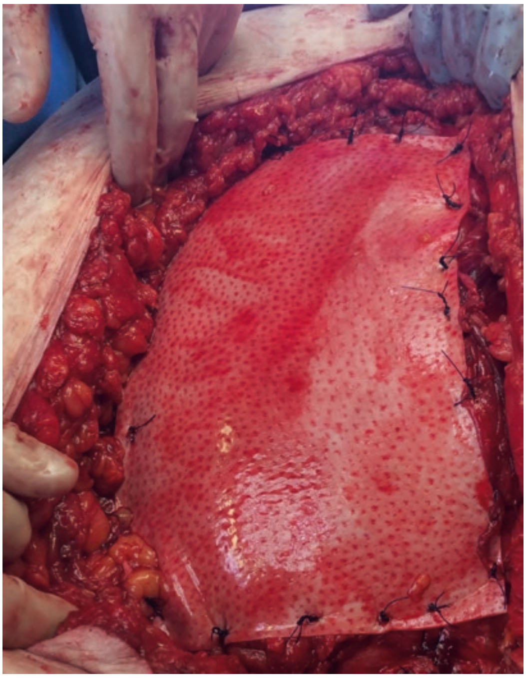

Fig. 17.1 Onlay biologic mesh re-enforcement

Preoperative Consideration and Risk Stratification

When geriatric patients present for elective repair of ventral hernia, it is imperative that a thorough evaluation of the patient with a detailed history and physical examination be performed [11]. In our experience, when these patients present to us for evaluation, it is not infrequent that they have had multiple previous attempts at repair of their ventral hernias. The risk of recurrent hernia increases with each subsequent repair as the abdominal wall strength decreased with each attempted repair. During the physical examination an attempt to should be made to estimate the size of the fascial defect. Often patients will have multiple fascial defects sometimes termed as Swiss cheese fascia which will require more extensive surgery and dissection to bring the fascial edges together without tension and a larger mesh for adequate reinforcement. Overall body habitus is an important factor in determining the risk of future recurrence. Patients with BMI >30 kg/m^2 have significantly higher risk for future recurrence. Similarly, obese patients have a higher risk for perioperative complications during hernia repair and prolonged hospital and ICU length of stay [12]. Due to the safety of bariatric surgery even in the elderly population, some centers will routinely offer preoperative bariatric surgery for patients who meet criteria for bariatric surgery prior to their abdominal wall reconstruction. Once the bariatric surgery has taken place and patients have lost weight, they will undergo a second operation to repair their ventral hernia. This two-staged repair has shown promise in reducing the perioperative morbidity and overall risk of recurrence of hernia [13, 14]. However, these results have not been replicated in the geriatric population, and therefore it is not our routine practice to offer preoperative bariatric surgery to these obese geriatric patients who require abdominal wall reconstruction for ventral hernias. It is imperative to assess the preoperative nutritional status in these geriatric patients using albumin, prealbumin, ferritin, and transferrin levels [15]. In elective patients, preoperative nutritional counseling and intervention can be performed to ameliorate the complications associated with poor nutritional status. While in the acute setting, no interventions can take place in terms of nutritional optimization, however, nutritional evaluation can still provide useful information during counseling patients and their families prior to surgery. Similarly, we routinely counsel our patients who are active smokers to quit smoking for 6 weeks as their risk of perioperative respiratory and wound complications as well as overall risk for recurrence is significantly higher compared to their non-smoking counterparts. In addition to the standard preoperative laboratory workup, we also check HbA1c levels in diabetic patients. Patients with HbA1c >7.0% have significantly higher wound related complications after ventral hernia repair [16].

Special attention should be paid in assessing the presence of preoperative respiratory, cardiac, or hepatic dysfunction. Patients with preexisting respiratory compromise such as those with severe asthma, COPD, or restrictive lung disease who have large ventral are at very high risk for postoperative respiratory failure, ventilator dependence, and need for tracheostomy. When the abdominal domain is restored and the large amount of abdominal viscera are returned back to the abdominal cavity, they have significant increase in intra-abdominal pressure which limits the movement of their diaphragm which combined with their preexisting respiratory dysfunction, and postoperative pain contributes to difficulty weaning them off the ventilator. Patients with preexisting cardiac disease should be evaluated by their cardiologist to determine the need for preoperative stress test, echocardiography, or invasive angiography to determine the safety to undergo general anesthesia. Cirrhosis from chronic alcohol use or hepatitis is one of the major causes of postoperative morbidity and mortality. These patients may look deceptively well prior to surgery; however they remain at extremely high risk for postoperative liver failure which is the major cause of mortality after major abdominal wall reconstruction. The candidacy of such patient to undergo a major abdominal surgery such as abdominal wall reconstruction should be discussed in detail through a combined team approach that should involve the surgeon, hepatologist, anesthesiologist, and the intensivist responsible for postoperative management of these patients. For imaging, CT scan is the most common and useful imaging modality which is used both to diagnose ventral hernias and for planning operative management. It provides reliable information about the number and size of defects and their relation relative to surrounding bony landmarks.

Multiple scoring systems have been developed to predict postoperative morbidity associated with ventral hernia repairs. ACS NSQIP calculator is a useful tool that provides relative risk for different complications and mortality. In our experience, ACS NSQIP calculator is a very useful instrument in the elective patient population but significantly underestimates the relative risk in emergent patient population. The likely explanation is the lack of ability of the NSQIP calculator to take into account hemodynamic parameters when assessing the relative risk of postoperative complications. Frailty plays an important role in determining the postoperative outcomes of geriatric patients as it provides information about the functional age of the patient. At our center, we use the modified frailty index which is an 11-point scoring system that assesses the functional status of the patient [17]. We will use this preoperatively on all of our elective geriatric ventral hernia patients. At this point, the presence of frail status does not directly impact the candidacy of patient to undergo a major abdominal wall reconstruction; however it helps us stratify patients who are at high risk for postoperative complications and helps guide informed decision-making. Joseph et al. have also proposed a frailty index derived from the Rockwood frailty index that is specific for emergency general surgery and may be more applicable to geriatric patients requiring emergency surgery for ventral hernia compared to the modified frailty index [18]. The score is based on 15 variables and uses a cutoff of 0.325 for frail status. The frailty index has been shown to reliably predict postoperative complications and mortality after emergency general surgery procedures.

Principles of Ventral Hernia Repair in the Elderly

The principles that guide the management of ventral hernias in the elderly are primarily the same as those of general population with few additional considerations. The surgical management of these hernias in the elderly has gained recent interest due to the increasing incidence seen in the elderly as well the associated morbidity and mortality when these patients presents with complications associated with hernias, similar to complications seen in inguinal hernia [8]. These patients have a higher risk of strangulation and incarceration and are much more likely to require bowel resection compared to their younger counterparts [19]. This results in higher ICU and hospital lengths of stays and increased associated morbidity and mortality.

All ventral hernias which are strangulated, obstructed, or acutely incarcerated require operative repair regardless of their size. Our practice is to repair these hernias on an urgent or emergent basis during the same hospital admission. When these patients present to us in an acute setting, they are evaluated with routine laboratory workup, and if there is no evidence of peritonitis, imaging with a CT scan of the abdomen and pelvis is performed. Elderly patients who present with acutely symptomatic ventral hernias are immediately resuscitated in the ED or the ICU and undergo operative repair ASAP depending on the acuity of presentation. While the overall management of emergent ventral hernia repairs is much more challenging, the decision-making regarding the need for elective ventral hernia repairs in the elderly population who are not acutely symptomatic is much more challenging for the majority of surgeons. In these patients the decision to perform elective ventral hernia repair depends on the size of the hernia, associated symptoms, quality of life, frailty, obesity, nutritional status, presence of fistulas if any, overall health, and patient preference. If the hernia is truly small and asymptomatic, these hernias can be observed non-operatively with an expected annual risk of complications of around 2.6%. However, it must be kept in mind that over the course of their lifetime, the cumulative risk of complications is much higher. It must also be noted that if hernia-related complications were to occur, the morbidity and mortality associated with an emergent hernia repair are significantly higher than that of elective repair [20]. Therefore, unless truly contraindicated, ventral hernia repairs should be repaired electively whenever possible to avoid life-threatening complications and to provide relief of symptoms. In our practice, we do not use any absolute cutoff of age as a contraindication for elective hernia repair, and only those who have truly prohibitive chances of mortality are not offered the surgery. Several studies have shown that elective ventral hernia repairs can be performed safely even in the elderly morbid population [6].

Open, laparoscopic, and robotic approaches have been utilized in the repair of abdominal wall hernias [21, 22]. However, the tenants that guide these approaches remain the same. The most important is to achieve a tension-free repair of the fascial defect with reinforcement of the native abdominal wall with a suitable mesh with at least an overlap of 3–5 cm in all directions from the fascial edge. The choice of mesh use in these situations can be challenging particularly in patients with contaminated fields, and this will be discussed in detail later on in this chapter. Primary repair of fascial defects alone is rarely, if ever, utilized due to the reported high incidence of recurrence. Primary repair results in fascial closure with very high tension which leads to recurrence rates often greater than 50% recurrence rates. This has been proven in multiple randomized clinical trials comparing primary and mesh repair for ventral hernias [23]. Laparoscopic and robotic repair of ventral hernias with mesh has gained recent popularity, and several studies have shown them to be at least equal or superior to open in terms of pain control and postoperative morbidity [21]. I have topped performing laparoscopic ventral or incisional hernia for the last few years, partly due to poor results and partly due to complex re-operative practice. However, these approaches are frequently not suitable for large complex abdominal wall defects and are much more technically challenging compared to open approach. Robotic repair offers the advantage of allowing technically easier primary fascial closure as opposed to the laparoscopic repair; however, currently there is no evidence to suggest that robotic approach has resulted in superior repair compared to laparoscopic approach at the expense of higher costs [24].

Choice of Mesh

As discussed earlier, nearly all ventral hernias will require placement of mesh due to its proven efficacy in reducing the rate of ventral hernia compared to primary suture repair. The next section will focus on the type of mesh and different placement techniques of these meshes. Broadly speaking meshes can be classified into two categories, i.e., synthetic and biologic mesh. The use of each kind of mesh depends on individual clinical situation as well as surgeon preference. Synthetic mesh has traditionally been used for abdominal wall reconstruction and hernia repairs in clean fields with low risk for infection. These include polypropylene mesh, polyester mesh, and ePTFE mesh. It is needless to say that the risk of infection is significantly higher with the use of synthetic mesh. The other major disadvantage with synthetic mesh is that once they are infected, they will require surgical removal to allow adequate control of infection. This however can be particularly challenging due to the extensive adhesion and scar formation associated with their use and can lead to further complications such as bowel injury and fistulas. Biologic mesh on the other hand is derived from human or animal (porcine, bovine) sources. Biologic meshes are non-immunogenic as they have been stripped off all their cellular components and are primarily composed of acellular matrix. This acellular matrix acts as a scaffold and promotes native tissue to form collagen scar around it, and it is eventually replaced. Biologic mesh like any synthetic mesh can be infected; however the major advantage is that it does not require to be explanted and will therefore avoid the major morbidity associated with infected mesh removal and its complications. All hernias associated with fistulas and stomas are contaminated by default and should preferably be repaired with biologic mesh where its use has become the standard of care [25–27]. The biggest challenge with the use of biologic mesh is its prohibitive high cost. There is no data to suggest that one type of biologic mesh is superior to the other in terms of reducing the risk of recurrence and their use if primarily driven by surgeon preference. We compared the outcomes of human-derived and porcine-derived acellular dermal matrix and found a significantly higher hernia recurrence rate of 22.5% for patients with porcine-derived mesh compared with a 2.9% recurrence rate for patients with human-derived mesh placement with a mean follow-up time of 16 months. However, there was no difference in the rates of infections, reoperations, or mesh explantation between the two groups. Our experience has been mostly limited to Alloderm™ (human-derived) and Strattice™ (porcine-derived) and the difference in the recurrence rates seen in our study may be due to a selection bias. For the last 10 years, we have used exclusively Strattice™, and currently are the evaluation phase of both retrospective and prospective studies [28].

Mesh Placement Technique

Several techniques exist for the placement of mesh during repair of ventral hernias. During ventral hernia repair, the mesh can be placed in four different locations each with its own pros and cons. The mesh can be placed superficial to the fascia (onlay), in the retrorectus space (sublay or extraperitoneal underlay), or in situations where the fascial edges cannot be approximated at all the mesh can be used as a bridge.

Onlay Mesh Placement

In this technique, the mesh is placed above the primary fascial closure to provide reinforcement (Fig. 17.1). The hernia sac is first dissected and freed from the edges of the fascial defect and then either inverted or excised. After that the hernia defect is repaired primarily and the fascia is closed with non-absorbable continuous or interrupted sutures. The mesh is then placed over the anterior rectus sheath and is anchored to it. We prefer fixing the mesh to the fascia using non-absorbable sutures, either interrupted or continuous. We then place and use three to four large, closed-suction drains (19 French) under the subcutaneous tissue until the output has significantly slowed down (<25 cc/24) to avoid any seroma formation. The biggest advantage of the onlay technique is the ease with which it can be performed [29]. This technique often does not involve extensive intraperitoneal manipulation as long as the hernia sac can be free from the fascial edges and therefore avoids intraabdominal adhesion formation. It also prevents contact between the mesh and the underlying abdominal viscera and decreases the likelihood of fistula formation. Despite these advantages, this technique is associated with a high recurrence rate compared to other techniques [30]. This technique is also associated with higher rate of ischemic necrosis of skin flaps due to the creation of large skin flaps in patients with large hernia defects [31]. For these reasons, this technique is used infrequently and we reserve its use in patients in which the creation of retrorectus planes is impossible.

Sublay or Retrorectus Mesh Placement

This is the most widely used technique for abdominal wall reconstruction in our practice (Figs. 17.2, 17.3, and 17.4). Technically it is a more challenging repair compared to the onlay technique. The sublay technique, also known as the extraperitoneal underlay or the retrorectus technique, is a more recently described technique. This technique was first described by Stoppa in 1989 and therefore is also known as Rives-Stoppa technique [32, 33]. In this technique the mesh is placed retromuscularly (behind rectus muscle) and preperitoneally, after closure of the posterior rectus sheath and the peritoneum (Fig. 17.2). This is followed by primary closure of the anterior fascia. When performing this repair, the hernia sac is dissected down to the margins of the fascia. The hernia sac is then opened, and adhesiolysis is performed from ligament of Treitz to rectosigmoid junction. Previously placed synthetic mesh is explanted. After this a plane is created behind the rectus muscle using a combination of blunt dissection and electrocautery starting approximately 1 cm laterally to the linea alba. Dissection should be continued sufficiently cranially up to the level of the xiphoid process. Similarly, dissection is carried down inferiorly as far as possible to allow at least a 5 cm of overlap from the fascial edge of the defect. Once dissected, the posterior rectus sheath and the peritoneum are closed with continuous sutures, and the mesh is placed in the retromuscular space. If synthetic mesh is used, it should be ensured with certainty that no direct contact occurs between the mesh and the bowel to avoid the development of adhesions, erosions, and fistulas [32]. Whenever possible, an overlap of 5 cm is essential in all directions. To fix the mesh, we place multiple u-shaped sutures that are brought out transfascially through multiple

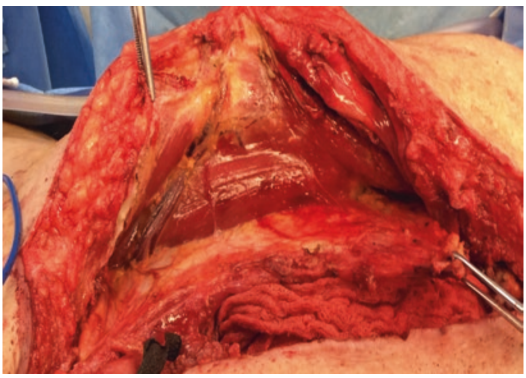

Fig. 17.2 Dissection of posterior rectus sheet

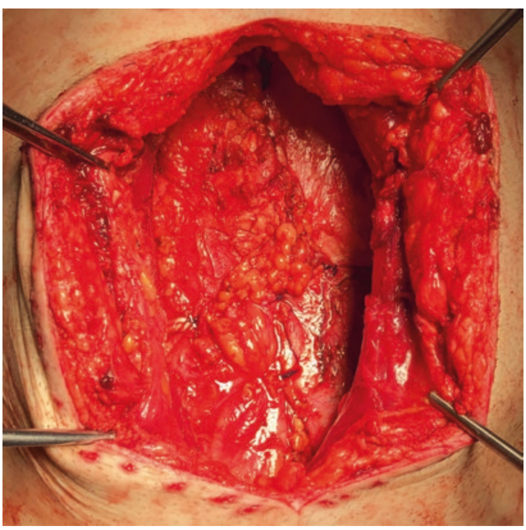

Fig. 17.3 Closed posterior rectus sheet

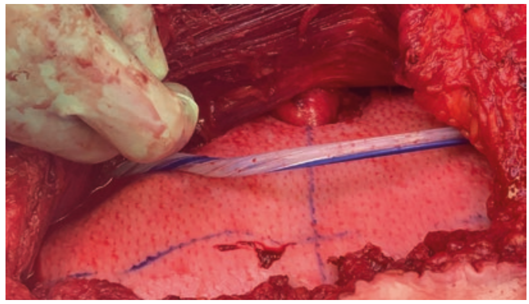

Fig. 17.4 Biologic mesh placed sublay and fashioned around the colostomy

small 5 mm stab incisions in the the skin which are tied down at the end. This step is critical as it must be insured that the mesh lays completely flat on top of the posterior rectus sheath and fascia which is made possible by placing the transfacial sutures as far laterally as possible. Finally, the anterior rectus sheath is closed using continuous slowly absorbable sutures ensuring no undue tension exists. If there is tension while closing the anterior fascia, additional mobilization using anterior component separation should be considered.

The retrorectus technique reduces the amount of soft tissue dissection and protects the mesh from environmental exposure due to native tissue coverage, which reduces the chances of mesh infection following a superficial surgical site infection. There is no direct contact between the mesh and the viscera which reduces adhesion formation. This technique is also associated with lower seroma formation rates due to the lack of need for large subcutaneous flap formation. Since the mesh is not placed in the subcutaneous plane, this reduces the likelihood of seroma formation [26]. Some recent studies have also demonstrated that sublay placement of mesh is associated with lower odds of recurrence and surgical site infection compared with onlay and underlay [31].

Intraperitoneal Underlay

The intraperitoneal underlay technique was first described in 1981 by McCarthy et al. [34]. When this technique was introduced, polypropylene mesh was used intraperitoneally; however, the intraperitoneal use of polypropylene mesh caused adhesions to the bowel and was, therefore, abandoned. This was then replaced by the use of a laminar polytetrafluoroethylene (ePTFE) mesh or bilayer composite prosthesis (PTFE and polypropylene) in order to avoid adhesions with the underlying bowel [35]. This technique can also be performed laparoscopically with the same principles of repair. The key component of this technique is to free up the internal aspect of the abdominal wall along its entirety. The mesh is placed intraperitoneally and secured into position with multiple transfacial or tacking sutures sufficiently close to one another in order to prevent the intra-abdominal contents from sliding and herniating between the mesh and the abdominal wall. The advantage of the underlay mesh is that the mesh is placed under abdominal wall and the intra-abdominal pressure presses the mesh against the wall which helps with incorporation. In contrast, with an onlay mesh placement, increase in intra-abdominal pressure forces the mesh away from the defect [36]. It also minimizes the risk of bowel injury during placement because of direct visualization of the intraperitoneal contents. However, it increases the risk of adhesions to the underlying bowel particularly if materials such as polypropylene are used. Studies that have compared the outcomes between onlay and underlay mesh placement and found underlay mesh placement had a lower risk for recurrence [0.59 (0.069–1.504)] and surgical site infection (SSI) [0.878 (0.291–1.985)] compared to onlay [31].

Bridge Mesh Placement

This is the least desired form of repair and is used when primary fascial closure cannot be achieved despite other attempts at mobilizing the components of abdominal wall [37, 38]. When the fascial defect cannot be approximated, an interposition mesh is placed to bridge the fascial defect. The mesh is sutured to the fascial edges and this type of abdominal closure is associated with high recurrence rates [38]. This may also be used where component separation cannot be performed due to prior surgeries or any other reason. In our experience, we prefer the use of biologic mesh. When inlay repair has been performed to bridge the fascia, all attempts should be made to cover the mesh with native skin and subcutaneous tissue. If no tissue coverage is possible, then a wound vacuum-assisted closure (VAC) may be employed to promote granulation that can later be used as the bed to perform skin graft for final closure [4, 11].

Summary

Complex abdominal wall reconstruction in elderly is possible and should be done in a timely fashion, when the presence of incisional hernia or complex abdominal wall defect is diagnosed. These hernias have significant risk of strangulation and require emergency surgery, and unless there are prohibitive risks of death, or when patient is deemed unable to survive the procedure, it should be offered to the patient.

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18 Bariatric Surgery in the Elderly

Vasu Chirumamilla, Miles Dale, Sarvesh Kaul, and Ashutosh Kaul

Obesity is a growing global epidemic characterized by the excessive accumulation and storage of fat in the body. Excess fat leads to severe health consequences, including both a significant increase and earlier onset of obesity-associated comorbidities and a decrease in both length and quality of life [1, 2].

Morbid obesity is an independent risk factor for cardiovascular disorders, including coronary artery disease, congestive heart failure, hypertension, and atherosclerosis. Obesity is also a major cause of metabolic syndrome, especially type 2 diabetes mellitus. From an epidemiological perspective, almost 90% of type 2 diabetes cases can be prevented by avoiding obesity [2]. The probability of acquiring musculoskeletal disorders including osteoarthritis, mobility problems, musculoskeletal pains, and gout are all increased in the morbidly obese. Moreover, obstructive sleep apnea and other respiratory conditions are also a common problem. Obesity is also associated with an increased risk of several types of cancer (i.e., breast, colon, gallbladder, pancreas, renal, bladder, uterine, cervical, and prostate cancers). Obese subjects have an approximately 1.5–3.5-fold increased risk of developing these cancers compared with normal-weight subjects. It has been estimated that between 15% and 45% of these cancers can be attributed to being overweight (BMI 25.0–29.9 kg/m^2) and obese (30–40 kg/m^2) in Europe [3]. The World Health Organization states that obesity is the most important known avoidable cause of cancer after tobacco. Obesity can also have harmful psychosocial effects, notably a perception that thin and underweight people are hardworking and attractive while obese people are lazy. This can lead to unfair treatment, lower wages, and depression among the overweight and obese. Overall, obesity significantly lowers both quality and length of life.

Body mass index, or BMI, is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. BMI is calculated by dividing a person's weight in kilograms by the square of height in meters. BMI levels are used to classify obesity as follows: <18.5 kg/m^{2,} underweight; between 18.5 and <25 kg/m^2, normal; 25 to <30 kg/m^2, overweight; between 30 and 40 kg/m^2, obese; and >40 kg/m^2, severely obese. Presently about 64.5% of the US population is overweight (BMI >25 kg/m^2), 30.5% of

V. Chirumamilla · M. Dale · A. Kaul (✉)
Department of Surgery,
Westchester Medical Center, Valhalla, NY, USA

S. Kaul
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

Colgate University, Hamilton, NY, USA

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the US population is obese BMI >30 kg/m^2), and 4.7% of the Americans are characterized as severely obese (BMI >40 kg/m^2) [4, 5]. The prevalence of obesity tends to increase with age and peaks in the 45–64 year range [5].

Most developed countries characterize a person as elderly when their chronological age is equal to or greater than 65 years. The United Nations, however, characterizes persons that are 60 years and above as elderly, while in the African population, a person that is 55 years or older is considered elderly [6].

The incidence of weight-related comorbidities continues to increase in the elderly population [5]. Obesity decreases the quality of life and diminishes the life expectancy of patients [2, 7]. Life expectancy in the USA dropped in 2016 and 2017, partly due to the continued obesity epidemic [8]. An increase in obesity contributed to about 186,000 additional deaths in 2011 alone [8].

Obesity is not solely a middle-age disease; geriatric obesity rates are also at an all-time high. 35% of people older than 60 are obese [9]. Aging is associated with a decrease in total energy expenditure, which leads to fat mass reaching maximum levels at 60–70 years of age [10]. Diabetes, metabolic syndrome, hypertension, arthritis, cardiovascular disease, and urinary incontinence are associated with obesity in advancing age. Obesity is a risk factor for chronic diseases and premature mortality, but the extent of these associations among the elderly is under debate [11]. In a pooled meta-analysis, it was found that the mortality rate was highest among malnourished subjects; it then decreased with increasing BMI but rose again in BMI over 30 kg/m^2 [11] . The lowest mortality is correlated with an average BMI of between 23.5 and 27.5 kg/m^2, [11]. A strong correlation between waist circumference and mortality risk in the elderly was confirmed in multiple studies [11]. Moderately high BMI was also found to be a protective factor against acute events that occur frequently in geriatric age groups [11, 12].

Obesity Treatment Options

In the morbidly obese, conservative measures, including diet, exercise, and medical treatments, usually fail to produce an effective sustained weight loss. On an average these measures only lead to a 2–3% weight loss [1]. Bariatric surgery has been shown to be superior to current medical therapies with regard to the induction and maintenance of weight loss and improvement in weight-associated comorbidities in the morbidly obese [13]. Bariatric surgery is the only consistent method for morbidly obese patients to lose weight in the long term according to the National Institutes of Health Consensus Development Conference in 1991 [14].

Elderly patients are a unique population with more comorbidities than their younger counterparts; surgery in these patients is often associated with negative outcomes. Over 70% of people over 65 years have associated comorbidities such as diabetes, hypertension, or hyperlipidemia [15]. As the population of the elderly grows and surgical techniques improve, the previous age restrictions of surgical procedures have become less defined. Bariatric surgery in elderly patients can greatly improve their health, but its repercussions need to be carefully considered [16]. A surgeon's decision process in the expanding requirement of surgical procedures for the elderly has to overcome the boundary of limitation based on age [17]. Therefore, selecting the right surgical candidate remains an integral part of the decision-making process in surgery, and age should no longer be the main component of the process.

Bariatric procedures in the elderly are not unique to the negative bias against geriatric surgery. Historically, bariatric surgical treatment of obesity in the elderly has been controversial based on past studies reporting increased surgical risk and a lack of data demonstrating bariatric surgery's long-term benefit. Several studies revealed better comorbidity, mortality, and weight loss outcomes in younger bariatric surgery patients compared to older subjects [8, 18]. Factors leading to decreased weight loss in elderly patients include sedentary lifestyle, sarcopenia, a higher calorie intake, poor fitness, chronic inflammation, hormonal changes, age-related decreased energy requirements, and lower lipolytic capacity, especially after sympathetic stimulation [19].

Several surgeons have explored utilizing bariatric surgery in the elderly population. The National Institutes of Health in 2006 and the French National Authority for Health in 2009 recognized the possibility of using bariatric surgery in patients older than 60. Despite its benefits, bariatric surgery is not performed at the same rate in the elderly compared to younger patients. As of 2015, only 10% of bariatric surgery is performed in patients >60 years of age [20], despite the fact that over 35% of this population was obese [9]. NSQIP data show that the proportion of bariatric procedures in patients >65 years of age significantly increased from 1.9% in 2005 to 4.8% in 2009 [21]. Irrespective of this progress, a hesitation regarding performing bariatric surgery in the elderly still exists.

Bariatric Surgery in the Elderly

Between 1987 and 2030, the total US population is projected to increase by 26% from 252 to 317 million, while the population of people 65 and older is expected to increase by more than 100%, from the present 12% of the total population to nearly 21% of the total population (67 million) [22]. Old age is not immune to obesity [23]. In the USA, the prevalence of obesity in the elderly ranges from 42.5% in women aged 60–69 years to 19.5% in those aged 80 years or older. The prevalence of obesity is 38.1% in men aged 60–69 years and 9.6% for those men aged 80 years or older [11]. The increase in BMI over the period of 1988–2011 is estimated to have reduced life expectancy at age 40 by 0.9 years in 2011 (95% confidence interval 0.7–1.1 years); it is also expected to have accounted for 186,000 excess deaths that year. Older age (>60) had been considered a relative contraindication for bariatric surgery due to increased complication risk until recently, but multiple studies have studied the outcomes of bariatric surgery in aged patients. Bariatric surgery in the elderly is not as efficient as in younger patients, but it is still superior to conservative medical treatment considering the resolution rates of comorbidities. In some initial reports, including those by Flum et al. and Livingston et al., an increased risk of complications and deaths were seen in patients over 65 years [24, 25]. In these studies, many patients had an open surgical or a laparoscopic procedure performed at the beginning of the RYGB learning curve, the procedures were performed 10–15 years ago, and the patients were probably frail (under the Medicaid scheme) [1]. Recent studies have highlighted the safety of bariatric surgery in this age demographic [1], and several case-control studies have shown mortality is equivalent across age groups when adjusted for other variables [9]. Qin et al. retrospectively reviewed the ACS-NSQIP registry procedures from 2005 to 2012 and found that advanced age was significantly associated with increased overall medical complications, but not surgical complications in laparoscopic sleeve gastrectomy. Their findings suggested that the risk conferred by advancing age in laparoscopic sleeve gastrectomy is predominantly for medical morbidity. Thus, they advocated for improved perioperative management of medical complications. They felt that laparoscopic sleeve gastrectomy may be the preferable option to RYGB for elderly patients, as neither procedure is riskier with regard to 30-day morbidity, while LSG has been shown to be safer with regard to long-term reoperation and readmission risk [9].

In a cohort study of 9,044 bariatric surgical procedures, there were no deaths among the 451 older group patients, while two deaths occurred in the younger group [26]. However, older patients lost less excess weight than younger patients (72.44% versus 86.11%, respectively). Additionally, older patients presented higher rates of complications (8.42% versus 5.59%), comorbidities (77.60% versus 55.45%), and revisions (1.33% versus 0.77%). There was no statistical difference in hospital stay between the older group and control group (2.27 versus 2.23, respectively). When performing a Clavien-Dindo classification of complications, the review demonstrated significant differences in class 3B and 4A and no differences in other classes. Diabetes, fatty liver, and sleep apnea improved or remitted in >90% of patients in both groups, while hypertension and hyperlipidemia improved by >80%. Hyperuricemia and ischemic heart disease were improved or resolved in >70% of the patients [26].

In a review of patients above the age of 60 years in Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program database, laparoscopic sleeve gastrectomy was compared Roux-en-Y gastric bypass in 3371 patients [27]. They discovered that LRYGB and LSG procedures in patients aged 60 years or older are relatively safe in the short term with an acceptable complication rate and low mortality. However, LRYGB was more challenging and was associated with significantly increased rates of leakage events (1.01% versus 0.47%, $p = 0.011$), 30-day reoperation (2.49% versus 0.89%, $p < 0.001$), 30-day readmission rate (6.08% versus 3.74%, $p < 0.001$), longer operative times (122 versus 84 min., $P < 0.001$), and a longer hospital stay [27].

When data were analyzed from the NSQIP database between 2010 and 2011 of patients over the age of 65 years, 1005 patients were found to have undergone SG and RYGB. Diabetes was more frequent in the RYGB group (43.2% versus 55.6%, $P = .004$) but the 30-day post-op mortality (0.6% versus 0.6%, OR 1.1, 95% CI .11–9.49), serious morbidity (5.2% versus 5.6%, OR .91, 95% CI .42–0.96) and overall morbidity (9% versus 9.1%, OR 1.0, 95% CI .55–1.81) were similar. In elderly patients undergoing laparoscopic bariatric surgery, they found that SG was not found to be associated with significantly different 30-day outcomes compared to RYGB. Both procedures were followed by acceptably low morbidity and mortality [21]. Improvement of intraoperative surgical management and optimization of perioperative care have decreased the complication rate [1].

With increased experience, the operative times for BS have decreased, and they compare favorably to operative times seen in elderly patients undergoing cardiac, orthopedic, or oncologic surgical procedures [28]. As life expectancy continues to increase on average, it is imperative to redefine previously held age restrictions on procedures that have been shown to improve people's health [7, 18].

The main goals of bariatric surgery include facilitating weight loss, alleviating or reversing comorbidities, and improving both the quality and length of life. The drive to push the envelope with bariatric surgery for the elderly is not aimed only for losing weight but also at reducing the use of medications for their comorbidities. The percentage of weight loss after BS is usually less in the elderly compared to younger patients. In a study comparing different procedures, weight loss (% of initial weight) was lower after a LAGB than after RYGB or SG. After LAGB, weight loss (%) did not differ between patients above 60 years and those aged <40 (difference 1.7 ± 1.5%, $P = .26$). Weight loss (%) was lower in patients aged >60 years when compared to those <40 years after both RYGB (−5.6 ± 1.7%, $P = .001$) and SG (−7.0 ± 2.6%, $P = .01$) [1].

Despite losing less weight compared to younger patients, significant comorbidity alleviation can still be achieved, as only a 5–10% decrease in weight helps in improving obesity-related comorbidities [1]. This beneficial impact on comorbidities elimination can be seen with a reduction in medication requirement and a decrease in overall medical care expenditure [1].

Which Bariatric Procedure to Choose

There is no standard protocol of preoperative evaluation for bariatric surgery in the elderly [29]. The standard general assessment may be insufficient for a population with specific needs and concerns, like that of older individuals [29]. Batsis and Dolkart proposed an individualized approach to older candidates and bariatric surgery that encompasses and contemplates factors that are not as prominent in younger individuals. These authors propose that older candidates should be evaluated by an extended multidisciplinary team that would include a geriatrician and a social worker. This proposed preoperative assessment must incorporate five specific topics for this population: (1) evaluation of functional status; (2) assessment of frailty; (3) cognitive assessment; (4) identification of depression; and (5) social support and discharge planning [30]. Their proposal is based on the fact that worse surgical outcomes are mostly related to impaired functional status, presence of frailty, delirium that occurs in previously cognitive impaired individuals, presence of depression, and other psychiatric conditions that may be underestimated prior to surgery, as well as the unavailability of caretakers and ideal housing conditions for these individuals after surgery [29]. The evolution of surgical techniques, especially the development of minimally invasive approaches, constitutes an important factor in the improvement of surgical outcomes over time, along with cautious and careful patient selection and preoperative assessment [29].

The four most common bariatric surgery procedures being done in the USA presently are sleeve gastrectomy, RYBG, AGB, and DS. Generally, the mortality and the 1-year excess weight loss after surgery progresses as follows (from the least to the most): LAGB< LSG< RYGB< DS (i.e., both perioperative mortality and weight loss after 1 year are least with LAGB and most with DS).

The number of BS done in the elderly has shown an increase from about 1.9% in 2005 to 4.8% in 2009 [31]. Between 2008 and 2012, the use of laparoscopic sleeve gastrectomy increased from 0.9% to 36.3%, while the use of laparoscopic adjustable gastric banding (LAGB) and RYGB both decreased from 23.8% to 4.1% and 66.8% to 56.4%, respectively [21, 32]. In the last few years, the number of SG has continued to increase, and multiple reviews have shown that both LSG and LRYGB can be safely performed in elderly both with low morbidity and mortality.

A MBSAQIP database analysis [26] of perioperative outcomes comparing laparoscopic sleeve gastrectomy with LRYGB in patients aged 60 years or older demonstrated that laparoscopic Roux-en-Y gastric bypass and laparoscopic sleeve gastrectomy are relatively safe in the short term, with an acceptable complication rate and low mortality. However, LRYGB was associated with significantly increased rates of leakage events, 30-day reoperation, 30-day readmission, longer operative time, and longer hospital stay, as compared to LSG. LRYGBP showed a trend toward higher perioperative mortality than LSG. In the short term, sleeve gastrectomy was associated with significantly fewer 30-day complications than gastric bypass [26].

Another study compared LSG with LRYGB and discovered that both procedures are followed by acceptably low morbidity and mortality [21]. While diabetes was more frequent in the RYGB group (43.2% versus 55.6%, P = .004), the 30-day mortality (0.6% versus 0.6%, OR 1.1, 95% CI .11–9.49), while serious morbidity (5.2% versus 5.6%, OR .91, 95% CI .42–0.96), and overall morbidity (9% versus 9.1%, OR 1.0, 95% CI .55–1.81) were similar. The authors concluded that in elderly patients undergoing laparoscopic bariatric surgery, SG was not associated with significantly different 30-day outcomes compared to RYGB. Both procedures are followed by acceptably low morbidity and mortality [21].

Results of Bariatric Surgery in the Elderly

Older patients may have more comorbidities but demonstrate an insignificant increase in mortality in relation to having bariatric surgery [7]. A meta-analysis concluded that mortality has ranged from 0.5% to 2.0% (30 days) and 2.8% (90 days) for gastric bypass patients [23]. When the age group was increased to a range of 65–90 years old, the mortality increased to 3.2% [24]. Laparoscopic Roux-en-Y gastric bypass can be done to achieve weight loss in the elderly population [5]. The same operations were offered regardless of age (LGB, LGS, and LRYGB – two converted to open). The elderly have more awareness of the negative consequences of their comorbidities and thus are more motivated for lifestyle changes that will facilitate a better quality of life [6]. Older age or Medicare status should not be part of the decision-making process for bariatric surgery [6]. In a study of 43,378 patients, of which 1994 were >65 years old, there was no difference in the complications after bariatric surgery, but the length of stay was longer in older patients than their younger counterparts [31, 33]. Another study of 1339 patients over 60 years old undergoing BS also supported the view of Dorman et al. [31, 33].

Insurance Coverage of Bariatric Surgery

Insurance companies have recognized the cost-benefit of bariatric surgery and approve BS for patients meeting their criteria. Analysis of outcomes of BS show a strong return of investment up to 5 years after surgery and find that cost savings start accruing by the third postoperative month [34, 35]. The short-term return on investment associated with bariatric surgery is consistent with a decrease in multiple comorbid conditions, including diabetes, coronary artery disease, hypertension, and sleep apnea [34]. The cost reductions in these diseases take into account prescription drug usage, hospital stays, and physician visits. Type II diabetes is greatly improved by bariatric surgery, and the estimated annual costs of managing a diabetes patient (US$13,243) are five times more than a patient without diabetes (US$2560) [36].

The majority of the geriatric population in USA has some form of Medicare or Medicaid coverage. After a review, Medicare authorized approval of bariatric surgery for older patients in 2006 [33]. However, the reimbursement amount was found to be inadequate in a study, and the low reimbursement amount was felt to lead to unequal access to care [14] by threatening the ability of patients to find a bariatric surgeon willing to perform surgery on Medicare patients. Combinations of the increased comorbidities of obesity accelerate senescence and increase the cost of acute and chronic rehabilitation and palliative care in the elderly [11].

Future of Bariatric Surgery in Elderly

At the moment, there is not a proven successful lifestyle change or medical therapy which leads to sustained weight loss to result in a decrease of comorbidities. Improving quality of life is an important goal of any treatment especially as people age. Obesity has been shown to negatively affect quality of life, and bariatric surgery can offer the obese elderly population improvement not only in their health and activities of daily living, thereby enhancing the quality of life. Continued research on bariatric surgery in the elderly is necessary to increase the strength of this recommendation.

The upper age limit for recommending bariatric surgery in the elderly is yet to be clearly established. Most programs stratify the patient's risk and expected benefits of bariatric surgery based on preoperative assessment and then make a decision on the suitability of surgical intervention. A geriatrician can assist in the surgical decision-making process by performing a comprehensive preoperative assessment including a detailed patient's history, comorbidities, and cardiopulmonary evaluation. It is also important to evaluate the level of recovery support required postoperatively. An ideal bariatric surgical preoperative approach would thus involve a multidisciplinary team consisting of a geriatrician, cardiologist, pulmonologist, psychiatrist, nutritionist, and social worker. This approach would help evaluate a patient's functional status, frailty index, social support, and cognitive state, and rule out psychological disorders.

Conclusion

BS provides an effective and long-lasting treatment option for morbidly obese elderly patients with significant improvement in weight- and obesity-related comorbidities. Bariatric surgery is safe in the elderly, with slightly increased risks when compared to younger populations. The decision on the type of the procedure to be recommended depends on the individual needs, the experience of the surgical team, and the health profile of the patient.

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Vascular Surgery in the Elderly

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Sateesh C. Babu, Aditya Safaya, Romeo Mateo, and Igor Laskowski

People have always fantasized about youth, health, fitness, and beauty that is everlasting and are frightened at the prospects of getting old and frail. The most extreme example of this is the Chinese Emperor Quin who ordered his personal physician to invent the "elixir of life" that would make him immortal. It was not until the late 1960s and 1970s did physicians and surgeons realize that there is more to the aging patient than graying of hair and wrinkling of the skin. Vascular disease is the disease of the elderly; hence, most patients fall into the category of geriatric population. The physiology of aging, significance of frailty, and its impact on treatment and outcome are dealt with in other chapters of this book. Hence this section will describe the most frequently encountered vascular conditions in the elderly and will outline current guidelines for management. These include the diseases involving the aorta, peripheral arterial disease (PAD), extracranial cerebrovascular disease, visceral artery disease, venous thromboembolic disease, amputations, and a brief review and update on dialysis access. Vascular surgeons in reality are vascular disease specialists. Thus all aspects of diagnosis and treatment – surgical, interventional, and nonsurgical options of management – will be described.

S. C. Babu (✉) · A. Safaya · R. Mateo · I. Laskowski
Section of Vascular Surgery, Department of Surgery, Westchester Medical Center, Valhalla, NY, USA
e-mail: Sateesh.babu@wmchealth.org

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Vascular disease management is complex. It is rendered even more difficult by its prevalence in the aged and presence of multiple coexisting other system disease processes. In order to achieve a successful outcome, the care has to be comprehensive involving multi-team approach. The old system of a "single physician" delivering total care of a patient is not feasible in this special cohort of patients. The team caring for the elderly patient with vascular disease should, in addition to vascular surgeon, include cardiologist, infectious disease specialist, podiatrist, endocrinologist, nutritionist, physiatrist, and orthotic specialist. Other specialists from hematology, plastic surgery, and neurology may also be called upon to render their expertise as needed.

Scope of the Problem

Age-related physiological changes combined with frailty make addressing management strategies in the elderly a unique problem. This is further compounded by factors like sedentary activity, subclinical depression, polypharmacy, and changes in cognitive function.

Frailty is fairly common in elderly vascular patients, though not all elderly are frail. As described in previous chapters, frailty is a condition characterized by loss of biological reserves across multiple organ systems together with failure of homeostatic mechanisms and vulnerability to physiological decompensation after minor stressor events. In other words, even though normal aging is characterized by normal physiological decline, with frailty this decline appears to be accelerated [1]. Frailty is seen in 10% of the patients 65 years old or older, and the incidence increases to 25% in patients aging 85 and older. The incidence of arterial diseases increases with age, owing to age-related changes in the vascular bed. PAD is uncommon before the age of 50 years. The incidence rates rise sharply around 20% after the age of 80 years [2].

Diseases Involving the Aorta

Aneurysms and Aortic Dissections

Aortic pathologies in the elderly usually present as acute, chronic, or acute on chronic conditions. Aortic dissections, aneurismal diseases, and occlusive diseases form the majority of the pathology. The newly defined category of acute aortic syndrome includes (a) acute aortic dissection, (b) penetrating aortic ulcer, (c) intra-mural hematoma, and (d) symptomatic thoracic aortic aneurysms. Acute aortic syndrome should be considered in differential diagnosis especially in an elderly patient presenting with signs of chest pain, hypotension, or neurological manifestations mainly syncope [3].

In contrast to aortic diseases in younger population where etiology would include connective tissue disorders such as Marfan's syndrome and/or Ehlers-Danlos syndrome, atherosclerosis is the most common etiology for aortic diseases in the elderly.

Aortic Dissection

In the elderly, symptoms of syncope, heart failure, and stroke are more common presenting features of acute aortic dissection than mere chest pain [3]. Stanford University classification of aortic dissection to type A and type B is based on the site of intimal tear, type A those involving the ascending aorta and type B those not involving the ascending aorta.

Acute aortic dissection is the most common catastrophe of human aorta with mortalities of 2% per hour if undiagnosed and untreated which is even higher in octogenarians [4]. Medical management is the standard for type B aortic dissection with the goal of keeping blood pressure normal and reduction of the force of pulse. Indications for surgical treatment are persistent pain despite medical management, presence of pseudoaneurysm, rupture or impending rupture, hemothorax, and visceral malperfusion. However, endovascular treatment has now become the treatment of choice in these situations. **T**horacic **e**ndo-**v**ascular **a**ortic **r**epair (TEVAR) is minimally invasive, effective, and superior to surgery in terms of in-hospital mortality, incidence of paraplegia, and long-term survival [5]. On the other hand, standard of care for type A dissection is still open surgery. This consists of replacement of ascending aorta with or without replacement of aortic valve and replantation of coronary arteries. Replacement of the entire aortic arch and reconstruction of great vessels may be required in those cases where the disease process involves the arch. Versatile stent grafts and sophisticated delivery systems are being developed to offer endovascular modality even for type A dissections. This will have significant impact on the ability to offer treatment for even the very elderly and frail in whom open surgery may be attendant with prohibitive risk [6, 7].

Aortic Aneurysms

Aneurysms are generally a disease of the elderly with incidence of 5% in people 65 years and 12.5% in men above 75 years of age [3]. The risk of rupture is directly associated with the size of the aneurysm.

The current guidelines recommend treatment at size of 5.5 cm in males and 5 cm in female patients. Aneurysms 4 cm or less can be followed annually, and sizes from 4 to 5.5 cm are to be followed every 6 months. In addition to these general indications, all symptomatic aneurysms and aneurysms with rapid growth (>1 cm/year) are indication for treatment [8].

The US Preventive Services Task Force favors screening for abdominal aortic aneurysms (AAA) in all men aged 65 and above with history of smoking, family history of aneurysms, or other coexisting risk factors like coronary artery disease (CAD), hyperlipidemia (HLD), hypertension (HTN), and obesity [9]. Ultrasonography is a simple noninvasive test with high sensitivity and specificity for detecting and following AAA. CT angiogram (CTA) is considered for planning treatment.

In 2000 the FDA approved the use of endovascular devices for the management of abdominal aortic aneurysms. It is now the current standard of care for this disease. Around 80% or more of patients with abdominal aneurysms are treated with this minimally invasive technique – **e**ndo**v**ascular **a**neurysm **r**epair (EVAR) [10]. The overall mortality of EVAR is 1.6%. This clearly has enabled high-risk elderly patients, who otherwise would have been denied treatment, get repaired. The incidence of late complications related to EVAR is around 8–10% [11]. Endoleak is the term used to describe entry of blood into the aneurysm sac after EVAR. This can be from some of the branches like lumbar, inferior mesenteric, or middle sacral artery. When not associated with enlarging sac, these type II endoleaks do not require intervention. When the leak into the sac is from inadequate seal zones (type I) or separation of graft limbs (type III), these require treatment. Graft migration and occlusion of one or the other limbs of stent graft are some of the delayed complications, which require prompt recognition and intervention. All patients who are treated with EVAR have to be followed lifelong to identify adverse events. Aortic duplex scan is noninvasive, safe, and repeatable making it the main imaging test of choice to follow patients after EVAR, generally at 6-month intervals. CTA is done if the duplex indicates increase in size of the sac or other findings indicating problems.

Aorto-iliac Occlusive Disease

Aorto-iliac occlusive disease due to atherosclerosis presents with symptoms of calf, thigh, or gluteal claudication and/or erectile dysfunction in men. Stenotic and sometimes even occlusive aorto-iliac segment lends itself to interventions like angioplasty and stenting with excellent results approaching the results of surgical procedures like aortofemoral bypass which had been the gold standard for treating aorto-iliac occlusive disease, before the era of interventions. In fact, open procedures for aorto-iliac diseases are now uncommon. Even in patients who are not amenable to endovascular approaches, extra-anatomic bypass (axillo-femoral or femoro-femoral bypass) is the preferred procedure in the elderly and frail owing to less systemic implications. Extra-anatomic bypass procedures may not have the same long-term patency of direct aortic reconstructions, but have the advantage of being less invasive and less stress on the elderly patient's cardiovascular hemodynamics [12].

Peripheral Vascular Disease

Incidence of chronic occlusive diseases of lower extremity arteries, commonly referred to as PAD (peripheral arterial disease), increases with age affecting nearly 25% of patients 80 years and above [3]. High incidence of chronic coexisting illnesses like diabetes, chronic kidney disease, chronic obstructive pulmonary diseases, coronary artery disease, etc. in this age group renders management of PAD an onerous task.

Intermittent claudication which is the classic presentation of PAD is often not the primary presenting symptom in elderly patients. Diseases such as hip and knee arthritis, degenerative diseases of the spine, frailty, COPD, and CAD compromise the functional status of the patient making them sedentary. Hence it is not uncommon for this group of patients to present with **c**hronic **l**imb-**t**hreatening **i**schemia (CLTI) – rest pain, non-healing ulcer, and/or gangrene as the initial presentation. Thus, medical management that focuses on lifestyle modifications, pharmacological agents, and exercise therapy which is the initial line of treatment for most patients with intermittent claudication may play little or no role in this group. Surgical or endovascular interventions may be the first line of treatment for these patients.

Historically open direct surgical reconstructions are known to have better long-term patency. Intuitively lesser invasive endovascular procedures may seem more suitable for this cohort of patient owing to less operative stress. Due to dearth of conclusive evidence regarding which approach is better, this particular field of research has become of important interest for a number of nationally and internationally funded studies [3].

Owing to all the factors mentioned above, these patients with CLTI have long hospital stays, frequent readmissions, and discharge to facilities other than their own home. Treatment should not only be directed to patients' physical illness, but their social, economic, and emotional components may also need to be addressed.

As mentioned in the beginning, an interdisciplinary team approach is vital for managing these patients with the goal of patient-centered care.

Use of alternative vascular conduits such as cadaveric vein grafts and prosthetic grafts may help in early management of symptoms in a subset of patients where achieving long-term patency with traditional autologous vein grafts may not be feasible or may add to increased morbidity.

This thought process or the new mind-set aims at achieving short-term goals leading to early return of patients to basal functional status. This is a departure from the traditional practice of focusing on long-term graft patency which in the elderly and frail comes at the cost of increased perioperative morbidity, long hospital stays, and failure to return home.

Advances in technology have made it possible for more distal revascularization procedures such as tibial and pedal artery interventions and reconstruction. This has expanded the scope of limb salvage in recent years.

Acute Limb Ischemia

Acute extremity ischemia in the elderly has the same etiology as in general population, the cause being embolism, thrombosis, and trauma. Embolus may originate from the heart (cardio-arterial) or from proximal arterial segment (arterio-arterial embolization). Patients who present with ischemic toes and palpable pedal pulses (blue toe syndrome, trash foot) should be worked up for the source of arterio-arterial embolization. Popliteal aneurysms and less commonly iliac and aortic aneurysms may be the cause. Severely atherosclerotic and ulcerated plaques in either thoracic or abdominal aorta (shaggy aorta) also can cause this syndrome. Acute aortic dissection can manifest with extremity ischemia, which should be considered in differential diagnosis of acute limb ischemia.

Recently, there is increased occurrence of acute limb ischemia caused by low-flow state. Patients who suffer cardiogenic shock are now being resuscitated and maintained on mechanical circulatory assist devices like left ventricular assist device (LVAD), intra-aortic balloon pump (IABP), and extracorporeal membrane oxygenator (ECMO). These critically ill patients are maintained on vasopressors and other vasoactive agents to maintain blood pressure. The combination of shock, vasopressors, and placement of large caliber cannulas in femoral and/or axillary arteries can cause limb ischemia. This "low-flow" state-induced limb ischemia has poor prognosis for salvage of limb and life [13]. Attempts should be made to treat the primary condition that caused circulatory collapse. Frequent discussions between multiple specialists – cardiology, cardiothoracic surgery, critical care specialist, and vascular surgery – are essential in managing this new brand of super ill patients.

Amputation

The incidence of lower extremity amputations is increasing owing to several factors – increasing aging population, increase incidence of vascular diseases in the elderly, and associated comorbidities like diabetes and kidney diseases. Significant innovations in open surgical and endovascular limb salvage techniques have reduced the amputation rates in the United States by 25% as per recent data. Despite this improvement, there is still need for amputations particularly in the elderly [14].

Indications for primary amputations are life-threatening infections, gangrene involving the foot or a part of the leg, and non-reconstructible pattern of vascular disease in patients with CLTI.

Failure of surgical or endovascular revascularization procedures is the more frequent etiology of amputations in elderly patients with CLTI. These secondary amputations are generally done at a higher anatomic level, thus diminishing the potential for rehabilitation. In select patients, decision to amputation is not reflection of failure of treatment but a primary palliative procedure.

Cerebrovascular Disease

The risk of stroke and transient ischemic attacks (TIA) increases exponentially with age [15]. The burden of extracranial cerebrovascular disease (CVD) in the elderly is quite established. Carotid artery disease is the most common cause for ischemic strokes. Elderly patient should be screened for presence of extracranial vascular disease, particularly when they have other risk factors like hypertension, diabetes, smoking history, and heart disease.

Screening as well as follow-up of carotid artery diseases is simple and convenient by means of ultrasound duplex scan. The Intersocietal Commission for Accreditation of Vascular Laboratories (ICAVL) has created reporting standards to classify the extent of carotid disease as 0–15%, 16–49%, 50–79%, and 80–99% stenosis and total occlusion. No additional imaging modality is needed for diagnosis and follow-up. MRA and CTA of the head and neck are required when the treatment is planned.

While there is universal agreement in treatment of symptomatic patients with carotid disease, there is controversy in the management of asymptomatic hemodynamically significant carotid stenosis [16].

Advances in medical management have significantly improved, since the days of NASCET (North American Symptomatic Carotid Endarterectomy Trial) and ACAS (Asymptomatic Carotid Atherosclerosis) trials which demonstrated superiority of surgical management.

Currently, the best medical therapy (BMT) for asymptomatic carotid disease includes antihypertensive and antiplatelet agent and statins. As per recent data, most patients with asymptomatic carotid stenosis can be best managed with intensive medical therapy [17].

However, there is a subset of patients with critical carotid stenosis (80–99% stenosis category) who are asymptomatic but at risk of stroke who would benefit from carotid endarterectomy or stenting. The challenge is to identify this select group of patients.

There is growing interest in characterizing the morphology of the plaque on imaging studies and not just the degree of stenosis. A smooth and fibrous plaque is likely to have a benign prognosis, whereas a soft plaque with signs of intraplaque hemorrhage, degeneration, and ulceration indicates a more ominous pathology with potential for neurologic events [18].

We routinely perform carotid endarterectomy under regional anesthesia with neuro-monitoring modalities (continuous EEG and SSEP) and selective shunting with the goal of reducing the risk of general anesthesia and intra- or perioperative complications. In addition to the conduct of the surgery itself, the immediate perioperative care is equally important. Creating a carotid care pathway model that standardizes post-op care and involves the recovery room and ICU nursing staff in decision-making is important. This protocol-driven care by nurses and doctors facilitates a more efficient and safe patient outcome.

Carotid Stenting

The seminal NIH-sponsored CREST trial has shown that over a 10-year follow-up, there was no significant difference between patients who underwent stenting and those who underwent carotid endarterectomy with respect to periprocedural stroke, myocardial infarction or death, and subsequent ipsilateral stroke. The rate of post-procedural ipsilateral stroke also did not differ between groups [19]. It should be noted that the criteria to participate in such a trial were extremely rigid and highly selective.

TCAR (Trans-Carotid Artery Revascularization)

As most neurological events during stenting are the results of embolization, a new concept has been developed. This entails deliberately reversing the flow in the carotid artery during the time of stent placement. This technique called trans-carotid artery revascularization (TCAR) is becoming the technique of choice for stenting carotids [20].

Other Extra-Cranial Vascular Diseases

Carotid dissection, extracranial aneurysms, and stenotic and occlusive diseases of the vertebral-basilar circulation are less common than the carotid disease. The clinical entity that requires special attention in the elderly population is subclavian steal syndrome. Significant stenosis at the origin or proximal subclavian artery results in decreased pressure beyond the stenosis causing a physiological reversal of flow in the ipsilateral vertebral artery. This condition called subclavian steal syndrome may be an incidental finding on imaging studies with no symptoms in majority of patients. However in the small group of symptomatic patients, symptoms include diplopia, loss of balance, and drop attacks (falling without losing consciousness). Symptoms may be triggered by exercising the affected upper extremity in some. When symptoms do occur, it is frequently misinterpreted as consequences of old age. It is good practice to measure blood pressure in both upper extremities in elderly patients. A difference in values of more than 20 mmHg is considered significant. Diagnosis can be confirmed with other imaging modalities like ultrasound duplex, MRA, and/or CTA. Once the diagnosis is established, and if patients have symptoms, treatment in most patients is by endovascular approach. Subclavian artery angioplasty and stenting via ipsilateral brachial artery approach is safe with good immediate and long-term cure. Carotid-subclavian bypass performed by neck incision is the surgical option when stenting is not feasible.

Mesenteric Vascular Disease

Chronic Mesenteric Ischemia (CMI)

The classic picture of chronic mesenteric ischemia is the clinical triad of postprandial abdominal pain (abdominal angina), weight loss, and steatorrhea. In most patients two of the three intestinal arteries have to be occluded to cause symptoms. However a small number of patients may get mesenteric ischemic syndrome when only one of the three visceral arteries is affected. We have termed this “territorial mesenteric ischemia” [21]. This occurs when there are incomplete or insufficient collaterals to compensate for the stenosed or occluded visceral artery. In these cases, symptoms will be from the territory supplied by the affected visceral artery. Thus stenosis or occlusion of celiac artery may present with gastric and hepatobiliary symptoms, that of SMA with intestinal symptoms and that of IMA presenting with ischemic events of left colon. Owing to the natural process of weight loss and decreasing appetite in the aging population, recognition and diagnosis of CMI may be missed or delayed. This disease may be effectively screened and diagnosed using duplex ultrasound imaging techniques. CTA/MRA and conventional visceral angiography will confirm the diagnosis of CMI. Lateral (sagittal) views are needed to assess the visceral arteries since most atherosclerotic plaques occur at the origin of these arteries as they take off from the aorta. Correction of SMA disease with or without treatment of celiac artery to restore intestinal perfusion is the treatment in most patients.

Angioplasty/stenting of mesenteric arteries has become the first therapeutic option in CMI [22]. Surgical bypasses to the vessels are reserved only for those patients where endovascular management is not feasible. SMA and celiac arteries are the usual targets for revascularization. In select patients who have occlusion of all three visceral arteries, angioplasty/stenting of the IMA as a single vessel treatment can be safely performed in patients with CMI, with satisfactory short- and long-term results [23].

Acute Mesenteric Ischemic Syndromes

Acute mesenteric ischemic (AMI) syndromes should be considered in any elderly patient that comes in with an acute abdomen. Delay or failure in diagnosis can result in high rates of mortality [24]. AMI may be caused by acute mesenteric artery occlusion by embolus (AMOE), acute mesenteric artery occlusion by thrombosis (AMOT), nonocclusive acute mesenteric ischemia (NOAMI), and acute mesenteric venous thrombosis (AMVT).

Acute Mesenteric Ischemia due to Embolus

Mesenteric embolic occlusion is the commonest cause of acute mesenteric ischemia. Among the visceral arteries, the superior mesenteric artery is the most common site for embolic occlusion. Generally, the embolus lodges just beyond the origin of the middle colic artery, which is clearly distinct from acute superior mesenteric artery thrombosis that occurs secondary to pre-occlusive stenosis at the origin of SMA. Clinically, embolic occlusion tends to spare the left colon. The most common source for the emboli is the heart with causes being atrial fibrillation, myocardial infarction, valvular heart disease, ventricular aneurysm, and left atrial thrombus. Severe atherosclerotic aortic disease of the descending aorta with heavy plaque burden and ulcerated disease – the so-called shaggy aorta syndrome – has also been a known source for the embolus. In any patient with AMOE, if a cardiac source is ruled out, we recommend imaging of the entire thoracoabdominal aorta to look for the source (arterio-arterial embolization). Treatment options will be discussed together with management of acute thrombotic occlusion of mesenteric vessels.

Acute Mesenteric Ischemia due to Thrombosis

As mentioned earlier, atheromatous plaque disease generally occurs at the orifice of the mesenteric arteries, leading to stenosis. Again, SMA is most frequently involved. Thrombosis, superimposed on a pre-existing critical stenosis, is the most typical finding. Thrombosis of severely stenosed SMA may be triggered by a variety of low-flow states like CHF, cardiogenic shock, dehydration, or any clinical state causing prolonged hypotension. The ischemic segment involved would be the entire small and large intestine that may lead to devastating consequences.

Nonocclusive Acute Mesenteric Ischemia (NOAMI)

In the late 1960s, it was recognized that mesenteric ischemia can occur without any major mechanical obstruction to the mesenteric flow. The classic picture was an elderly patient presenting with a clinical picture of mesenteric ischemia in the setting of severe heart failure, arrhythmias, or severe volume depletion. This "low-flow" state-induced ischemia of the bowel is termed as nonocclusive mesenteric ischemia (NOAMI) which accounts for 20–30% of all cases of acute mesenteric ischemia. This condition was brought to the attention of physicians by Scott Boley [25]. Mortality of NOAMI is high. Treatment should be directed to correcting the primary condition that caused the low-flow state [26].

Acute Mesenteric Venous Thrombosis

Acute interruption of venous return from the intestines due to thrombosis of the superior mesenteric vein and/or portal vein will present with clinical symptoms which may be indistinguishable from acute mesenteric arterial occlusion. The common etiologies for this condition comprise of either primary or secondary hypercoagulable states. Primary hypercoagulable state may occur due to polycythemia vera, leukemias, myelodysplastic syndromes, and inherited thrombophilias (protein C and S deficiency, prothrombin gene mutation, hyperhomocysteinemia, etc.). Secondary hypercoagulable state can be brought on by cancer, contraceptive pills, etc. Advance liver cirrhosis causing portal venous hypertension and direct extrinsic compression by periportal neoplasms are other causes.

Management of Acute Mesenteric Ischemic Syndromes

High index of suspicion, early diagnosis, and prompt intervention remain the hallmark tenets for successful management of this condition. Delay or misdiagnosis almost always results in mortality [24]. Once the diagnosis is confirmed, systemic anticoagulation should be initiated as the patient is being prepared for surgery. Surgical embolectomy is the treatment of choice for an embolic occlusion. Promptly done, this results in good outcome. In mesenteric thrombosis, the treatment is generally more complex owing to the need for correction of the stenotic or occlusive lesion in addition to thrombectomy. Unlike thrombosis of peripheral vascular bed, thrombolytic therapy for mesenteric thrombosis is generally not recommended because of the urgency to restore flow to the ischemic bowel.

Angioplasty and stenting of the mesenteric vessels can be performed retrograde through the superior mesenteric artery at the time of exploration or through a traditional endovascular brachial approach [22, 26]. Inability to perform angioplasty or stenting will need an urgent bypass to the superior mesenteric artery. We recommend iliac artery as an inflow for the bypass in order to avoid clamping of the aorta in these critically ill patients, who may not tolerate the consequences of aortic clamping [21].

For NOAMI, treatment should be aimed at correcting the low-flow state while the systemic anticoagulation is initiated. In select patients, mesenteric angiography and selective catheterization of the superior mesenteric artery for infusion of papaverine to dilate the mesenteric vascular bed may be needed [26]. Mesenteric venous thrombosis has a more insidious clinical course. Management mostly comprises of systemic anticoagulation, with fluid resuscitation and serial clinical examination and trending biochemical markers such as white count and serum lactate levels. For unprovoked or idiopathic mesenteric venous thrombosis, a hematologic workup is mandatory to determine the need for lifelong anticoagulation. The indication for surgery in these patients is reserved for clinical deterioration despite adequate treatment and/or frank peritonitis or other symptoms of bowel infarction.

Venous Thromboembolism (VTE)

VTE in the elderly patients has the same etiological factors as in the general population (Virchow's triad of stasis, endothelial damage, and hypercoagulability). Advance age and frailty resulting in a sedentary lifestyle render this subset of population at high risk for VTE [27].

When VTE occurs in an elderly without any triggering causative factors, it is imperative to rule out malignancy. This would require further imaging studies of the chest and abdomen to rule out a primary source. Pancreatic, renal, and lung cancers are among the most common neoplasms presenting with VTE.

Upper extremity venous thrombosis, including the central venous occlusive syndromes, is also frequent in this category of patients. Presence of central venous access catheters such as those for dialysis and chemotherapy is now the most common cause for upper extremity and neck vein deep venous thrombosis in these patients [28]. Effort thrombosis (Paget-Schroetter syndrome), which is upper extremity DVT occurring in young patients with thoracic outlet syndrome, is uncommon in the elderly.

Anticoagulation is the standard treatment for VTE. Elderly patients have been found to be more sensitive to anticoagulants. This along with a higher incidence of fall in the elderly calls for close follow-up and modification of the dose and duration of the anticoagulation treatment [27].

Surgical and/or endovascular therapy is reserved for limb-threatening conditions such as phlegmasia (acute iliofemoral thrombosis). Catheter-directed thrombolysis (CDT) and pharmaco-mechanical thrombectomy (PMT) have replaced surgery in most patients.

Indications and use of inferior vena cava filters (IVC filters) are the same for general population, namely: (1) contraindication to anticoagulation and (2) progression of VTE despite adequate anticoagulation. While there is general recommendation to remove these filters once the risk VTE has passed, owing to the risk of additional procedures, this may not be applicable in elderly patients with multiple co-morbidities and limited lifespan.

Hemodialysis Access

The number of patients above the age 65 years requiring hemodialysis access for end-stage renal disease is increasing. As reported by the European Renal Association-European Dialysis and Transplant Association (ERA-EDTA), approximately 25% of patients undergoing dialysis for end-stage renal disease (ESRD) are above the age of 65 years [29]. The initial recommendation by the National Kidney Foundation to follow the strategy of "fistula first" may not be realistic when considered in the subgroup of elderly patients. High incidence of comorbid conditions like diabetes, congestive heart failure, and vascular disease of the upper extremities influences the choice and location of placement of dialysis access procedures.

Although AVF is superior to arteriovenous grafts (AVG) across all age groups, the fistula failure rate in patients above 65–70 years is nearly double than when compared to those younger [29]. All of these issues underscore the need for careful selection. Whether fistula or graft is better, and in very select cases, just the tunneled catheter may be the access of choice – need to be individualized. It would be prudent to choose AVG in an elderly patient with limited longevity. The goal is to minimize the stress of repetitive interventions in the elderly as each hospitalization increases the risk of other complications like hospital-acquired pneumonia or *Clostridium difficile* infections, delirium, and falls.

Close communication between the nephrologist and vascular surgeon is important throughout the course of ESRD patients. The time to maturation from the creation of AVF is about 12 weeks. Patients should be referred at least 3–4 months in advance when the nephrologist anticipates any one progressing from chronic kidney disease to ESRD. Arterial and vein mapping using duplex ultrasound to predict the successful AVF placement is routine. Once placed, duplex surveillance of AVF or AVG at regular intervals will help identify impending failures so that prompt intervention can improve the patency of the access.

The failure rate of a radio-cephalic fistula is higher in the elderly population when compared to their younger counterparts; hence, choosing a more proximal anatomic site (e.g., near the antecubital fossa) must be strongly considered [30]. To facilitate an open but poorly maturing fistula, balloon-assisted maturation (BAM) can be tried in some cases.

Central venous catheters in patients for HD present with their own set of problems and serious complications such as central vein stenosis/occlusions, superior vena cava syndrome, infections and need for repeat interventions. Frequent presence of pacemakers/defibrillators and central venous access catheters (e.g., for oncological conditions) may further limit the options available for placement of HD access. Tunneled catheter may be the only choice in some select patients with limited life expectancy and who have no veins or exhausted all access sites. Novel interventions such as minimally invasive endovascular AV access are soon becoming a reality. However, their long-term efficacy is yet to be determined.

Decision-Making in the Elderly

Decision-making in the elderly has to be based on a realistic outcome, as opposed to the ideal outcome. This comprises not only of symptom- and pathology-guided treatment but also takes into consideration the patients' expected longevity, functional status, established goals of care, and expectations. For example, although we are aware that a lower extremity revascularization bypass is superior in terms of long-term patency, for an elderly patient, an endovascular modality for the same lesion may be preferable to facilitate minimal hospital stay and early mobilization. Aggarwal et al., in their analysis of nationwide trends of hospital admissions and outcomes among CLI patients, had shown that endovascular procedures are associated with reduced hospital stay, major amputation, and mortality [31].

The other important surgical aspect of decision-making comes from the understanding of age-related physiological decline in homeostatic mechanisms. Involving the anesthesiologist in the process of preoperative assessment of the patient becomes an essential component of decision-making in this population. Recognizing the importance of limiting the use of general anesthesia for vascular procedures has led to a paradigm shift in performing long and complex procedures under regional anesthesia.

One also needs to understand that while initial medical management such as lifestyle modifications, diet changes, exercise, high-intensity statin therapy, and antihypertensive and antiplatelet medications may form the basis of treatment for all PAD patients, this may not be a practical solution for an octogenarian. Expecting compliance for lifestyle changes, regular exercises, and diet modifications from an elderly is unlikely to produce satisfactory results.

Conclusion

Scientific evidence has clearly shown us that the geriatric population is at risk for adverse surgical outcomes due to the prevalence of chronic diseases such as hypertension, hyperlipidemia, diabetes, coronary artery disease, and chronic lung and kidney disease. These long-standing chronic medical conditions, together with years of exposure to environmental stressors, poor diet, nicotine, alcohol, polypharmacy etc., are strong risk factors for developing vascular pathologies requiring medical and surgical intervention.

The incidence of arterial diseases increases with age. Vascular surgery as a branch of surgery deals with treating and attending to this unique age group of the population. It is important for the treating physician to understand the concepts of physiological changes in the vasculature in an elderly, the different disease processes that arise as a result of them, and the various modalities available for their management. The decision to perform a vascular procedure in the elderly does not depend on knowing merely what surgeries to perform. Understanding the patient's social background, anticipated quality of life after intervention, and presence or absence of family support forms the other half of the toolkit required to provide not only the best available treatment for the disease but the best-suited management for that patient. This patient-centered approach with patient participating in the overall treatment plan is the new paradigm. Finally, it should be acknowledged that the wide range of therapeutic spectrum – medical, endovascular, and surgical – is merely an intervention for an organic structural lesion. Our understanding of the process of atherogenesis and the formation and progression of a plaque still remains elusive. Advanced research directed toward preventing this process of atherosclerosis would be the most ideal solution.

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20 Operative Surgical Oncology in the Elderly: Epidemiology, Opportunity, Outcome, and Ethical Issues

Xiang Da Dong and Samuel Barasch

Cancer is currently the second most common cause of death in the USA [1]. In addition, the incidence of cancer increases with age. Statistically, about 38 percent of the population will have a diagnosis of cancer in their lifetime [1]. Approximately 54 percent of the cancer diagnosis is discovered after age 65 [2]. Currently, about 15 percent of the population is older than 65, with the number expected to exceed 22 percent by 2050 [3]. The incidence of cancer in the geriatric population is likened to a "silver tsunami" that is approaching the healthcare system threatening to overwhelm the system [4] (Fig. 20.1).

Since development of neoplastic diseases is typically associated with aging and cellular degeneration, cancer diagnoses are expected to blossom with the aging population. As part of the multidisciplinary approach to cancer care, surgery will remain a key component to the management of these patients. The challenges faced by these patients due to frailty caused by reduction in physiological reserves, medical comorbidities, and impact of decreased long-term survival from other medical problems make decision-making complex [5]. Palliative approaches to cancer care in the elderly are one of the many options that need to be addressed as well. The introduction of newer medical and surgical approaches to dealing with oncologic diseases brings another layer of complexity to the decision-making. With the advent of multiple modalities including minimally invasive surgery and targeted immunotherapy to augment traditional chemotherapy, the management is complex and requires a multidisciplinary team of physicians to balance the risks and benefits for the patients.

The Elderly Cancer Patient: An Impending Silver Tsunami

According to the US census projections, the current US population that is over 65 is approximately 15.6 percent [6]. That proportion of the US population over 65 will reach 18.9 percent in 2025 and then 22.0 percent in 2050 [6]. Despite being around 15 percent of the population, the over-65-year-old group utilizes 34 percent of the total healthcare expenditures in the USA [6]. Fully 60 percent of healthcare spending occurs in the 65 and older group. Approximately 1/3 of the healthcare dollars is spent on the oldest group (85 and older). Within that sobering statistic, a third of the death is secondary to heart disease, while 22 percent is secondary to cancer. The projected

X. Da Dong (✉)
Surgical Oncology, Department of Surgery, Westchester Medical Center and New York Medical College, Valhalla, NY, USA
e-mail: Xiang.dong@wmchealth.org

S. Barasch
Department of Pathology, Westchester Medical Center, New York Medical College, Valhalla, NY, USA

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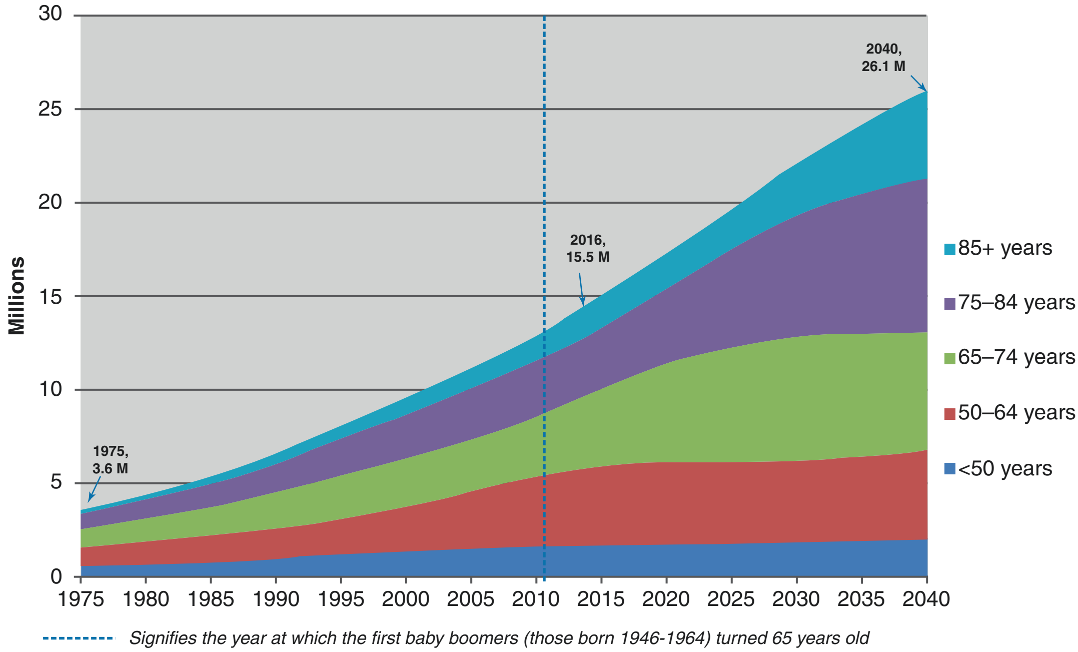

Fig. 20.1 Estimated cancer prevalence by age in the US population from 1975 (216 M) to 2040 (380 M). (From Bluethman et al. [4], with permission)

cost of cancer care in 2020 is going to be around $174 billion, second only to heart disease at $199 billion [7, 8].

On average, estimates of comorbid conditions in the elderly diagnosed with cancer are around five comorbid conditions [4]. The incidence of comorbidities and frailty is even higher in the oldest adults (aged 85 and greater) [9–12]. With advances in treatment and early detection, elderly patients can often be cured and placed in remission. But, the act of treatment poses two additional problems. Firstly, the treatment of malignancies often leads to cancer-related toxicities that will persist after completion of treatment. Secondly, the effective treatments for cancer will surely lead to long-term survivors that will require additional resources for management including posttreatment surveillance and management of complications from treatment. It is estimated that 64 percent of patients become 5-year survivors of cancer and 40 percent become 10-year survivors [4]. This will surely add to the burden of treatment when considering the elderly patient.

Although the treatment options as outlined by national guidelines for elderly patients with cancer do not differ significantly from their younger cohorts, there are differences because of the challenges from the decrease in the physiological reserve in these patients [7, 8]. The studies on management of cancer were often done on younger patients with less medical comorbidities and declining health parameters. It is also well-known that older patients have differences in tumor biology, alterations in their DNA mismatch repair systems, increases in microsatellite instability, and higher likelihood of advanced disease on presentation [13]. However, little adjustments have traditionally been made on the workup and management of elderly patients with cancer solely based on age.

Surgical Oncology Geriatric Risk Assessment

Surgeon attitude toward management of elderly patients differs widely. Almost all surgeons view a patient's chronological age as relative and physiological age as more representative of their true performance status [14–16]. However, assessment of physiological age preoperatively is much more varied in terms of consistency and undertaking. In order to address the attitudes of surgeons toward this problem, the Surgical Task Force at SIOG (International Society of Geriatric Oncology) sent a web-based survey to members of the ESSO (European Society of Surgical Oncology) and SSO (Society of Surgical Oncology) to gather their response and management of geriatric patients [16]. As expected, almost all surgeons (>90 percent) offer surgery to patients regardless of age [16]. Only 48 percent consider mandatory preoperative frailty assessment. Collaboration with geriatricians to assess risk and optimize surgical outcome is also low at 36.3 percent [16]. In terms of cognitive status, the differences are even more pronounced. Only one in two would not offer surgery regardless of cognitive status bearing in mind that meaningful survival will be impacted [16]. As much as one in three would offer surgery regardless of cognitive status due to patient or family requests or wishes. There seems to be a significant lack of data-driven prospective studies to address onco-geriatric surgery in terms of its risks, benefits, and approach.

In light of the risks in treating elderly patients due to their medical comorbidities and declining health status, several societies have created guidelines in terms of medication adjustments and management recommendations [17]. Perhaps the most obvious field in need of stricter guidelines is surgery as the effects of frailty associated with older patients can lead to detrimental surgical outcomes [18–20]. Therefore, frailty assessment and medical optimization is recommended for surgical planning for the geriatric patient population.

Surgical oncology patients benefit from frailty assessment preoperatively. One of the easiest means to assess surgical risk is a chronological age of the patient [21, 22]. However, although it is the simplest means to document surgical risk, it is also the least accurate as it lacks any consideration in the medical comorbidities of the patient, the physiologic status of the patient, the type of surgical intervention involved, or the type of anesthesia required. As a result, multiple nomograms, indexes, and assessment tools were developed to assess the operative risk of the patient in relation to the perceived risk of the surgical intervention [23–25]. Each of the assessment tools aims to balance certain aspect of the patient performance status with respect to the operation involved, with each having particular strengths and weaknesses.

One of the most comprehensive assessments supported by the American Geriatric Society is the Comprehensive Geriatric Assessment (CGA) [16]. This assessment takes into account the physical, mental, social, economic, functional, and environmental aspects of the elderly. However, the assessment is impractical for surgical risk assessment due to the details required. It also involves different aspects of the patient well-being that is not directly related to surgical outcome. Only 6.4 percent of surgeons have reportedly used this assessment prior to surgery [16].

Several other useful tools that are easier to manage are supported by the American College of Surgeons and the American Society of Anesthesiologists (ASA). An easier and often useful tool, as endorsed by the American College of Surgeons (ACS), is the modified Frailty Index (mFI) [24]. The mFI combines 11 variables linked to a patient's medical comorbidities and generates a risk for the patient using data derived from the National Surgical Quality Improvement Program (NSQIP) database [22, 24] (Table 20.1). The mFI is predictive of postoperative complications as well as morbidity and mortality associ-

Table 20.1 The modified Frailty Index

History of diabetes
History of congestive heart failure
HTN requiring medication
History of transient ischemic attack or cerebral vascular accident
Non-independent functional status
History of myocardial infarction
History of either peripheral vascular disease or rest pain
History of cerebral vascular accident with neurologic deficit
History of COPD or pneumonia
History of percutaneous coronary intervention, stent placement, or angina
History of impaired sensorium

From Velanovich et al. [24], with permission

Table 20.2 ASA Physical Status Classification System

ASA Classification	Definition
I	A normal healthy patient
II	A patient with mild systemic disease
III	A patient with severe disease
IV	A patient with severe systemic disease that is a constant threat to life
V	A moribund patient who is not expected to survive without the operation
VI	A declared brain-dead patient whose organs are being removed for donor purposes

From Dripps [25], with permission

ated with surgical interventions. The American Society of Anesthesiologists score is also a relatively easy to follow risk assessment tool. It is also frequently used to communicate risks between anesthesiologists and surgeons since it assigns a numerical value to the surgical patient with regard to the operative risk [25] (Table 20.2).

In addition, there are other risk assessment tools that will give a percentage risk for major morbidities and mortalities for specific surgical procedures based on medical information that is relatively easy to determine. One of the popular risk assessment tools is the ACS Surgical Risk Calculator. Another popular risk assessment tool is the POSSUM score [26]. Using specific patient-defined factors, the risks for the procedure are given to help the healthcare provider generate an honest discussion with the patient. Each of the risk calculators has inherent biases based on the weight of each variable used in determining the risk of the procedure.

Minimally Invasive Approaches in Geriatric Patients

In recent years, multiple surgical approaches have been developed to minimize postoperative morbidity [27–29]. Notably, development of laparoscopic approaches, robotic platform, single incision surgeries, and even endo-luminal approaches offer alternatives to the traditional open surgery in surgical oncology [27–30]. Benefits of laparoscopic surgery include decreased blood loss, less postoperative pain, and shorter length of stay. Furthermore, laparoscopic and minimally invasive surgical approaches offer the potential for fewer cardiopulmonary dysfunction compared with open traditional approaches [31].

The benefits of minimally invasive surgery on oncologic diseases have been addressed previously [31]. Many surgeries such as lower gastrointestinal surgery and upper gastrointestinal surgery are performed routinely with minimally invasive approaches at present with good short-term and long-term outcomes [32–35]. However, the approach and its applicability in the elderly is less well defined. The elderly patients require increased technical expertise due to previous surgeries, more advanced tumor presentations, and poor tolerability of pneumoperitoneum and increased operative time [32–35]. The demands of minimally invasive surgery in the elderly present technical challenges, but it also presents an opportunity to improve outcomes in patients due to the decrease in surgical trauma without compromising their oncologic outcome [28, 31].

Laparoscopic colorectal, gastrointestinal, and hepato-pancreato-biliary (HPB) surgery have shown with some level 1A evidence with results that are comparable to open surgery with less morbidity and hospital stay [32, 34]. The short-term outcomes are improved due to a reduction in surgical trauma and less postoperative physiologic and immune response in the patient. Reductions of intraoperative blood loss, manipulation of viscera, and incisional discomfort likely contribute to the short-term improvements in minimally invasive surgeries.

Despite improvements in short-term outcomes, the data on long-term prognosis for patients following oncologic surgery is not as robust. Definitive validation for minimally invasive treatment of cancers in terms of oncologic outcome for the elderly is particularly sparse. For example, in the case of laparoscopic colorectal surgery, out of 52 study protocols available, 44 percent excluded the elderly because of age and medical comorbidities [4, 5]. The data of these approaches are limited at present. Several prospective studies have been performed for breast cancer and colon cancer. Limited data is available for less common diagnoses such as pancreatic, liver, or gastric cancers.

Surgical Oncology Outcomes in the Elderly

The outcome of elderly patients following surgery is expected to be worse than their younger age cohorts [9]. Specifically, older patients (>=65yo) are more likely to die from a variety of major abdominal surgeries than younger patients (<65yo) [9]. Both physiological reserve and medical comorbidity contribute to the expected poorer outcome. Multiple studies have demonstrated feasibility of major oncologic surgeries with acceptable surgical outcomes in comparison to younger patient cohorts [36–43]. However, few studies have looked into long-term patient outcome. Most studies of surgical outcome are short-term without long-term oncologic survival data. While feasible, long-term data from NSQIP suggests that elderly patients do worse especially when their care is complicated. The odds ratio of mortality in this patient cohort increases significantly when there is post-op morbidity.

Elderly patients, defined simply as those >= 65 years of age, are twice as likely to have multiple comorbidities compared to the younger cohort (<65yo). Risk of surgery is the most significant in those undergoing rectal and liver surgery, although the risks of mortality, major adverse events, and prolonged LOS are increased across the spectrum of surgical interventions for GI malignancies including colectomy, proctectomy, gastrectomy, pancreatectomy, and hepatectomy [5, 9] (Fig. 20.2). Standardized multi-institutional data such as those collected from ACS-NSQIP provides estimated of the risks for specific complications. Specific surgical diseases such as pancreatic, esophageal, hepatobiliary, and colorectal provide good estimates of the risk of surgery in the elderly balanced with the complexity of the surgical intervention. Finlayson et al. estimated the risk of perioperative mortality in patients undergoing esophageal and pancreatic surgery was threefold higher than younger patients [10]. Others also found a similar increase in the elderly in high-risk surgical procedures [5, 36, 38–40]. Although single institution studies show that elderly patients can undergo major gastrointestinal surgeries with good outcomes [38], majority of databases where patient selection is less subjective revealed that perioperative morbidity is 2.9–6.7 times higher in elderly patients and mortality to be 1.2–2 times higher in elderly patients [5].

As a result of the bias implicit in management of elderly patients, the treatment for these patients tends to be less aggressive than their younger cohorts. Studies of soft tissue sarcomas illustrate that patients undergoing major resections have similar long-term results. Studies of non-metastatic soft tissue sarcoma in a total of 6043 patients following complete surgical resection showed that elderly patients have similar probability of metastatic relapse after 2 and 5 years despite having more adverse prognostic features at presentation [37]. The conditional survival of patients at 5 years is almost identical between the younger and older patients when offered similar treatment strategies [37]. After 5 years, the outcome of perioperative treatments is less important in patients surviving 5 years after the initial diagnosis.

Ethical Considerations

Treatment of oncologic patients is often intertwined with ethical issues. These issues spring up at the intersection of medical science with societal standards and personal morality [44]. Rather than defining guidelines and following guidelines, ethics require each clinician to understand ethical principles involved to determine appropriate balance for each patient. Beneficence, non-malfeasance, autonomy, and justice are key ethical principles in balance when managing geriatric oncology patients.

Current medical ethics heavily weight autonomy; a principle in which patients have functional decision-making capacity, make informed decisions, and give consent for treatment based upon advice from the medical team. In geriatric

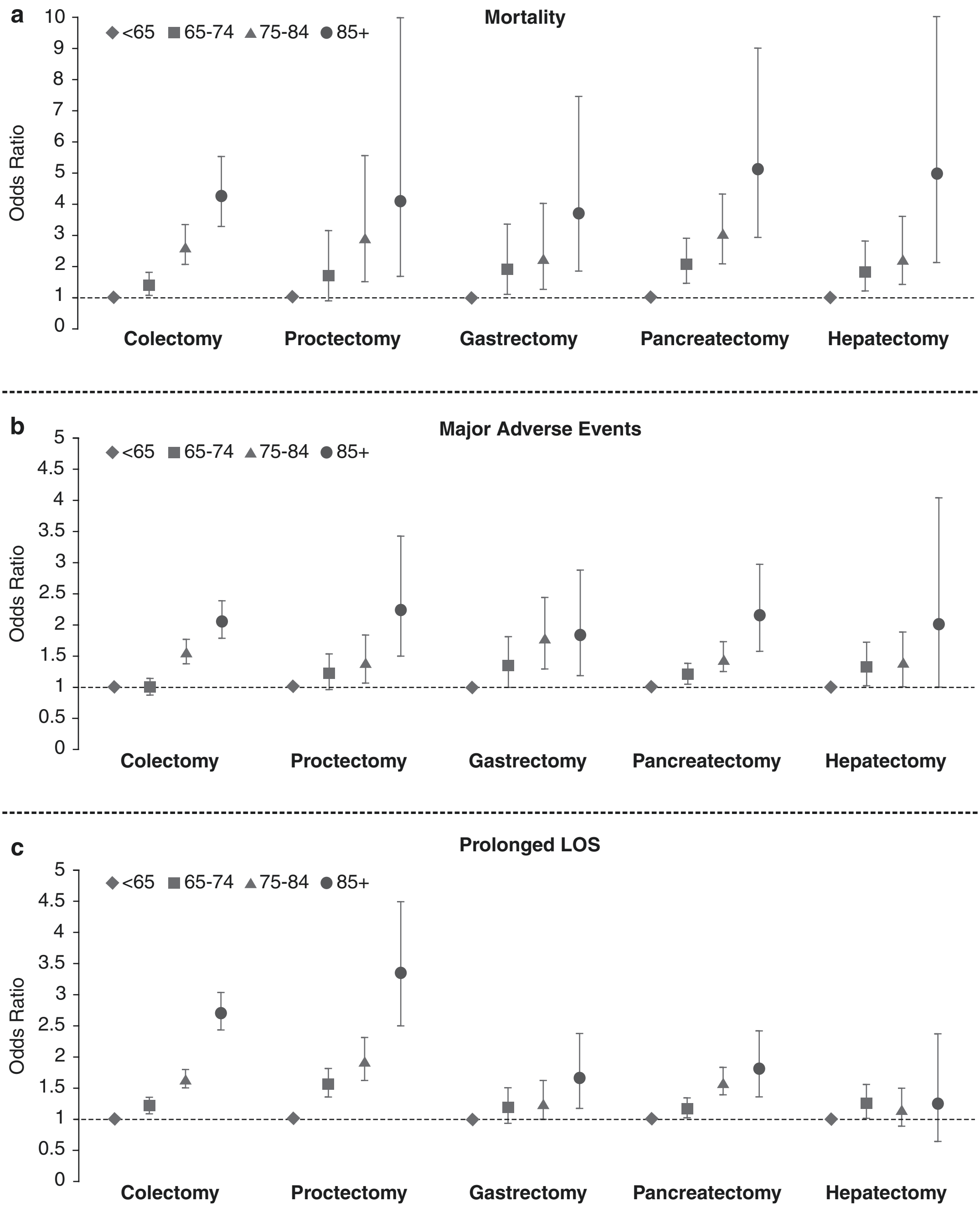

Fig. 20.2 (**a–c**) Age-adjusted mortality rates after major GI cancer surgery. (From Yeo [9], with permission)

oncology patients, individual decision-making capacity can be compromised by both the disease and by comorbid conditions. Patients who have increased reliance on family or social networks of caregivers due to comorbid medical conditions or cognitive disability may have reduced autonomy in medical decision-making. Because the principle of autonomy can interdict between non-malfeasance and beneficence, a living will or clearly defined health-care-power-of-attorney can continue to allow autonomy when balancing non-malfeasance with beneficence. In situations where a patient's predetermined preferences are known, autonomy can be preserved and weighted more greatly in balancing ethical concerns.

Lack of clarity about patient wishes could play a role in providing futile end of life care in close to 40 percent of situations in which futile care is provided [45]. Futile care which could increase complications and decrease quality of life raises ethical concerns of non-malfeasance (i.e., "First Do No Harm"). Perceptions of patient suffering by the family and the clinical patient care team can differ; this difference influences the perception of suffering and the interpretation of medical care as futile [44]. Doctor, patient, and hospital/healthcare system factors can all contribute to situations in which futile care is provided. For physicians, a focus on curative treatment during training and inexperience with death and dying are leading contributors to the provision of futile end of life care. Patient or family requests as well as a possible uncertain prognosis drive family decision to pursue care which may, in retrospect, be perceived as futile. Finally, medical systems which include specialization, hierarchy, and a focus on acute care can influence a trend to ineffective treatment in the end of life setting [45].

While avoiding futile care can be an example of non-malfeasance, it is important in the ethical principal of justice as well. Justice includes appropriate distribution of healthcare resources and allocation to individuals based upon need as well as appropriately within the medical system. It is unjust to deny patients medical care based solely upon their age. Patients who perform well on a CGA should be treated as autonomous individuals and have the right to consider all options for their oncologic treatment – including surgery. While advanced stage cancer is generally discussed and understood in the geriatric/palliative patient, full determination of stage may require surgical staging for a complete clinical assessment of the disease in the appropriate geriatric patient. Comprehensive geriatric assessment allows for evaluation of an individual's comorbidities and decision-making capacity. This aids in just allocation of healthcare resources for the individual and healthcare system [46, 47].

Beneficence, service of the greatest good, combines a disease-oriented approach with acknowledgment of patient goals for care, in the light of a CGA, which includes assessment of patient comorbid diseases and medications. This allows the greatest good for the patient while preserving the greatest good for the medical system, and the patient's family. Beneficence has been overplayed in the twentieth century and has trespassed on paternalism. Thus, the principle of beneficence, in current medical ethics decision-making, is balanced by autonomy. For patients with manageable comorbidities including a good mental and psychological state, functional completion of activities of daily life, participation in instrumental activities of daily life, appropriate nutritional status, and good management of poly-pharmacy, the greatest good is preserved by allowing patients and families curative surgical oncologic care.

For example, in contrast to oncologic considerations, current guidelines for joint replacement do not include patient age and focus on provision of quality of life, relief of pain, and maintenance of joint mobility for the appropriate patient. While a specific roadmap is not available to outline definitive treatment for geriatric oncology patients, the CGA can provide a framework for ensuring that patients, families, doctors, and nurses can have all the information needed to make decisions about geriatric surgical oncology. This information allows the clinical team to balance ethical principles of medical care provision. In appropriate patients, surgical oncologic care can preserve quality of life for geriatric patients.

Conclusions

Management of geriatric oncology patients are complex and require multimodality treatment and development of strategies to minimize treatment side effects while optimizing care. Although several studies have confirmed feasibility of major surgical approaches to complex diseases, short-term outcomes need to be balanced with long-term quality of life. Limited data is available at this time in terms of patient outcome in the elderly.

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21 Colorectal Surgery in the Elderly

Mahir Gachabayov and Roberto Bergamaschi

It is well-known that elderly patients constitute a group requiring special needs and approach in colorectal surgery. The ongoing debate to operate on the elderly with colorectal cancer or not is an old one. Since the publication by Campbell and Samson in 1953, tons of articles on the topic have been published [1]. Besides colorectal cancer, benign colorectal diseases such as diverticulitis, inflammatory bowel disease, and pelvic floor disorders may also require specific approach. Herein, we attempted to elucidate the current state of colorectal cancer surgery in the elderly. Although this is not a comprehensive review, we would like to highlight some controversial issues related to the impact of age and frailty in the context of different colorectal diseases.

What Matters in Colorectal Surgery: Age or Frailty?

The US Census Bureau reported an almost 13-fold increase in the proportion of people older than 65 years from 1900 to 2010 [2]. After the age 75, 95% have at least one comorbidity [3]. A recent meta-analysis reported that compared to colorectal cancer patients without comorbidity, those with mild/moderate and severe comorbidity had significantly higher 30-day, overall, and colorectal cancer-specific mortality rates [4]. Moreover, twice more medical rather than surgical postoperative complications occur in the elderly, which was reported to be associated with longer length of hospital stay (15 vs. 7 days) as well as more frequent transfer to ICU (11/72 vs. 0/118) [5]. In addition to in-hospital postoperative complications, almost 20% of frail older colorectal cancer patients experience post-discharge complications, two thirds of which were medical complications [5]. Yeo et al. found chemotherapy to be a risk factor in 65–74 and 75–84 age groups and sarcopenia in >85 age group in a recently published NSQIP database study evaluating elderly patients undergoing CRC surgery [6].

The question as to whether chronological age matters is still debated. Impact of chronological age makes sense when the attributable difference between two patients is high. However, frailty may vary within the pool of elderly patients. Frailty is a category defined based on different criteria and/or scoring systems such as Balducci and Extermann criteria [7]. A recent study compared frail patients with colorectal cancer to their non-frail counterparts as defined by the above-mentioned criteria [8]. The authors found that 5-year survival in frail patients was only 24% as compared to the 66% survival rate in non-frail patients (log rank $p < 0.001$). A recent systematic review concluded that evaluating frailty in patients with colorectal cancer is important.

M. Gachabayov · R. Bergamaschi (✉)
Department of Surgery, Westchester Medical Center and New York Medical College, School of Medicine, Valhalla, NY, USA

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Nonetheless, the authors emphasized the fact that being frail is not a contraindication for surgical approach [9].

Geriatric Assessment

Geriatric assessment is a systematic assessment of an elderly patient encompassing a multitude of domains such as comorbidities, nutrition, medications, functional status, cognitive abilities, and signs of depression [8]. Geriatric assessment holds three major aims: estimation of patient's physiological reserves and capacity; decision-making support; and evaluation for potentially reversible conditions such as depression, malnourishment, and harmful polypharmacy [10]. In fact, International Society for Geriatric Oncology recommended geriatric assessment in all oncologic patients more than 70 years of age. Likewise, personalized management of elderly patients with rectal cancer including geriatric assessment and preoperative evaluation by a geriatrician was supported by expert recommendations of the European Society of Surgical Oncology, European Society of Coloproctology, International Society of Geriatric Oncology, and American College of Surgeons Commission on Cancer [11]. Geriatric assessment should result in an estimation of the patient's frailty and fitness for standard of care. Due to the changes in treatment strategy and emergence of individualized approach, the value of geriatric assessment has been evaluated in several studies with controversial findings. A recent study found significantly reduced delirium rates in patients undergoing geriatric assessment as compared with usual care (11% vs. 29%; $p < 0.001$) [12]. Similarly, other studies reported that geriatric assessment may serve as a tool to predict postoperative morbidity [13] and mortality [14]. On the other hand, a recent randomized trial compared colorectal cancer patients undergoing surgery with geriatric assessment to the standard of care and found no difference in outcomes [15]. Similarly, Puts et al. concluded in a systematic review of 13 prospective studies that evidence supporting the role of geriatric assessment in the prediction of adverse outcomes is insufficient [16]. Further clinical trials as well as quality control studies evaluating the impact of geriatric assessment are mandated.

Enhanced Recovery in the Elderly

Enhanced recovery after surgery (ERAS) has become the gold standard of care for surgical patients across a range of specialties. Developed by Kehlet in 1995 [17], the majority of data for its use and application currently relate to colorectal surgery.

ERAS consists of a range of techniques such as preoperative carbohydrate loading, small incision surgery, reduced use of opioid analgesia, early postoperative mobilization, and early oral feeding to achieve improved recovery. Currently, there is no standardization of the various ERAS components, and they have remained unchanged in their application to elderly patients undergoing colorectal surgery. Elderly patients undergoing colorectal surgery are at higher risk compared with their younger counterparts for postoperative complications, such as pulmonary infection, urinary tract infection, heart failure, and delirium. A recent systematic review found that ERAS reduces the occurrence of these complications in older patients [18]. It remains questionable whether elderly patients undergoing colorectal surgery have the ability to adhere to ERAS protocols to the same extent as younger adults. Moreover, it is not known which components of ERAS protocols contribute to superior outcomes in elderly patients who differ physiologically from younger adults undergoing colorectal resection. Great emphasis has been placed on length of stay when evaluating the effectiveness of ERAS. For younger patients, this seems reasonable as discharge home and return to baseline functioning is likely. However, there is limited evidence as to whether the same can be said for elderly patients. It is unclear what proportion of elderly patients are discharged directly back to their original environment and which need to first undertake a further interim placement or rehabilitation before they return home. Moreover, one study found that elderly patients, who met the criteria for safe discharge, remained in hospital for a further 3–5 days after this date [19]. This may be due to limited availability of social support in the community, patient anxieties, and an unwillingness of surgeons to discharge their elderly patients in as timely a fashion as they may be inclined to with the younger population.

More recently, functional status is gaining ground as a key outcome measure. Relying on length of stay as an outcome measure for older patients after major surgery is disingenuous. A recent study went beyond the assessment of length of stay when qualifying the effectiveness of the ERAS protocol for older patients; it compared pre- and postoperative functional status in individuals undergoing major colorectal resections and found that for 83% of patients, postoperative function was at least as good as preoperative function [20]. Other centers have addressed the concept of prehabilitation with the aim of maintaining or improving functional status in elderly patients postoperatively. One study compared prehabilitation, based on resistance activities, nutritional counselling, and relaxation exercises, with rehabilitation in patients undergoing colorectal resection. Patients who had undergone prehabilitation had a significant improvement in functional exercise capacity and returned to their functional baseline postoperatively [21]. Further evaluation of elderly patient outcomes beyond discharge is needed. Both disease absence and preserved functional ability following major surgery should be considered in order to maintain physical and social independence for elderly patients.

Colon Cancer in the Elderly

The incidence of colon cancer increases with age, but the progression also varies by anatomic site, population, and gender. The mean age at diagnosis for men was 63 years, and for women, 62 years [22]. In women, colon cancer ranks third in the United States in number of cancer deaths. Adult males have a slight excess of cancer of the descending and transverse colon. There is a controversy as to whether the incidence of right colon cancer is the same for both genders or whether women have more right-sided colon cancer [23]. Generally, there are no differences with respect to presentation, location, TNM stage, and prognosis in comparison with younger adults. All studies confirm that there are no statistically significant differences in age-corrected survival curves. However, emergency operations are associated with a higher morbidity and mortality in elderly patients. Colon cancer in the elderly may present with the simple change in bowel habits, lower GI bleed (the second most common symptom), discharge of mucus mixed with stool and blood, abdominal pain, palpable abdominal mass, unintentional weight loss, symptoms of “appendicitis,” history of inguinal hernia of short duration, colocutaneous fistula, and intussusception. Colonoscopy and CT scan are the main elements of the workup. Colonoscopy with biopsy should be performed first in case of change of bowel habit, chronic lower GI bleed, mucus discharge, and colocutaneous fistula. CT scan is the preferred first test in case of abdominal pain, palpable abdominal mass, unintentional weight loss, symptoms of “appendicitis,” history of inguinal hernia of short duration, and intussusception. Unlike rectal cancer, the preoperative staging of colon cancer by CT scan can generally only rule out stage IV disease, namely, liver and/or lung metastases. Occasionally, when enlarged lymph nodes are detectable on CT scan, stage III disease can be suspected. Cardiac, pulmonary, and medical clearance are essential in order to risk stratify elderly patients. A multicenter prospective cohort study from Norway [5] recently described in-hospital and post-discharge complications in patients over 65 years of age concluding that most complications were medical and related to preexisting comorbidities. Nonetheless, there is no justification for avoiding necessary surgery on the mere basis of chronological age. There is a general trend in longer survival for colon cancer which is applicable to the elderly as well. Owing to improved survival, elderly colon cancer patients more frequently develop lung metastases over time. A recent study reported the 3-year survival rate in elderly patients to be 50% [24]. A recent NSQIP study assessed risk factors for readmission in geriatric patients undergoing colon cancer surgery with stratification by age ranges. The authors found chemotherapy to be a risk factor in 65–74 and 75–84 age groups and sarcopenia in >85 group [6]. A Dutch cancer registry study on 33,000 patients found significant decreased use of chemotherapy and laparoscopy in patients older than 75 years [25]. Regarding laparoscopy for colon cancer in the elderly, there is a never-ending controversy regarding the association between pneumoperitoneum and lower respiratory compliance, increased airway pressure, enhanced venous stasis, reduced portal venous pressure, and impaired cardiac function. A Cochrane meta-analysis of 5 RCTs published in 2013 found no difference in complication rates between pneumoperitoneum and abdominal wall lift. A meta-analysis comparing laparoscopy to laparotomy for colon cancer in the elderly [26] reported better 3-year survival rates after laparoscopy, although the 5-year survival rates did not differ. Heterogeneity was high in both outcomes; hence, no robust conclusions may be drawn from this meta-analysis.

In elderly patients who are not candidates for resection due to severe comorbidities, palliation may be achieved with one of the following options: argon plasma coagulation, endoscopic stenting, palliative resection and colostomy, and endoscopic submucosal dissection (ESD). In case of bleeding, palliation can be achieved endoscopically with argon plasma coagulation delivered through a colonoscope. In case of obstruction, stenting should be the first choice provided expertise is available. However, stenting should be considered as bridge to resection to be performed within a week following patient stabilization. Resection may have to be performed with palliative intent, which means no lymphadenectomy, no anastomosis, but colostomy. Nonetheless, there will always be a few cases where stenting will become the definitive therapy. ESD is an option in patients with early stages of colon cancer (T1) when the patient is not fit for surgery. Although colonic ESD (especially right colon) may be technically challenging due to narrow tubular lumen as compared to stomach, in experienced hands ESD can provide low margin involvement rates as well as cancer recurrence rates. Having minimally invasive palliation methods, the question whether we should operate on the elderly with colon cancer will always exist. A recent SEER database study compared survival rates in patients who underwent surgery to those who did not undergo surgery stratified by age ranges and cancer stages. The authors found that in all ages and all cancer stages, survival following surgery was significantly better than survival following no surgery. The only category in which survival was comparable was patients older than 94 with stage III cancers.

Rectal Cancer in the Elderly

In high incidence countries, 25% of intestinal cancers develop in the rectum with a slightly higher prevalence in men (30%: 21%). Over the past 40 years, several advances have been made in the management of rectal cancer, one of which is certainly the understanding that it is very much a team effort. A range of experts is required to treat patients with rectal cancer: enterostomal therapists, radiologists, interventional radiologists, pathologists, radiation oncologists, medical oncologists, and colorectal surgeons. Most of the time patients are asymptomatic, and occasionally the diagnosis is established on a CT scan ordered for an unrelated reason. The symptoms of rectal cancer include bleeding per rectum, mucous discharge, and incomplete evacuation. Weight loss and pain are rather symptoms of advanced disease. Although surgical technique is very relevant in the treatment of rectal cancer, its role and goals may drastically change when it comes to frail patients. There are a number of options that can be considered in the management of elderly patients with rectal cancer such as local excision and palliative procedures. Prior to making a decision, local and distant staging must be established by means of MRI and CT scan, respectively. PET scan is traditionally added as rectal cancer (unlike colon cancer) can be associated to ectopic metastatic lymph nodes such as paraesophageal, axillary, etc. Digital examination is reliable in assessing fixity of the tumor in the pelvis, whereas rigid proctoscopy is essential in establishing the level of the tumor. If necessary both might be performed under light sedation. A flexible sigmoidoscope should not be preferred for measuring although it is better tolerated by patients. In order to ascertain accurate measurements, the scope must be seen exiting the anal verge rather than emerging from the contour of the buttocks. Rigid (rather than flexible) scopes are also reliable in terms of determining whether the tumor is located on the anterior or posterior wall of the rectum. In the former, the depth of anterior invasion has to be carefully assessed as the female or male organs might be involved. The treatment options appropriate for frail elderly patients with rectal cancer may include transanal excision, trans-sphincteric excision, trans-coccygeal excision, laser photocoagulation, electrocoagulation, cryosurgical destruction, endocavitary irradiation, and others.

The first approach to the management of rectal cancer was transanal, and it predated the era of laparotomy [27]. Over a century passed before a transanal, this time endoscopic approach would be grabbing the headlines [28]. This endoscopic approach consisted of a rigid platform, which required a long learning curve and a capital budget purchase. Both factors most likely limited its popularization in the United States. American surgeons developed and implemented the concept of soft platform named transanal minimally invasive surgery (TAMIS) [29]. The procedure is performed by inserting a disposable single port in the anal canal with the patient prone or supine depending on the location of the lesion in the rectum. A pneumorectum is created insufflating CO_2, and laparoscopic instruments are inserted. Notwithstanding the opportunities for better visualization, simpler technique, and less expensive instrumentation, TAMIS is not flawless. Its limitations include restricted working angles within the confined space of the rectal lumen and external torque in attempt to compensate for the lack of instruments' articulation. It is not surprising that the abovementioned limitations of laparoscopic instruments created an opportunity for a robotic transanal approach. One of the goals of a robotic soft platform is to facilitate the suture closure of an anterior rectal wall defect [30]. Clearly, the 360-degree range of motion of the robotic instruments in the rectal lumen is the key advantage. The reassignment of the robotic arms from left to right and vice versa after instrument crossing and the 3D high-definition visualization allow for instrument manipulation similar to open surgery. The only available clinical data consist of a multicenter study including 16 patients only and reporting involved margins in 2 of 16 cases (13%) [31]. Hence, transanal excision of rectal cancer (regardless of the platform being rigid or soft) should be restricted to elderly patients with prohibitive comorbidities precluding curative resection. A trans-sphincteric approach does not seem to be the best choice particularly in elderly women. In fact, this procedure entails complete division of the posterior internal sphincter and levator ani muscles [32]. Although this approach offers access to only low-lying tumors, it does allow for segmental resection with transanal anastomosis as it is the case with the trans-sacral approach [33]. In addition to transanal, trans-sphincteric, and trans-sacral excision, there are a number of other local procedures that may be considered for palliation of bleeding, obstruction, and pain. Although electrocoagulation is rarely practiced today, it was advocated as early as in 1913 for palliation in frail patients with rectal cancer [34]. Electrocoagulation may be considered when the tumor is exophytic, confined to the rectal wall, not circumferential, when the patient with known distant metastases can have bleeding palliated, or when the patient refuses or cannot manage a colostomy due to blindness. The most common complication is fever for which antibiotics are recommended pre- and postoperatively for at least 24 hours. Pelvic sepsis may occur without recognizable rectal perforation. There are at least two more ablative methods for palliative endoscopic treatment of malignant strictures in the rectum: laser photocoagulation and cryosurgical destruction. The neodymium:yttrium-aluminum-garnet (Nd:YAG) laser is unique in that it is applicable to tumor located above and below the peritoneal reflection. Although laser therapy can be performed as outpatient, it often requires hospitalization. Concerns have been expressed about the laser power settings which allow to enhance the hemostatic or the vaporizing effects. In essence, excess cavitation must be avoided.

Laser therapy may be combined with the implantation of self-expanding metal stents, which however tend to migrate distally toward the anal canal and cause pain. Cryotherapy may also be used to palliate bleeding or obstruction with a 8% risk for perforation thank to its reduction of tumor bulk [35]. Endocavitary irradiation has been employed in the palliative treatment of rectal cancer for over 50 years [36]. The procedure requires a device to be inserted through a large diameter rigid proctoscope. The unit develops a 10–20 Gy/minute radiation output with 50 kV x-rays to be applied to a 3 cm surface with absorption limited to a 2 cm depth.

The combined use of endoscopic laser and radiation is viewed by many as a safe alternative to stenting in frail patients with obstructed rectal cancer. However, endoscopic transanal resection (ETAR) with a urologic resectoscope has been advocated mostly in Europe for frail elderly patients with obstructed rectal cancer [37]. The potential metabolic implications of absorbing glycine-irrigating fluid during ETAR have been directly correlated to operating time [38].

Complicated Diverticular Disease of the Colon in the Elderly

Diverticular disease resulted in 312,000 admissions and 1.5 million days of inpatient care per year in the United States [39] at a cost of over 2.6 billion dollars [40]. Recent studies have found the prevalence of colonic diverticula to be up to 50% in patients older than 60 years [41]. Hospital admission rates due to diverticulitis have increased by 26% with an average age decreased from 64.6 to 61.8 years [42]. The incidence of diverticular disease remains stable in patients aged 65 to 74 years but is decreasing in patients 75 years of age or older [43]. As opposed to the striking male predominance in younger adults, diverticulitis had a slight female prevalence in elderly subjects. A recent population-based study reported that up to 12% of patients with acute diverticulitis may develop complications at some point of time with no significant change over time [44]. The most common complication is microperforation with abscess and/or extraluminal air accounting for 69% of the cases. Dissimilarly, free perforation with peritonitis is not common in elderly patients with previous episodes of diverticulitis. Chronic intramuscular fibrosis of the colon wall can develop in up to 15% of patients leading to stricture. Similarly, the rate of fistula formation has been reported around 14% [45]. Several classifications of diverticular disease and its complications have been proposed by different authors. The first clinical classification of acute diverticulitis was proposed in 1963 [46]. In 1978, Hinchey et al. published a 4-stage classification [47] later modified by several authors [48]. A recently published review of six guidelines has concluded that clinical assessment of acute diverticulitis is insufficiently precise, hence agreed on the need for imaging, namely, CT scan [49]. In fact, several CT-based classifications have been proposed [50–52]. Moreover, the DICA (Diverticular Inflammation and Complication Assessment) classification based on endoscopy was recently proposed focusing on four findings: diverticulosis extension, number of diverticula, presence of inflammation, and complications [53].

Microperforation with Abscess and/or Extraluminal Air

It has been estimated that 10–20% of the individuals who develop acute diverticulitis will develop an abscess [54]. The fact that immediate operative management would most likely entail a colostomy constituted a robust argument in favor of initial nonoperative management, which gradually gained acceptance approximately 15 years ago [55]. Nonoperative management typically includes nil per os, IV fluids, IV antibiotics, and CT-guided percutaneous drainage. Inpatient total parenteral nutrition (TPN) may be considered in case of persistent ileus, and patients may receive outpatient TPN in case of low albumin and/or weight loss. Although the long-term outcomes following nonoperative management remain unclear in terms of rates and severity of disease recurrence, it seems the logical approach in elderly patients. A meta-analysis of 22 retrospective studies amounting to 1051 patients with acute diverticulitis complicated by abscess concluded that nonoperative management can lead to recurrent symptoms with high probability for resection [56]. Patients with acute diverticulitis may only exhibit at initial CT scan extraluminal air typically pericolic or retroperitoneal. Similar to acute diverticulitis with abscess, the practice of urgent resection in presence of extraluminal air has been gradually replaced by nonoperative management [57]. Although extraluminal air may also occur as isolated finding, it may be followed by the development of an abscess. A recent RCT reported that a repeat CT scan with rectal contrast on hospital day 3 may show interval development of an abscess ranging up to 13 cm in diameter in patients with extraluminal air and no detectable abscess on initial CT scan [58]. The data of this RCT are not in line with the American Society of Colon and Rectal Surgeons (ASCRS) clinical practice guidelines claiming that extraluminal gas alone is not to be viewed as complicated disease unless the patient is immunocompromised [59]. Patients who recovered after nonoperative management of an acute episode of diverticulitis with microperforation are typically recommended to undergo colonoscopy at a several-week interval. This practice should be tailored to the individual case when it comes to elderly patients. The practice of considering elective resection following resolution of an acute episode of diverticulitis with microperforation treated with nonoperative management has been supported by the ASCRS clinical practice guidelines [59] but recently challenged by an RCT [58] and certainly not to be recommended to frail patients. Unfortunately, not all patients with acute diverticulitis complicated by microperforation will recover with nonoperative management. Retrospective reports have suggested that patients with larger size abscesses particularly if located in the pelvis, as well as renal failure or immunosuppression, are unlikely to recover with nonoperative management. A recent RCT found that the percentage of failed nonoperative management was as high as 14% and such patients had an average of 19 locules of pericolic air on initial CT [58].

Perforation with Peritonitis

Free perforation with peritonitis is a life-threatening complication of diverticulitis. Although uncommon in elderly patients, perforated diverticulitis with peritonitis has been reported to account for more than half of emergency operations [60]. The prevalence of perforated diverticulitis has increased in developed countries from 2.4/100000 in 1986 to 3.8/100000 in 2000 [61]. The question of whether perforated diverticulitis with peritonitis should be treated by resection or non-resectional surgery has been addressed by one review published in the 1980s [62] and two randomized-controlled trials in the 1990s [63, 64]. Mortality rates following primary resection and non-resectional surgery were reported to be 12% and 28% ($p < 0.05$), respectively [62]. Regretfully, the two RCTs were heavily underpowered, used different outcome measures (postoperative death and postoperative peritonitis), and drew opposite conclusions. When it comes to elderly and/or frail patients with peritonitis, it is imperative to provide the patient and the patient's family with realistic expectations about the high mortality rates following resection with end colostomy and discuss alternative options such as (but not limited to) comfort care, etc.

Fistulae

Fistula formation is a complication affecting 2% of the patients with a prevalence in the elderly with long history with diverticular disease. Starting from the less frequent ones, diverticular fistulae may present as colovaginal, coloenteric, colouterine, colocutaneous, or colovesical [65]. Although the management of diverticular fistulae is in principle surgical since fistulae generally do not close spontaneously, the presence of a fistula is rarely an indication for urgent surgery. Hence, it is unlikely that frail and/or elderly patients should be benefitting for surgery.

Colovesical fistula is the most common form of colonic fistula in men, and more than half of them result from complicated diverticular disease. A clinical diagnosis is based on pathognomonic signs including pneumaturia, fecaluria, and recurrent urinary tract infections with mixed organisms. Colonoscopy and cystoscopy have a limited role in diagnosis because of poor sensitivity but are useful for clarifying anatomy and excluding strictures and malignancy. CT-cystogram is the preferred diagnostic imaging modality owing to its over 90% sensitivity. Fistulae may be demonstrated by gas or contrast in the bladder, or local colonic and bladder wall thickening. The surgical management of colovesical fistulae due to diverticular disease generally consists of colon resection with anastomosis or colostomy. The most sensible procedure to consider (if any) in frail patients is a transverse colostomy. Most colovaginal fistulas originate from diverticular disease [66], and it is uncommon for colovaginal fistula to occur in the absence of hysterectomy. The diagnosis of colovaginal fistula is largely based on clinical presentation and imaging. CT and contrast enema have demonstrated greater sensitivity for diagnosing colovaginal fistula and identifying etiology, while endoscopy has the advantage of biopsies and excluding malignancy. The surgical management of colovaginal fistula involves either a multi-stage repair or primary resection, both unsuitable for frail patients, who may consider a colostomy. A colouterine fistula secondary to diverticulitis was first described in 1929, and about 27 cases have been reported in the literature since [67]. The clinical presentation can be with or without vaginal discharge. Diagnostic hysteroscopy is the first-choice diagnostic tool for investigation of any abnormal vaginal discharge such as blood or stool because it enables direct vision and biopsy of the lesions of the lower genital tract quickly and at low cost. In terms of surgical management, colon resection with or without en-bloc hysterectomy is not indicated with frail patients, who may be offered a colostomy. Colocutaneous fistula is a rare complication of complicated diverticulitis. Mainstay of surgical therapy for colocutaneous fistula is primary resection with anastomosis or colostomy, similar to other forms of diverticular-related fistulas. However, in frail patients a colostomy can be considered, and the cutaneous fistula opening can be debrided and packed either with gauze or wound vacuum dressing applied.

Obstruction

Although the current incidence of large bowel obstruction due to diverticulitis is unknown, there is reason to believe that its incidence has increased in the past four decades. The main cause for the increased rates seems to be the implementation of nonoperative management. Recurrent episodes of diverticulitis, sometimes subclinical, can initiate progressive fibrosis and stricturing of the colonic wall without persisting inflammation. Ultimately complete obstruction can develop. Strictures may present in an insidious manner with non-specific symptoms being typical or less often with acute obstruction. Intestinal obstruction due to diverticular disease may also occur with and/or without colonic stricture. In the latter case, a small bowel obstruction can result from adhesion of a loop of the small bowel to an inflamed sigmoid colon. This presentation usually improves as inflammation subsides with treatment. A colon stricture can be identified at CT scan and/or colonoscopy. The challenge is to distinguish between a diverticular stricture and a stenosing neoplasm, which is particularly true in older patients. Although it may not always be possible to advance the instrument into the sigmoid colon owing to angulation, narrowing, and tortuosity of the bowel, brush cytology should be performed. Colonic stenting may have a role as definitive treatment in frail patients with limited life expectancy. However, in most cases stenting is viewed as bridge to resection (within 7 days) and carries a 38% complication rate (such as re-obstruction, migration, and perforation) [68]. Performing a loop transverse colostomy through a trephine incision has been the preferred treatment option for decades particularly in patients who are not candidates for resection. Nonetheless, the challenge of a so-called blind colostomy remains the uncertainty of the diagnosis, especially in emergent situations. This statement is supported by the delayed diagnosis of cecal ischemia in patients undergoing blind colostomy for acute large bowel obstruction [69].

Ulcerative Colitis in the Elderly

Samuel Wilks is credited with coining the term ulcerative colitis (UC) in England [70]. The condition was known under the same term to surgeons in the Union Army during the Civil War [71]. Regretfully, to this day our understanding of the pathogenesis of UC still remains obscure despite extensive research on the possible role of genetics, autoimmunity, infection, diet, oxidative metabolism, stool, smoking, psychological factors, and appendectomy. Evaluation of the epidemiology is rendered difficult by the plethora of diarrheal states that present with symptoms not unlike those of nonspecific UC. Most of the data have been accumulated in the Western countries although UC is not a reportable condition in the United States. Although UC is most commonly affecting individuals younger than 30 years, recent population-based cohort studies have reported an increased prevalence in the elderly population [72]. The main concern in elderly UC patients is, however, the relationship to colorectal dysplasia and carcinoma. Older studies had already made known the bimodal distribution of UC with the highest incidence of colon cancer in the seventh decade [73]. Furthermore, the development of UC in the older population has become a source of a difficult differential diagnosis. It is not uncommon for several elderly patients with UC to be misdiagnosed for having ischemic colitis. Colonoscopic biopsies should be obtained from a mucosa that appears macroscopically uninvolved in order to distinguish UC from Crohn's colitis. In fact, granulomas may be found underlying ulcerated mucosa in UC patients. In fact, in the elderly UC may have a sudden and fulminating onset. Although a detailed description of the medical management of UC is beyond the scope of this chapter, a critical appraisal of the common errors in the cornucopia of available medications is briefly enumerated: the irritable bowel components of UC (bloating, gas, fullness) are not in and of themselves indications to steroids; under-treating with aminosalicylates should be avoided, and elderly patients should be encouraged to use enemas or suppositories to maintain remission; steroids have no role in maintaining remission; under-treating with antimetabolites commonly occurs in delaying introduction, underdosing, and early discontinuation; misusing Infliximab by giving to patients with bowel obstruction and/or internal fistulas; misusing Cyclosporine by giving it in fulminant or hemorrhagic disease. Unfortunately, gastroenterologists generally speaking tend to accept as criterion of success their ability to keep the patients from surgery [74]. While subtotal colectomy with end-ileostomy and mucous fistula remains the standard in emergency, the question remains whether there is any role for elective restorative proctocolectomy in the elderly. Unlike for Crohn's disease, there is no role for segmental colectomy in UC. Recent population-based data on 1749 elderly-onset subjects with UC have reported that such patients are more likely to undergo surgery with no significant difference in mortality by chronological age (when compared to young patients) [72]. The International Pouch Database encompassing 101 variables has suggested that elective restorative proctocolectomy may be performed in selected elderly patients, albeit with higher complications rates and longer length of stay [75]. Finally, advanced age does not seem to be a contraindication to ileostomy. Large volume centers have found that although lifestyle did not appear to be altered in the elderly than in younger individuals, elderly patients experienced more appliance management difficulties [76].

Crohn's Disease in the Elderly

The US data published in 2019 indicate that the prevalence of Crohn's disease (CD) is rising in the elderly population, a fact related to its increased incidence but also to improved life expectancies [77]. Presentation, natural history, and treatment of CD differ between young adult-onset patients who progress to elderly age and elderly-onset patients. Presentation at elderly age can also make diagnosis challenging due to pre-existing comorbidities that mimic the symptoms of CD or UC. Identifying patients at high risk for progression or aggressive disease is particularly important as elderly patients may respond differently to medical and surgical treatment, and may be at higher risk for adverse effects. Despite newer agents being approved for CD, the data regarding efficacy and safety in the elderly are currently limited. Balancing symptom management with risks of medical and surgical therapy is an ongoing challenge and requires special consideration in the elderly populations. The 2019 Scandinavian registry report found that elderly-onset UC patients are at increased risk of death when compared to reference population [78]. Moreover, the increased mortality remained also after the introduction of biologic therapies [78]. A US multiregional data set confirmed the trends reported in similar countries and also confirmed lower rates of perianal CD in the elderly [79]. In contrast to UC patients, a patient with CD may have obvious findings on physical examination. Abdominal findings are common in cases of regional enteritis and may include a mass felt in the right iliac fossa or a large mesenteric abscess can be palpated. Patients with Crohn's colitis most commonly have normal findings on physical examination. Inspection of the perianal skin and digital rectal exam may raise the suspicion of CD. Increasing evidence supports the statement that CD of the intestine is actually a systemic disease rather than one limited to the small and large bowel. Hence, extraintestinal symptoms are not uncommon and may include polyarteritis nodosa, erythema nodosum, psoriasis, arthritis, spondylitis, polymyositis, uveitis, and others. Endoscopy, MRI-enterography, and capsule endoscopy are part of the workup. Similar to the case of elderly UC patients, the relationship to dysplasia and carcinoma is a concern in elderly patients with CD. It is very difficult to assess the true incidence of CD and carcinoma of the small intestine, as the latter is such a rare condition. Moreover, the distribution of carcinoma of the small intestine in CD patients differs from its counterpart in patients without CD. The most common (70%) location to develop a carcinoma in CD patients is the ileum, whereas patients without CD most commonly develop tumors in the jejunum [80]. Furthermore, the likelihood of developing a carcinoma is increased by intestinal by-pass surgery [81]. The mortality rate is as high as 80% in CD patient who develop cancer in the excluded bowel. In the large intestine, CD with cancer is most commonly found in the right colon, as opposed to the more common left location in the general population. With regard to dysplasia, both radiology and endoscopy are of little benefit in establishing the diagnosis. Unfortunately, with the exception of the very distal ileum, the small intestine does not lend itself to endoscopy with biopsy. Although a detailed description of the medical management of CD is beyond the scope of this chapter, it is useful to provide a critical appraisal of the safety of drugs used in the treatment of CD. There are, in fact, concerns about the safety and adverse events associated with biologic agents. A review from Australia examined safety data on thiopurines, methotrexate, anti-TNFα agents, vedolizumab and ustekinumab in elderly patients focusing on trial and real-world data. The review found that the data are in support of concerns about an elevated risk of serious infections, skin cancer, and lymphoma particularly with thiopurines and anti-TNFα agents. The review also concluded that long-term data are required to identify risks with extended use of vedolizumab and ustekinumab [82]. In addition, smoking is an additive risk factor for relapse in CD, whereas nutrition is essential to decrease complication rates. Although the concept of short-term intravenous hyperalimentation has advantages, needed emergency surgery such as for free perforation of the small intestine or colon should not be deferred. Dissimilarly, lower GI bleeding very rarely will require surgery. Regardless of the choice of operation, it must be absolutely clear that surgery for Crohn's disease is palliative, not curative. This concept is particularly relevant when it comes to elderly patients with CD. Unlike for UC, segmental colectomy may become indicated in Crohn's colitis although endoscopic stenting can be an option in frail patients. The presence of abscess or fistula should prompt an assessment as to whether parenteral nutrition and interventional radiology may be indicated in frail patients.

Furthermore, in elderly patients the risk of carcinoma of the ileum must be kept in mind. This point is particularly relevant given the fact that achieving uninvolved resection margins and dissecting lymph nodes are not part of the standard of care in surgery for CD.

Pelvic Floor Disorders in the Elderly

Full-Thickness Rectal Prolapse in the Elderly

More than 150 years have elapsed since the first report on external full-thickness rectal prolapse surgery (FTRP) appeared in the literature [83]. Although there are a number of abdominal procedures for the treatment of external FTRP, which differ technically as to whether sigmoid resection is added to rectal mobilization and rectopexy, none of such procedures are actually appropriate in elderly patients. In fact, any abdominal operation for external FTRP will require general anesthesia with endotracheal intubation, whereas perineal procedures can be performed under epidural or spinal anesthesia. In elderly patients the most frequent primary complaint is referable to the prolapse itself. Three quarter of patients report a lump in the perineum. Problems with bowel regulation and incontinence are also common presenting features. Almost one half of our patients had a history of constipation. Major bleeding is rare unless the prolapse is massive or irreducible. The patient may however complain of small amounts of blood and mucous soiling the underwear.

Fecal incontinence is frequently associated with prolapse. Indeed, among the one quarter of patients who do not report a lump, many will complain of fecal incontinence as the main presenting problem, and rectal prolapse should be suspected whenever this symptom presents, especially in the elderly. Incontinence becomes more severe as the protrusion increases in degree. Dilatation of the canal by the mass results in further relaxation of the sphincter muscles and further prolapse. Protrusion may occur when lifting or coughing and not necessarily solely on defecation. Initially the prolapse may retract spontaneously but manual reduction eventually becomes necessary, and ultimately external FTRP may protrude for most of the time. Infrequently, the prolapse may become incarcerated or even strangulated resulting in a surgical emergency.

The patient with rectal prolapse may present with a myriad of different symptoms that range from constipation and straining to fecal incontinence. Therefore, it is of utmost importance that all patients undergo a complete preoperative workup before surgery. Upon physical examination, inspection may reveal an external rectal prolapse, especially during straining. However, external FTRP must be differentiated from mucosal prolapse. The mucosal prolapse can be differentiated from the full-thickness presentation because of the radially oriented grooves, while the FTRP has concentric grooves. In order to measure the prolapse adequately, the patient is asked to position himself in a squatting position. The patient is then asked to increase straining and the prolapse enlarges and lengthens. While the patient is straining, the distance from the perianal skin to the top of the prolapse is measured. Digital rectal examination may also add valuable information by detecting anal pathology and assessing sphincter tone and squeeze pressures. This information is important and aids the surgeon to choose the appropriate procedure for each individual patient.

Although not a standard test ordered for the evaluation of a patient with rectal prolapse, MRI defecography provides the surgeon with valuable anatomic and functional information for pelvic floor abnormalities. In addition, the results may indicate the presence of sigmoidocele or enterocele.

Colorectal transit time (also known sitz-marker study) provides essential information when confronted with a patient with concomitant constipation. Among the different methods for establishing the colorectal transit time, we recommend the method described by Gore et al. [84]. The patient receives six numbered day-packs. The five first packs contain 10 rings and the sixth contains 10 rings and 20 cylinders. Each day, at the same time, a pack is ingested. A plain abdominal radiography is taken on day 7. Rings are counted and the transit time is measured by the hospital's radiology department protocol. Colonoscopy must be performed in order to rule out any mucosal abnormality, especially in patients with a prior diagnosis of diverticulitis, inflammatory bowel disease, or cancer. Anal manometry is important in evaluating the patient with a longstanding history of rectal prolapse and incontinence. Patients with pudendal nerve damage, from either obstetric trauma, diabetes, or neoplasms, must also undergo manometric evaluation prior to surgery.

There are, in essence, two perineal procedures that should be considered in elderly patients with external FTRP. Such procedures are referred to with the names of the surgeons who described them initially: Altemeier's procedure and Delorme's procedure. Altemeier's is the procedure of choice in case of external FTRP exceeding 5 cm length, but it is also indicated in the rare circumstance of strangulated unreducible external FTRP where gangrene may or may not occur. Moreover, a levator-plasty and a colonic J-pouch may be considered in case of associated severe fecal incontinence. Delorme's procedure should be considered in case of external FTRP of less than 5 cm in length. Because the peritoneal cavity is not entered, Delorme's procedure is the procedure of choice in case of cirrhotic patients with ascites. Dissimilarly, it should be kept in mind that the peritoneal cavity is always entered during Altemeier's procedure.

In Altemeier's procedure, a circumferential incision is made through all layers of the outer bowel wall 1 cm proximal to the mucocutaneous junction. When the circumferential incision is completed, clamps are reapplied to the distal edge of rectum, and the prolapse is delivered as a single loop of externalized bowel. With a deep Douglas pouch, it is straightforward to enter the peritoneal cavity by incising the peritoneum anteriorly. The redundant colon is delivered through the defect. The peritoneum is repaired using a continuous suture to obliterate the sac. A plication of the levator ani muscles is carried out. The redundant intestine is transected. The anastomosis is fashioned with an interrupted long-term absorbable suture technique.

In Delorme's procedure, a circumferential incision is made 1 cm proximal to the dentate line, similar to that for Altemeier's procedure. The bowel is not transected, however. A submucosal dissection with a mucosal stripping is carried out to the apex of the protruding bowel. Dissection may be facilitated by infiltrating the submucosa with saline solution. The redundant mucosa is excised, and the denuded muscularis propria is plicated longitudinally, collapsing the bowel like an accordion. The edges of the mucosa are then sutured.

Postoperatively, the usual considerations are addressed. Early activity and incentive spirometry are encouraged. Pain is initially controlled with an epidural catheter with local anesthetic. Diet is advanced with the return of bowel function, and the pain medication is transitioned to oral formulations. The Foley catheter can be removed on the first postoperative day unless other comorbidities are present. Upon discharge, the patient is instructed to avoid heavy lifting. Dietary goals should be addressed. Avoidance of constipation or overly loose stool should be discussed. The patient should be seen in the office within 1–2 weeks of discharge. Continued follow-up will assist the surgeon in his or her evaluation of the success of the repair.

Incontinence

Fecal incontinence is very common in the elderly population and can cause morbidity and decrease quality of life. Many patients feel embarrassed to discuss the condition with a physician. Incontinence can result from intestinal disease-causing irritability and urgency of defecation due to inflammation or loss of capacity of the rectum or neorectum or from a defective anal sphincter mechanism. The management of incontinence associated with intestinal diseases is part of the treatment of those conditions.

Previously fecal incontinence was regarded as a mechanical disorder, whereas it has become increasingly clear that there is a large functional component. Behavioral therapies have been developed and their value is now established. Importantly, surgical correction is reserved for patients who have a mechanical disruption of the sphincter mechanism. Its use has therefore declined having been largely replaced by neuromodulation including stimulation of sacral, posterior tibial, or pudendal nerves. Artificial sphincters either biological in the form of graciloplasty (stimulated or non-stimulated) or prosthetic are not indicated in elderly patients. Anal procedures including the injection of bulking agents into the anal canal lining and so-called radio frequency energy delivery (SECCA) to promote scarring of the anal canal have been developed, particularly for patients with passive incontinence due to failure of the internal sphincter.

Clinical assessment combined with anal ultrasound to establish the anatomy of the sphincter and physiological testing by manometry will result in satisfactory decision-taking in most circumstances. Anal ultrasound is now routine in the assessment of continence. Some of the physiological parameters thought to be important in the past, for example, electromyography and pudendal nerve terminal motor latency, are no longer regarded to be useful in clinical practice.

The outcome for the patient is now expressed as much by quality of life as by the frequency of incontinent episodes. The important symptom of urgency, which may be the only manifestation of a continence disturbance, can now be quantified enabling improved assessment. The development of continence scoring systems has also improved our ability to assess the effectiveness of treatment.

The development of scoring systems has been an important feature of practice. In 1993, Jorge and Wexner proposed a continence grading scale which is now termed the Cleveland Clinic Incontinence Score that has now come to be used by many investigators [85].

Attempts have been made to compare functional estimations of anal sphincter capacity in the elderly population as compared to younger adults. Some studies have concluded that elderly patients have lower anal pressures, required lower rectal volumes to inhibit anal sphincter tone, and have increased rectal pressures as measured by balloon implying lower compliance [86]. Some authors suggested that internal anal sphincter dysfunction may be the important factor [87]. Others suggested that, especially in women, the pudendal and somatic pelvic nerves are injured when there is perineal descent on straining as occurs with aging [88].

Patients with loss of sphincter function through injury, whether surgical, obstetric, or trauma, are the most amenable to reconstructive surgery, whereas those with incontinence due to a general disease or a locally diffuse weakness of the pelvic are generally poor candidates for an attempt at repair. For these, conservative treatment in the form of dietary advice, antidiarrheal medication, and behavioral therapy such as biofeedback should be the initial approach along with treatment of any underlying disease. Some of these patients will be candidates for neuromodulation if conservative management is not successful.

The management strategy of fecal incontinence depends on the results of assessment. The key to decision-taking depends on whether the sphincter is intact or not. This is determined on clinical examination by inspection, palpation, and anal ultrasound. A patient with no sphincter defect will not respond to surgical repair. Conservative management should be tried, and if that fails, the options include neuromodulation, anal canal injection, SECCA, or irrigation.

A patient with a sphincter defect will benefit from surgical repair if the defect is large. If the sphincter defect is small, the patient may be suitable for neuromodulation as long as the muscle has contractility. A failed repair is not a contraindication to a second attempt at repair provided that the sphincter muscle is not atrophic. Irrigation is also an option when the above treatments fail.

In general, conservative treatment should be tried first unless a cloacal deformity with severe incontinence is diagnosed, a condition that requires immediate repair is indicated. Conservative management should be abandoned when the patient feels with full knowledge of the options and disadvantages that another treatment is necessary. When this situation is the case, the treatment options depend on whether the sphincter is intact or not.

Treatment options are traditionally classified in non-invasive and invasive. The former includes perineal exercises, biofeedback, electrical stimulation, anal plug, and anterograde or retrograde colonic irrigation. Unlike anterograde, retrograde irrigation is easy to perform and has very low morbidity. The available evidence strongly indicates that it can have a success rate of 50% or more. It may be sufficiently successful to avoid a colostomy when all other treatments have been tried and failed. In current practice, this option is probably underused. Invasive treatment options include injection of bulking agents, radiofrequency energy (SECCA procedure), neuromodulation, sacral nerve modulation, posterior tibial nerve modulation, pudendal nerve stimulation, and sphincter repair.

Two different forms of sphincter dysfunction (diffuse weakness and localized sphincter trauma) have been traditionally treated with sphincter repair. Patients present with an acute injury caused by direct lacerating or blunt trauma often associated with other injuries. There may be fecal contamination of the injured field, and management will involve a decision whether or not to perform a defunctioning stoma along with debridement of the wound removing non-viable tissue and foreign material. Defunctioning stoma may be necessary. After recovery of the patient, any pelvic floor damage can be repaired electively. It is recommended that reconstruction should not be performed for at least 3 months to allow the acute inflammation to settle. Although earlier publications demonstrated improvement in continence after delayed sphincter repair in 80% of patients [89], more recent reports showed that an initially good result was followed by deterioration with time [90].

Performing a colostomy in a patient with fecal incontinence is thought generally to be an admission of failure, but it should not be regarded as such. Elderly individuals should not be submitted to the morbidity of a sphincter-saving operation. The likelihood of success in elderly patients who have neurologic deficit, or who have severe bowel function problems, is limited. Fecal diversion is virtually often the optimal choice for elderly patients confined to a nursing home or to a convalescent facility unless they are blind. Irrespective of the method of treatment, more frequently than in any other colorectal disease, elderly patients with fecal incontinence need to be partners in the decision-making process.

Constipation

Elderly patients who present with constipation may have a mechanical reason, or the condition may be functional. In the latter case, the constipation could be due to slow transit through the intestine or to a difficulty in evacuating the rectum. Not infrequently both factors can present in elderly patients. Moreover, delayed intestinal transit can be present in bowel of normal or dilated caliber. In the latter circumstance, the condition is usually chronic, but it can also be acute such as in pseudo-obstruction (Ogilvie's syndrome) [91]. Normal caliber constipation may also be caused by factors such as advanced age, institutionalization and immobility, drugs, metabolic disorders (hypothyroidism, hypercalcemia), depression, or neurological disease. Obstructed defecation should be viewed as mechanical and functional, although overlap is not uncommon. In the last 10 years there has been a marked move away from surgery toward behavioral treatment (biofeedback and neuromodulation) for patients with functional constipation due to delayed transit. In the United States, the cost of over-the-counter laxatives is in excess of 400 million dollars, and the outpatient medical care of elderly females with constipation is twice as costly as those without [92]. The prevalence in the community of the so-called functional constipation has been reported to be between 20% and 30% [93]. Constipation is more common in adults older than 60 years of age (23%), and in those who were inactive [94]. Painful anal disease may also result in constipation through the reluctance of the patient to have bowel movements leading to impaction in the rectum. Non-mechanical causes of constipation include conditions resulting in reduced transit. The causes of the various forms are unknown, but delayed transit may involve the entire intestine including gastric function or be confined to the colon [95]. The differential diagnosis can be made by radio-opaque markers or isotope scintigrams, which can measure gastric emptying as well as oro-cecal and colonic transit times. Obstructed defecation is a common cause of constipation. Functional obstructed defecation may be caused by failure of the pelvic floor adequately to relax as in anismus including the solitary rectal ulcer syndrome or it may be due to laxity of the pelvic floor associated with perineal descent or even rectocele [96]. The diagnosis is based on the Rome III criteria [97], and its severity can be assessed with validated constipation scores [98]. Immobility plays a major role in constipation. In fact, there is evidence that physical activity is associated with a higher stool frequency [99]. In a survey of elderly patients, the overall incidence of constipation was no different than in younger adults but it was related to immobility and/or depression [100]. Bedridden elderly patients are more likely to have constipation than those who are able to walk and even more so than patients who walk several hundred yards a day [101]. Constipation is often due to fecal loading in the rectum. Impaction is commonly seen in institutions where immobility and constipating drugs are both factors delaying transit and evacuation. Exercise improves bowel function in normal sedentary men and women [102], but not in patients who are already severely constipated [103]. There is evidence from institutional studies that exercise, adequate hydration, and fiber intake can reduce the need for laxatives [104]. There is a large literature regarding the questions whether laxatives can affect the structure and/or function of the intestine. With respect to the former, there is poor evidence that laxatives can cause intestinal nerve and smooth muscle damage. The effect of laxatives on the enteric nerves and smooth muscle was reported in the 1960s [105]. In fact, such elderly patients had severe constipation due to the primary disease itself rather than to secondary damage by laxatives. Moreover, ultrastructural changes seen in elderly patients on long-term laxatives can also be found in amyloid, diabetic neuropathy, and inflammatory bowel disease [106]. More recent studies have demonstrated reduced numbers of Cajal cells and enteric neurons in patients with severe colonic inertia [107, 108]. However, such changes may be due to the disease and not to the laxatives [109]. Laxatives can certainly cause electrolyte inbalance when taken in high doses. A review of the literature showed 70 publications including 240 patients with diarrhea caused by hidden laxative administration. The laxative in question was phenolphthalein and the metabolic disturbance was hypokalemia [110]. Certainly, laxatives can lead to melanosis coli if used over time. This condition is due to the deposition of pigment due to staining by anthroquinones of cell debris from colocytes ingested by macrophages in the submucosa [111]. This condition is of no clinical significance and disappears within months after stopping the laxatives.

Drug-induced constipation may be caused by opioids, anticholinergics, antidepressants, iron, bismuth, antiparkinsonians, aluminum-containing antacids, antihypertensives, and anticonvulsants. In fact, both symptoms and radiologic findings of colonic dilatation may completely resolve following discontinuation of the medications [112]. Low levels of thyroid hormones have been regarded as a cause of constipation although there is a low prevalence of hypothyroidism in a prospective study in elderly female patients with constipation [113]. Constipation may also develop as a result of impaired rectal evacuation. Conditions responsible include prolapsing disorders and anismus. The latter is described as a functional disorder of the pelvic floor muscle in which straining or attempting to defecate leads to muscle contraction instead of relaxation, thereby causing a physiologic outlet obstruction and the inability to defecate [114].

The clinical assessment should include three elements: frequency of defecation, the consistency of the stool, and the presence of urgency.

In fact, patients with an evacuation disorder of the type seen in the solitary ulcer syndrome may make numerous visits to the bathroom where they may stay straining for hours. The physical exam should always include a neurological assessment. Unless the patients have symptoms suggestive of a mechanical cause, it is reasonable to treat the patient in general terms before carrying out sophisticated investigations such as sitz-marker transit time with ingestion of radio-opaque rings; scintigraphy with oral ^{111} Indium bound to diethylenetriaminepentacetic acid (DTPA) followed by a gamma scan at 72 and 96 hours; colonic manometry involving transanal insertion of open tipped or balloon probes; anal manometry particularly useful patients with anismus (high resting pressure at internal sphincter) and paradoxical contraction of the puborectalis muscle; balloon expulsion failure which is indicative of obstructed defecation; and MRI defecography. Treatment options can be medical or interventional. The former includes the management of any underlying disease, discontinuation of constipating drugs, dietary changes, and increased physical exercise. Biofeedback, neuromodulation, posterior tibial nerve stimulation, and retrograde (better than anterograde) irrigation are the available interventions. Currently, neuromodulation is the first choice of invasive treatment when the patient is still suffering despite medical and behavioral treatment. Elderly patients are generally not candidates for colectomy, which can be complicated by high rates of small bowel obstruction [115]. Furthermore, the reported 70% decrease in laxative consumption after colectomy may last for only a few years or less. In addition, about 10% of patients experience urgency and abdominal bloating after colectomy, unlike with neuromodulation [116].

Vascular Diseases of the Colon

Lower Gastrointestinal Bleeding

Elderly patients may develop a lower gastrointestinal (GI) bleeding due to common conditions, such as colorectal cancer, inflammatory bowel disease, hemorrhoids, infectious colitis, ischemia, radiation, and renal transplantation [117]. Uncommon conditions that can produce massive bleeding are coagulopathy, Dieulafoy's disease, aortointestinal fistula, rupture of a splenic artery aneurysm, microaneurysm of the superior hemorrhoidal artery, rupture of a pancreatic pseudocyst into the colon, angiosarcoma, and colorectal varices [118–121]. Regardless of the cause of the bleeding, a systematic approach to diagnosis and management is required to care for the elderly patient adequately. This includes stabilization of the patient and initial workup, followed by diagnostic studies (colonoscopy and angiography) to identify the source of bleeding, and finally intervention to stop the bleeding.

The importance of obtaining an accurate history cannot be overemphasized. For example, knowledge of prior abdominal aorta surgery may be critical. In addition to a detailed medical and surgical history, identifying risk factors for bleeding is essential in the history, such as the patient's use of anticoagulants or antiplatelet drugs. However, patients usually present with no history of lower GI bleed, and they frequently have no abdominal pain.

One should, obviously, perform a digital rectal examination and a limited rigid sigmoidoscopy with anoscopy as the initial examination. However, the yield from these diagnostic procedures is less than 10% [122]. The placement of a nasogastric tube can eliminate the stomach as a potential source, especially if clear bile is returned. The approach to the bleeding patient (after initial assessment is complete and the patient is believed to have a lower GI source for bleeding) is to proceed with colonoscopy or CT scan.

Classically, massive lower GI bleeding has been generally attributed to diverticular disease. The vasa recta, through their proximity with the diverticulum, can rupture either at the apex or at the neck as the vessel proceeds into the submucosa of the colon. The problem, however, is that most lower GI hemorrhage comes from the right side of the colon, where there are few or no diverticula. Evidence suggests that unexplained vigorous lower intestinal bleeding, even in the presence of known diverticulosis, is most likely due to an arteriovenous malformation (vascular ectasia, angiodysplasia) [123–125]. With the availability of CT-angiography and scinti-angiography, and the ability to identify preoperatively the site of bleeding, arteriovenous malformations have not uncommonly been observed in areas where diverticulosis is present. The current opinion is that lower GI bleeding mostly originates from vascular malformations. Since vascular malformations are more common in the right colon, we are assuming that the right colon is the most common site for lower GI hemorrhage. Bleeding associated with vascular malformations is usually less severe than that from diverticular hemorrhage.

The etiology of the vascular malformations has been unclear. However, new studies suggested that the vascular lesions are actually degenerative from an acquired and progressive dilatation of previously normal blood vessels as the result of the aging process [126].

Although Dieulafoy's lesion is most often a pinpoint nonulcerated arterial lesion, high in the gastric fundus, it has rarely been described as the source of bleeding in the colon, rectum, and anal canal.

Colorectal varices are a rare cause of lower GI bleed, almost always associated with cirrhosis, with resultant portal hypertension, or portal venous obstruction [127]. The condition has been reported in approximately 2.5% of those undergoing sclerotherapy for esophageal varices [128]. As few as 3.6% and as many as 56% of cirrhotic patients have been demonstrated to have concomitant rectal varices. Portal hypertension can also lead to stomal and parastomal varices, especially in an individual with sclerosing cholangitis and biliary cirrhosis as an extraintestinal manifestation of inflammatory bowel disease [129].

As implied from the foregoing, if the bleeding point is identified by means of angiography, tagged red cell scan, and endoscopy, appropriate therapy can be instituted: medical management, a local procedure, or resection, depending on the nature of the lesion and the patient's clinical course.

In the patient who continues to bleed and the source cannot be identified, blind left colectomy has historically been advocated, and later, right colectomy. Nonetheless, most surgeons today would rather perform subtotal colectomy with ileostomy. In spite of a 20% rebleeding rate after right hemicolectomy for angiographically demonstrated vascular malformations, some authors believe that the mortality risk of subtotal colectomy is greater than that of rebleeding [130]. Other authors reported an unacceptable mortality of 27% following subtotal colectomy [131]. On the other hand, rebleeding rate following subtotal colectomy with a mean follow-up of 1 year was 0% [132]. The rebleeding rate after segmental resection was 14% with a preoperative positive angiogram and 42% if the angiogram was negative. The latter patients also had an extremely high mortality rate (57%).

Nowadays, thanks to the availability of CT-angiogram and interventional radiology, surgeons should rarely have to resort to blind resections. Nonetheless, if the bleeding source is clearly demonstrated and cannot be controlled by some other means, a segmental colectomy is appropriate. Conversely, if the source of the bleeding is not identified with certainty, an emergency subtotal colectomy should be considered even in frail elderly patients. Finally, it is strongly recommended to perform a rigid sigmoidoscopy with the patient in stirrups prior to subtotal colectomy in order to definitively determine that the bleeding site is not the rectum or the anus.

Ischemic Colitis

Ischemic colitis is a term to describe a syndrome due to occlusive or nonocclusive vascular disease as it affects the large bowel. It is a very common disorder in elderly patients, being the most common form of intestinal ischemia and responsible for 1 in 2000 patient admissions [133]. It is a condition that usually is found in the aging population, with an increased incidence in women [134]. The following conditions produce their pathologic manifestations on an ischemic basis: arteriosclerosis, emboli, myocardial infarction, vasculitis, colorectal neoplasms, portal hypertension, strangulated hernia, volvulus, diabetes mellitus, hypertension, chronic renal failure, periarteritis nodosa, systemic lupus erythematosus, rheumatoid arthritis, polycythemia vera, scleroderma, hemodialysis, and methamphetamine abuse [135–138]. Hypotension with associated low-flow state is responsible for ischemic colitis in individuals on hemodialysis [139]. Ischemic colitis can also be the consequence of a colon resection, of operations performed on the aorta and the heart, and/or of embolization for lower GI bleeding [140]. Ischemic colitis has been classified on the basis of its three general manifestations: gangrenous, strictured, or transient.

If gangrene of the colon develops, the patient will require emergency surgery. The sigmoid colon is the most frequent area of symptomatic stricture. Radiology is often not of benefit to identify ischemia of the colon. Endoscopy would allow differentiating with malignant stricture. Non-operative management with reevaluation at a later time can be considered for strictured ischemic colitis. However, if the patient has a symptomatic stricture and the diagnosis cannot be established with certainty, resection is indicated.

Rectal bleeding may be the only complaint in elderly patients with transient ischemic disease. Abdominal pain and tenderness on the left side are usually minimal. Colonoscopy will always reveal rectal sparing with changes starting at approximately 15 cm from the anal verge.

If the rectum is involved, another etiology is likely to be the cause: ulcerative colitis, antibiotic-associated colitis, or an infectious colitis.

Surgery is indicated for peritonitis and obstruction. A previous study found intraperitoneal fluid on CT scan and the absence of blood per rectum to be independent predictors of surgery for ischemic colitis [141].

Intraoperative use of indocyanine green injection can facilitate the diagnosis as the degree of ischemia is often difficult to determine at the naked eye. Segmental colectomy is generally a poor alternative, but if undertaken should always be accompanied by diversion. Subtotal colectomy with an ileostomy is undoubtedly safer.

Ischemic colitis may develop following cardiac surgery or resection of an abdominal aortic aneurysm with the rate of up to 25%. This complication may lead to a mortality rate of as high as 75% [142]. Rectal bleeding within the first 72 hours following aneurysmectomy should raise suspicion. Colonoscopy would be useful to establishing the diagnosis of ischemic colitis in the postoperative period.

Proctitis

Proctitis is a clinical entity often misdiagnosed and not uncommon in the elderly population. The most common symptom is generally rectal bleeding with pain and tenesmus. The two most common causes of proctitis are ischemia and radiation.

Generally, the rectum is spared from ischemia due to its collateral blood supply. The diagnosis is established by its appearance at sigmoidoscopy. In extremely rare cases ischemia of the rectum will evolve to gangrene.

The rectum is particularly vulnerable to the effects of radiation due to its fixed position in the pelvis. As known, elderly patients may have undergone radiation for gynecological cancers or prostate cancer.

Management of proctitis is usually directed to dietary measures, the addition of medications for diarrhea, bulk agents, stool softeners, iron replacement if anemia is a concern, and antispasmodics. Retention enemas containing hydrocortisone have been recommended for rectal bleeding.

A number of other topical approaches to the control of symptoms associated with radiation proctitis have been offered; including sulfasalazine, tranexamic acid, and sucralfate enemas, but the efficacy of these approaches has not been well documented.

The use of topical formalin has been used with success in radiation proctitis. Formalin (3.6% solution) can be irrigated with a total of 2 liters for 15 minutes, followed by irrigation with sodium chloride solution. This technique should be performed in lithotomy or left lateral position as migration of the solution up into the descending and transverse colon may lead to a significant colitis. More controlled is the application of a gauze soaked in 4% formalin, laid in contact with the hemorrhagic surface. Improvement rate of up to 88% was previously reported [143]. One study claimed that the rectal bleeding due to radiation proctitis can be successfully treated with daily low pressure tap water enemas in addition to oral antibiotics [144]. As an alternative to enemas, short-chain fatty acids have been described in elderly patients with radiation proctitis [145]. In case of failure of enema treatment, laser therapy can be offered to control bleeding caused by radiation proctitis [146–148]. Another option in the management of radiation proctitis is hyperbaric oxygenation [149].

In the uncommon case of an elderly patient with urethro-rectal fistula secondary to radiation, the management will depend on the size of the fistula, the degree of pain, and the function of the urethral and anal sphincters. Because of frailty, such patients are rarely candidates for major restorative resections, and colostomy should be considered.

Volvulus

Sigmoid volvulus is a relatively uncommon condition. Urgent detorsion is recognized as the main goal. In the United States, the incidence is only approximately 5%. The most commonly involved location is sigmoid colon, followed by cecum, transverse colon, and the splenic flexure. In English-speaking countries, the average age is considerably older, and the condition is as likely to occur in either gender. The pathogenesis of sigmoid volvulus is obscure. Most patients are elderly and have a high incidence of associated medical or psychiatric comorbidities with chronic constipation. Volvulus is associated with neurologic deficit. In fact, the high incidence of volvulus in institutionalized elderly patients may be more a reflection of the associated neurologic disease. Previous surgery (especially rectal mobilization for prolapse) may be a risk factor for volvulus.

The clinical manifestations can be typical or atypical. The typical presentation is acute, whereas an indolent presentation represents a slowly progressive onset with less pain. Clinical features of sigmoid volvulus are usually similar to those of colonic obstruction including absence of bowel movements, failure to pass flatus, crampy abdominal pain, nausea, and vomiting. Distended abdomen with no peritoneal irritation is usually present on physical examination. Rectal examination shows an empty ampulla.

A plain abdominal x-ray will usually reveal a markedly distended ahaustral sigmoid loop with relatively minimal gas noted in the rectum ("coffee bean" sign). CT scan with rectal contrast may demonstrate complete retrograde obstruction at the level of the torsion or may reveal an area of narrowing with proximal dilatation if the obstruction is incomplete. Flexible sigmoidoscopy can be used for the treatment of sigmoid volvulus. If necrotic bowel is observed at the time of endoscopic examination, emergency laparotomy is indicated. It is recommended to perform rigid sigmoidoscopy in the operating room before laparotomy.

A study utilizing the US Department of Veterans Affairs database found that 81% of the 189 patients underwent successful endoscopic detorsion [150]. Although endoscopic detorsion avoids emergency surgery, the recurrence rate is as high as 23%. Emergency surgery in the elderly may be associated with the mortality rate of up to 20%. It is obvious that if the patient can possibly tolerate an elective operation, this should optimally be performed during the same admission after the bowel and the patient have been prepared. The type of surgery will mostly depend on whether the colon is viable. If the colon is non-viable, resection with colostomy is unavoidable, and the transection should be performed on the rectum distal to the paper-thin bowel wall involved in the volvulus. Any transection of the colon too close to the ischemic sigmoid wall may lead to blowout of the staple line. Oversewing the staple line with interrupted silk sutures is recommended even when the transection is placed on the rectum appropriately distal to the ischemic rectal wall. If the colon is viable, fixation techniques should be favored instead of colon resection. Percutaneous endoscopic colostomy was successfully carried out in elderly patients in whom surgery was considered unsafe [151]. Laparoscopic sigmoidopexy can be considered unless there are contraindications for pneumoperitoneum.

Cecal volvulus is much less common than sigmoid volvulus particularly in elderly subjects. There are three well-recognized types of cecal volvulus: the axial torsion type (type 1), loop type (type 2), and cecal bascule type (type 3). Eighty percent of all cecal volvulus cases are attributed to type 1 and 2 [152]. Low grade and colicky abdominal pain is usually the most common complaint. On X-ray or CT scan, the cecum and ascending colon can be displaced, the most common sites of displacement being the epigastrium followed by the left upper quadrant. Classic x-ray findings include a "coffee-bean" shape and visible mucosal folds at the site of obstruction with no gas distal to the point of obstruction. Colonoscopy has been successfully employed for detorsion of cecal volvulus. If attempts at colonoscopic detorsion fail, laparoscopy or laparotomy should be performed. In case if the viability of the bowel is compromised or if perforation is present, resection is mandated. If the bowel is viable, cecopexy may be performed. Cecopexy may be associated with high risk of recurrence.

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22 Liver Transplant Surgery in the Elderly

Seigo Nishida

Liver transplant (LT) becomes a real practice for end-stage liver disease and liver failure patients. The results of liver transplantation have improved gradually over the years. Patient selection, anesthesia, liver transplant surgery, postoperative management, intensive care, and immunosuppression have significant improvement. The number of liver transplant performed in the United States steadily increased. UNOS data showed that the number of liver transplants in the United States was 1713 cases in 1988, 4519 cases in 1998, 6319 cases in 2008, and 8250 cases in 2018. General population becomes older. Liver transplant recipients in elderly have increased over the years. Percentage of the liver transplant over 65 years is also steadily increasing over the years (from 1.7% in 1988 to 21.8% in 2018) [1]. The older patients tend to have more comorbidities and higher surgical risk [2]. The chronological age is an important factor but not the best to assess the patient [2, 3]. Physiological age is more important [2, 3]. We reviewed the national data, publications, and our experience. We also discussed the donor, pretransplant evaluation and management, waiting list, liver transplant surgery, post liver transplant, immunosuppression, and future.

S. Nishida (✉)
Department of Surgery, Transplant Section, Westchester Medical Center and New York Medical College, Valhalla, NY, USA
e-mail: Seigo.Nishida@wmchealth.org

Increased Numbers of Older Recipients

United Network of Organ Sharing (UNOS) data showed that the number of liver transplant has increased steadily, and the age of the liver transplant recipients has increased [1]. UNOS data showed that the number of liver transplants in the United States was 1713 cases in 1988, 4519 cases in 1998, 6319 cases in 2008, and 8250 cases in 2018. Age group data showed that age group between 50 and 64 years old and age group 65 or more increased steadily [1]. Especially age group 65 or more has strongly increased (Figs. 22.1 and 22.2). UNOS data showed that the number of liver transplants of age group 65 or more in the United States was 29 cases in 1988, 322 cases in 1998, 621 cases in 2008, and 1795 cases in 2018 (Fig. 22.3). Percentage of the age group 65 or more also showed steady increase of this group (Fig. 22.4). UNOS data showed that the percentage of liver transplants of the age group 65 or more in the United States was 1.7% in 1988, 7.1% in 1998, 9.8% in 2008, and 21.8% in 2018 (Fig. 22.4). The waiting list of the age group 65 or more is also increasing [1–3]. Recent report showed about 23.8% of the liver transplant waiting list in 2017 is this group [1, 4].

The improvement of surgical technique and perioperative care gradually increased the indication of liver transplant for older liver transplant patients [5]. The aging population with hepatitis

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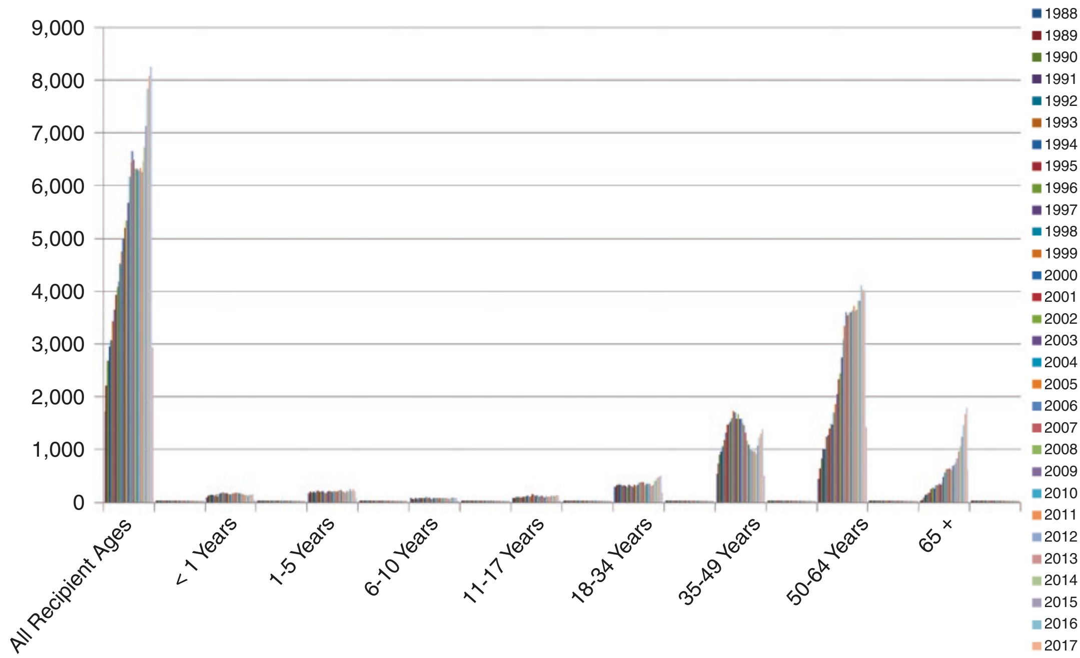

Fig. 22.1 Liver transplant between 1988 and 2019

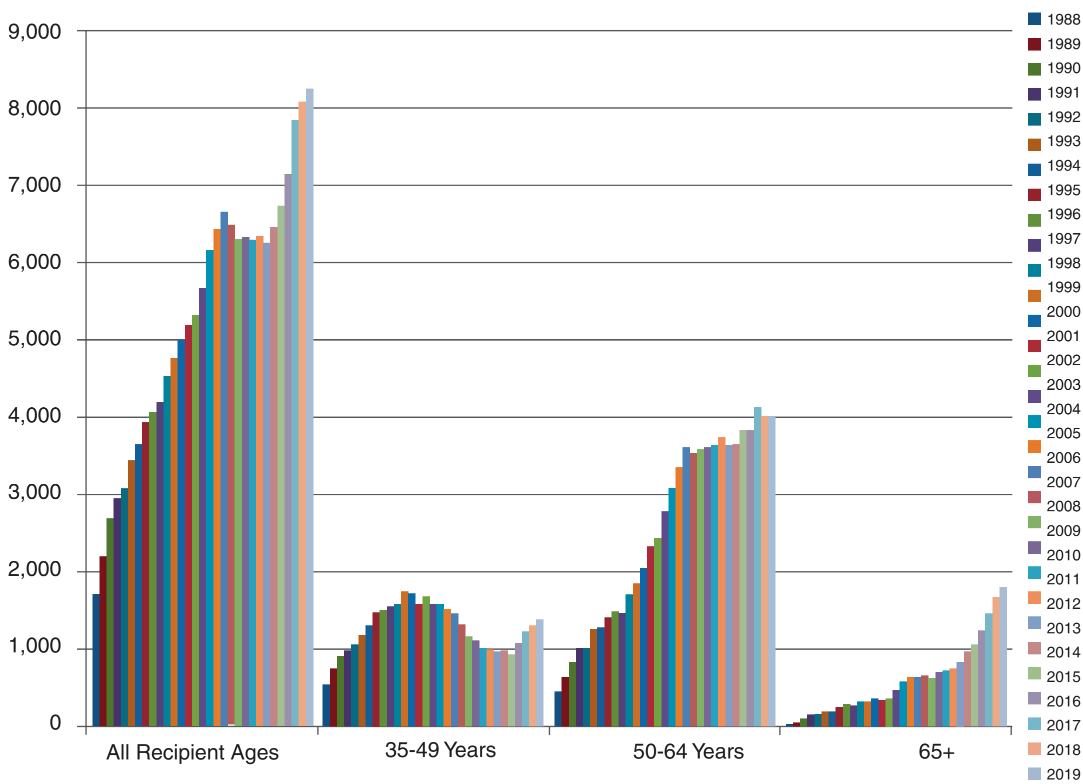

Fig. 22.2 Liver transplant age groups between 1988 and 2018

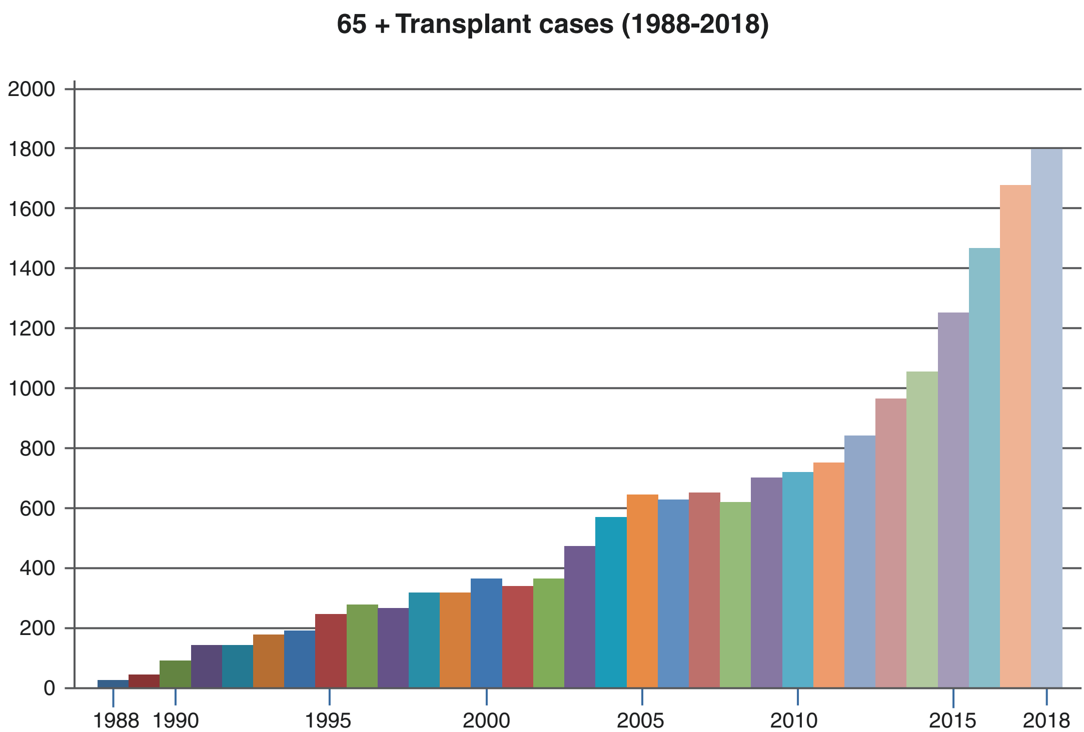

Fig. 22.3 Liver transplant 65+ between 1988 and 2018

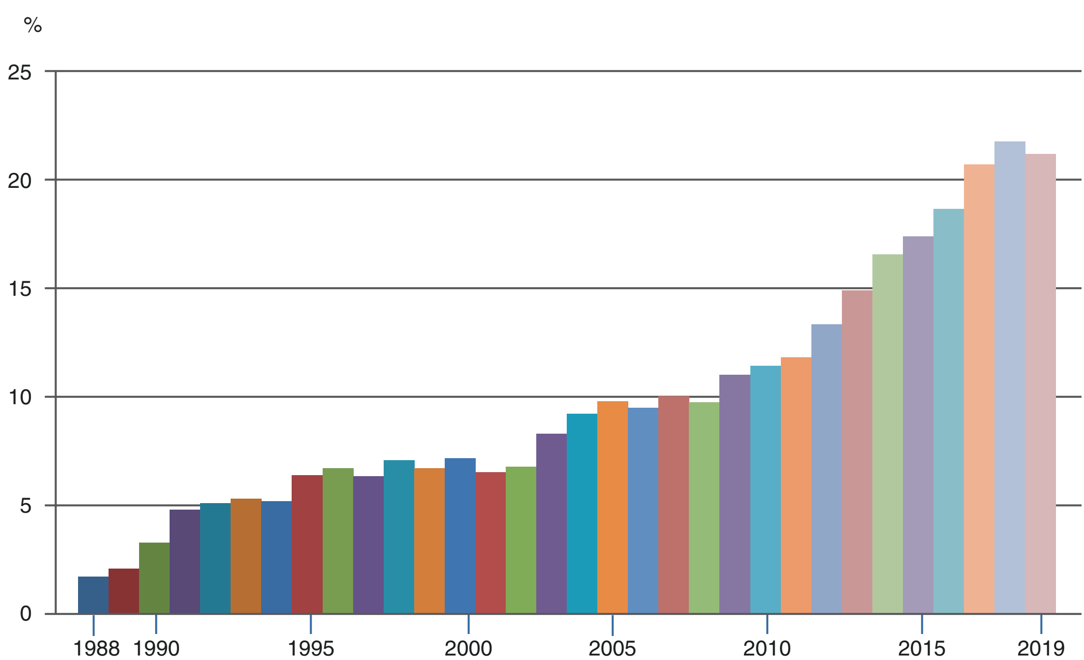

Fig. 22.4 65+ recipient percentages between 1988 and 2019

C, nonalcoholic steatohepatitis, and hepatocellular carcinoma may be the factor to increase the older patients [1–5]. The improvement of hepatitis C treatment has also change the patient populations [5]. Since the recent introduction of effective direct-acting antivirals (DAAs) for hepatitis C virus infection, recipient population may change. Before DAAs, HCV virus infection was the most common primary diagnosis for liver transplant recipient. Currently, NASH, alcoholic liver disease, and HCC patients have been increasing steadily. Especially NASH with HCC patients is older than HCV patients. Even the change of the primary disease, older recipients may increase further over the years.

Liver Transplantation in Elderly

General population becomes older. The number of liver transplantations has increased over the years [1]. Durand et al. reported about these topics in 2019 [2]. In general, older liver transplant patients have less chance of having rejection [2]. Especially patients with nonimmune conditions such as NASH and alcoholic cirrhosis do not require higher maintenance immunosuppression [2]. These patients may get benefits from lower immunosuppression. Dual or triple immunosuppressive therapy may not be needed and may increase the risk of infection and malignancy. We also observe similar outcome and agreed with this concept. More malignancy and infection can cause the mortalities in liver transplant patients, especially in elderly.

Su F et al. reported that between 2002 and 2014, the mean age of liver transplant registrants increased from 51.2 to 55.7 years, with a more prominent increase in hepatitis C virus-positive (50.9–57.9 years) than hepatitis C virus-negative (51.3–54.3 years) registrants [3]. The proportion of registrants aged ≥60 years increased from 19% to 41%. In hepatitis C virus-negative patients, aging trends were driven by increasing proportions of patients with hepatocellular carcinoma or nonalcoholic steatohepatitis. Among transplant registrants, increasing age was associated with increasing mortality before transplantation and decreasing likelihood of transplantation. Among transplant recipients, increasing age was associated with increasing posttransplantation mortality. There was little difference in 5-year transplant-related survival benefit between different age groups who had the same Model for End-Stage Liver Disease score. They concluded that dramatic aging of liver transplant registrants and recipients occurred from 2002 to 2014, driven by aging of the hepatitis C virus-positive cohort and increased prevalence of nonalcoholic steatohepatitis and hepatocellular carcinoma. Increasing age does not affect transplant-related survival benefit substantially because age diminishes both posttransplantation survival and waitlist survival approximately equally.

Benitez et al. from Spain reported prospective multicenter clinical trial of immunosuppressive drug withdrawal in stable adult liver transplant recipients [6]. They reported that lifelong immunosuppression increases morbidity and mortality in liver transplantation. Discontinuation of immunosuppressive drugs could lessen this burden, but the safety, applicability, and clinical outcomes of this strategy need to be carefully defined. They enrolled 102 stable liver recipients at least 3 years after transplantation in a single-arm multicenter immunosuppression withdrawal trial. Drugs were gradually discontinued over a 6–9-month period. The primary endpoint was the development of operational tolerance, defined as successful immunosuppressive drug cessation maintained for at least 12 months with stable graft function and no histopathologic evidence of rejection. Out of the 98 recipients evaluated, 57 rejected and 41 successfully discontinued all immunosuppressive drugs. In nontolerant recipients rejection episodes were mild and resolved over 5.6 months (two nontolerant patients still exhibited mild gradually improving cholestasis at the end of follow-up). In tolerant recipients no progressive clinically significant histological damage was apparent in follow-up protocol biopsies performed up to 3 years following drug withdrawal. Tolerance was independently associated with time since transplantation (odds ratio [OR] 1.353; $P = 0.0001$), recipient age (OR 1.073; $P = 0.009$), and male gender (OR 4.657;

$P = 0.016$). A predictive model incorporating the first two clinical variables identified subgroups of recipients with very high (79%), intermediate (30–38%), and very low (0%) likelihood of successful withdrawal. They concluded that when conducted at late time points after transplantation, immunosuppression withdrawal is successful in a high proportion of carefully selected liver recipients. A combination of clinical parameters could be useful to predict the success of this strategy. Additional prospective studies are now needed to confirm these results and to validate clinically applicable diagnostic biomarkers [6].

Author analyzed the graft survival and impact of specific risk factors on long-term graft survival outcome in primary liver transplant patients at single institute and reported at world transplant congress 2006 [7]. Purpose: Specific survival impact based on pretransplant disease etiology, donor factors, recipient factors, and intraoperative factors have not been addressed clearly on the long-term survival results. To evaluate the impact of these specific risk factors on long-term graft survival outcomes in liver transplant (LT), this retrospective study analyzed these factors on survival results with a long-term follow-up. Methods: Between June 1994 and December 2001, 1067 cadaveric adult whole LT were performed. Of 1067, 966 patients underwent primary LT. Median follow-up is 2199 days. Of 966, impact of donor factors (age, cytomegalovirus infection (CMV), presence of replaced hepatic artery), recipient factors (presence of HCV infection and tumor, CMV, age, sex, body weight, blood type, UNOS status, and length of the hospital stay), and surgical factors (cold and warm ischemia times, presence of portal vein thrombosis(PVT), intraoperative transfusion requirements of blood(PRBC), fresh frozen plasma(FFP) and platelet, duration of surgical procedure, type of arterial reconstruction, type of caval reconstruction, and type of biliary reconstruction) on graft survival were determined using univariate analysis. Cox proportional hazards modeling was further used to investigate the independent effects of multiple covariates on graft survival. Results: The overall 5 year patient and graft survival was 70% and 66%, respectively. Factors that significantly predict poor graft survival by univariate analysis were older donor age, recipient HCV infection, presence of tumor, presence of PVT, recipient CMV positive, amounts of FFP and PRBC, longer cold ischemia time, and longer hospital stay (Table 22.1). Factors that significantly predict poor graft survival by multivariate analysis were older donor age, recipient HCV infection, presence of tumor and PVT, and longer hospital stay (Table 22.2). Conclusion: Disease-related causes (HCV infection and presence of tumor), donor-related causes (older donor), and patient-related causes (PVT, longer hospital stay) represent the negative impact on the long-term graft survival. Specific surgical factors (caval, arterial, and biliary reconstruction) did not have the long-term survival impact. Donor age remained as a prognostic factor. If recipient were selected carefully, recipient age was not the independent prognostic factor for graft survival after liver transplantation.

Rana A et al. reported that no gains in long-term survival after liver transplantation over the past three decades [8]. The short-term survivals after orthotopic liver transplantation have improved due the improvement of surgical technique, introduction of calcineurin inhibitor immunosuppression, and improvement of patient management. Identified risk factors for patient survival are African American recipient, cold ischemia time, donor age, ETOH cirrhosis, hepatitis C, hospital admission, ICU admission, male gender, and recipient age. Those are similar findings with other reports [2–6]. Common cause of death in long-term survivors was malignancy, graft failure, and infection. Malignancy has been rising. Advanced recipient age had the most detrimental impact on long-term outcomes. Younger donors had the most beneficial impact. Long-term results of immunosuppression are the most common causes of death, especially malignancy and infection. Thus, most important thing is better long-term immunosuppression management. Those similar findings are also reported by others [2–5]. Adjustment of immunosuppression may be one of the important factors in long-term survival patients after liver transplantation.

Table 22.1 Univariate analysis for prognostic factor for graft survival after liver transplant

	Beta	Standard Error	*t*-value	Hazard Ratio	Wald Statist	*P*
Donor factors						
Age (yr)	0.008953	0.003014	2.970310	1.008993	8.822743	0.002977
CMV positive (yes/no)	−0.044282	0.114426	−0.386992	0.956684	0.149763	0.698765
Replaced hepatic artery (yes/no)	0.210779	0.119958	1.757107	1.234639	3.087424	0.078909
Recipient factors						
HCV infection (yes/no)	0.343779	0.104194	3.299423	1.410266	10.88619	0.000970
Tumor presence (yes/no)	0.537692	0.149788	3.589685	1.712051	12.88584	0.000332
CMV positive (yes/no)	0.302337	0.130044	2.324885	1.353017	5.405090	0.020084
Age(yr)	0.003242	0.004575	0.708623	1.003247	0.502146	0.478564
Gender (male/female)	−0.018986	0.107966	−0.175851	0.981193	0.030924	0.860412
Body weight (kg)	−0.002300	0.001606	−1.43210	0.997703	2.050908	0.152125
Blood type	−0.013324	0.018537	−0.718775	0.986765	0.516638	0.472285
UNOS status (1/2/3)	−0.000530	0.001091	−0.485657	0.999470	0.235862	0.627214
Length of hospitaI stay (day)	0.036814	0.005226	7.043732	1.037500	49.61415	0.000000
Operatlve factors						
Cold ischemic time (min)	0.000706	0.000348	2.029631	1.000706	4.119403	0.042402
Warm ischemic time (min)	0.004910	0.004694	1.046121	1.004922	1.094368	0.295513
Portal vein thrombosis (yes/no)	0.556528	0.145200	3.832831	1.744606	14.69059	0.000127
Amount of PRBC (unit)	0.016566	0.003550	4.666391	1.016704	21.77521	0.000003
Amount of **FFP** (unit)	0.008560	0.003227	2.652865	1.008597	7.037690	0.007985
Amount of pit (unit)	0.002731	0.003051	0.895279	1.002735	0.801525	0.370645
Operative time (min)	0.000261	0.000309	0.844134	1.000261	0.712562	0.398601
Arterial graft (yes/no)	−0.068743	0.066269	−1.03733	0.933567	1.076058	0.299589
Caval reconstruction (conventional piggyback)	0.338802	0.140215	2.416303	1.403265	5.838521	0.015685
Biliary reconstruction (R-oux-y/duct to duct)	0.093460	0.107387	0.870307	1.097966	0.757435	0.384139

Donor: Brain Death Donor, Donation After Cardiac Death Donor, and Live Donor

Donor age is a single independent prognostic factor after liver transplantation [9–15]. Recipient age is also a single independent prognostic factor after liver transplantation [3, 16]. When older donors are used, younger recipient do well. However, the transplant program tends to use older donor for older recipient. Gilbo et al. reported those issues. Older donors and recipients are increasingly considered for liver transplantation. Both donor and recipient age have a negative impact on outcomes. Large registry analyses show that older donors are frequently matched to older recipients. Whether age-related risks accumulate in a synergic negative effect on outcomes because of donor-recipient age matching is poorly understood. Gilbo et al. investigated the impact of donor-recipient age interaction on patient and death-censored graft survival in multivariate Cox regressions in 849 transplants (January 2000 to December 2015). Donors 70 years or older did not affect long-term patient or graft survival. Recipient age independently increased the risk of

Table 22.2 Multivariate analysis for prognostic factor for graft survival after liver transplant

	Beta	Standard Error	*t*-value	Hazard Ratio	Wald Statist.	*p*
Donor factors						
Donor age (yr)	0.007690	0.003081	2.496030	1.00772	6.23017	0.012564
Recipient factors						
PVT Presence (yes/no)	0.409647	0.151543	2.703170	1.506286	7.30713	0.006872
Presence of tumor	0.355031	0.169247	2.097713	1.426225	4.40040	0.035938
HCV infection (yes/no)	0.289715	0.106551	2.719013	1.336047	7.39303	0.006551
Recipient CMV positive	0.203998	0.131044	1.556708	1.226296	2.42334	0.119550
Hospital stay (day)	0.005049	0.001235	4.089408	1.005062	16.72326	0.000043
ICU stay (day)	0.022243	0.006309	3.525545	1.022492	12.42947	0.000423
Operative factors						
Cava (conventional)	0.111214	0.173019	0.642787	1.117635	0.41317	0.520367
Venous bypass(yes/no)	−0.090292	0.131215	−0.688125	0.913664	0.47352	0.491379
PRBC (unit)	0.008289	0.004407	1.881021	1.008324	3.53824	0.059978
FFP (unit)	−0.000653	0.003861	−0.169107	0.999347	0.02860	0.865714
Cold ischemic time(min)	0.000496	0.000361	1.372022	1.000496	1.88244	0.170066

death (hazard ratio [HR], 1.03; 95% confidence interval [CI], 1.02–1.05, $P < 0.0001$), but donor-recipient age interaction was non-influential. The negative impact of recipient age on patient survival was significant as early as 6 months after transplantation (HR, 1.06; 95% CI, 1.03–1.09; $P = 0.00008$). The adjusted risk of death was significant for patients aged 60 to 69 years (HR, 1.995; 95% CI, 1.40–2.85; $P < 0.0001$) and 70 years or older (HR, 2.001; 95% CI, 1.10–2.66; $P = 0.04$). In contrast, the risk of graft loss was not influenced by recipient age (HR, 1.02; 95% CI, 0.996–1.04; $P = 0.11$) or age interaction. They concluded that older livers can be safely used in older recipients without jeopardizing graft and patient survival if other risk factors are minimized [16]. Donation after cardiac death (DCD) donor has increased risk of primary nonfunctioning of the liver and higher incidence of biliary complications. Croome et al. reported that use of liver graft from donor 50 years or older had acceptable graft and patient survival [17]. Use of DCD graft has higher risk and older recipient can't tolerate those risks. Cautious selection of the older recipient for DCD organs is necessary. Similarly, use of live donor for low MELD patients may be the option with caution.

Pretransplant Evaluation of the Recipient and Selection of the Liver Transplant Candidate

In general, older patients have more comorbidities and cardiac risks [2–5]. Older patients were carefully selected to liver transplant candidacy because of the poor outcome after the liver transplant. But, there are recent reports of liver transplant in elderly patients with better outcomes [5].

Physical impairment, frailty, and old age in itself are associated with higher risk of poor outcome after liver transplantation. Careful Considerations in the selection of older candidates for liver transplantation may contribute the better outcome after liver transplantation. Durand et al. reported that with the average age of listing for liver transplantation increasing significantly in the last decade, 25% of patients receiving liver transplantation in the United States are over 65 years of age [2]. Durand et al. reported that above the standard evaluation, the selection of older candidates should pay particular attention to cardiovascular diseases, functional status, and the assessment of malignancy risk. Both ischemic (coronary artery disease) and nonischemic (cardiomyopathy, heart failure, arrhythmia, valvular heart disease) assessments become equally important during the evaluation in the older population. Age is a significant risk factor for all of these complications. Thus, at a minimum, initial transthoracic echocardiography, electrocardiography, noninvasive stress testing, and consultation with a cardiologist familiar with end-stage liver disease hemodynamics are important. If indicated, further cardiac evaluation using right side and left side cardiac catheterization are studied. Recent guideline emphasized a multidisciplinary approach to assess risks and prepare for peri- and postoperative cardiac complications. Cardiopulmonary exercise testing and other functional measures such as 6-minute walk distance also add prognostic data for candidates and correlate with the presence of frailty. Recent data have provided evidence that frailty predicts waitlist mortality independent of MELD score, and those older candidates are more likely to be frail with less physiological reserve. Although there are no universal standard criteria for frailty, and multiple tests are available, simple to perform performance-based tests of muscle function may have more clinical applications than imaging-based measures of sarcopenia. A recent frailty assessment called the Liver Frailty Index demonstrated that less than half of patients become “robust” after transplantation, supporting the need for pre- and posttransplant rehabilitation [2]. Durand et al. reported that extra hepatic malignancy directly increases with age, and most centers are reluctant to transplant patients with recent diagnoses of malignancy other than nonmelanoma skin or early, treated, less aggressive localized cancers, for fear of relapse following transplantation [2]. All candidates should undergo age and risk factor appropriate cancer screening prior to listing, such as colonoscopy, mammography, prostate screening, etc. Ongoing tobacco consumption should be strongly discouraged. Liver transplant candidates with a prior extra hepatic malignancy should have received definitive treatment with adequate tumor-free survival before liver transplant listing. Most programs would consider adequate tumor-free survival to be at least 1–5 years, depending again on the particular malignancy. As each patient often presents a unique clinical scenario, consultation with oncologists having specific experience in estimating the general risk of relapse, as well as additional risk with immunosuppressive therapy, is warranted particularly in the older population. Older recipients are at higher risk of developing de novo malignancy. However, the excess in cancer incidence compared to the general population is higher in the youngest recipients than in older recipients [2].

Waiting List and Accepting the Organ Offers

Increasing mortality while waiting in older patients and increasing risk after liver transplant surgery in older recipients are reality. Risk and benefit of the liver transplant in older recipient is difficult issues. Feng S et al. reported that Age and Waitlist Outcomes [3]. They analyzed the UNOS data.

Among 122,606 adults listed for transplantation between 2002 and 2014, 65,725 (53.6%) underwent transplantation, 21,009 (17.1%) died on the waiting list before undergoing transplantation, 11,124 (9.1%) were removed from the waitlist due to being too sick for transplant, 4823 (3.9%) were removed due to improved condition, 8080 (6.6%) were removed due to “other” factors, and 11,845 (9.7%) were still alive but had not been transplanted by June 30, 2014. Of the patients removed from the waiting list, 7185 (29.9%) died after removal by June 30, 2014. Waitlist outcomes by age group are analyzed. It showed that the proportion who dropped out due to being too sick to transplant increased from 6.3% in age group 18–49 years to 16.3% in age group ≥70 years. Conversely, the proportion who underwent transplantation progressively decreased with increasing age from 52.5% in age group 18–49 years to 44.1% in age group ≥70 years. Among registrants with HCC, the proportion of who died increased from 12.7% in age group 18–49 to 16.8% in age group ≥70 years, and the proportion who dropped out due to being too sick to transplant increased from 6.7% to 12.5%. The proportion who underwent transplantation progressively decreased with increasing age from 74% in age group 18–49 years to 61% in age group ≥70 years. Similar trends across age groups were observed in subgroups defined by MELD score ≤ 16 or > 16 at listing. In competing risk analyses, increasing age was associated with increased mortality before transplantation and decreased likelihood of transplantation. The associations between increasing age and increasing waitlist mortality were not substantially different in subgroups defined by MELD score and functional status. In other subgroup analyses, the association between increasing age and increasing waitlist mortality was substantially stronger in the HCV-negative (compared with HCV-positive), non-HCC (compared with HCC), and long-wait regions (compared to short-wait regions). Increasing age group was associated with decreasing MELD score at death, dropout, or transplantation, especially among patients without HCC, suggesting that older patients tolerate high MELD scores more poorly than younger patients. Causes of death on the waiting list were similar among all age groups.

Liver Transplant Surgery

Liver transplant surgery techniques have improved over the three decade [8]. It is still challenging for the high-risk patients. Selected older patients are safely transplanted; however, many attentions are necessary for the good outcome. Older patients have much comorbidity, especially cardiovascular issues. Pretransplant work-up for ischemic heart disease is mandatory [2–5]. High pulmonary artery pressure such as mean pulmonary artery pressure higher than 38 mmHg is risk factors for liver transplant. Anticoagulation, atrial fibrillation, and ischemic heart disease are also very common. Renal function is very important. In older patients, there are many issues including renal dysfunction, hepatorenal syndrome, indication of liver and kidney transplant, use of nephrotoxic medications, and immunosuppression. Neurological issues are also very common. They include hepatic encephalopathy, confusion, delirium, stroke, intracranial bleeding, central pontine myelinolysis, demyelination syndrome, posterior reversible encephalopathy syndrome, and neurotoxicity due to immunosuppression. Minimize the intraoperative bleeding, avoiding intraoperative complication, and good hemodynamic management are important to avoid morbidity and mortality. Shorter cold ischemia time, good quality of liver graft, and uneventful surgical course are ideal.

Posttransplant Management and Outcome

Watt et al. from Mayo clinic reported that although mortality rates following liver transplantation (LT) are well described, there is a lack of detailed, prospective studies determining patterns of, and risk factors for long-term mortality [18]. They analyzed the multicenter, prospectively obtained NIDDK Liver Transplantation Database of 798 transplant recipients from 1990 to 1994 (follow-up 2003). Overall, 327 recipients died. Causes of death >1 year: 28% hepatic, 22% malignancy, 11% cardiovascular, 9% infection, and 6% renal failure. Renal-related death increased dramatically over time. Risk factors for death >1 year (univariate): male gender, age/decade, pre-LT diabetes, post-LT diabetes, post-LT hypertension, post-LT renal insufficiency, retransplantation >1 year, pre-LT malignancy, alcoholic (ALD) disease, and metabolic liver disease, with similar risks noted for death >5 years. Hepatitis C, retransplantation, post-LT diabetes, hypertension, and renal insufficiency were significant risk factors for liver-related death. Cardiac deaths associated with age, male gender, ALD, cryptogenic disease, pre-LT hypertension, and post-LT renal insufficiency. Watt et al. summarized that the leading causes of late deaths after transplant were graft failure, malignancy, cardiovascular disease, and renal failure. Older age, diabetes, and renal insufficiency identified patients at highest risk of poor survival overall. Diligent management of modifiable post-LT factors including diabetes, hypertension, and renal insufficiency may impact long-term mortality.

Lower Immunosuppression for Nonimmune-Related Liver Disease Patients

Risk of developing chronic renal disease is higher in older liver transplant recipients [19]. Risk of developing de novo cancer is 10–15 times higher than in the general population [19]. Zhou et al. reported that using SRTR data (Oct 1987–Dec 2009), among 89,036 liver transplant recipients, 6834 recipients developed 9717 posttransplant malignancies. They focused on non-skin malignancies. A total of 3845 recipients suffered from 4854 de novo non-skin malignancies, including 1098 de novo hematological malignancies, 38 donor-related cases, and 3718 de novo solid-organ malignancies. Liver transplant recipients had more than 11 times elevated cancer risk compared with the general population.

Older Patients Have More Risks of Cardiac Complication, Infection, and Cancer Development

Recent report from Haugen et al. showed median length of stay decreased from 10 days in 2003–2006 to 9 days in 2013–2016. A stay of longer than 2 weeks for older liver transplant recipient decreased from 30.8% in 2003–2006 to 28.0% in 2013–2016. Graft survival in older liver transplant recipients also improved over time. One-year survival improved from 80% in 2003–2006 to 90% in 2013–2016, 3-year survival form 71% to 84%, and 5-year survival form 63% to 70% [4]. Based on the national study of 8627 older liver transplant recipients from 2003 to 2016, Haugen et al. showed the increase in number of liver transplant performed, improvements in length of stay, acute rejection, graft survival, and overall survival [4]. Ferman TJ et al. reported that liver transplant recipients older than 60 years old show executive and memory function improvement comparable to younger recipients [20].

Feng et al. reported about Age and Posttransplantation Outcomes [3]. They found that older patients had a significantly higher mortality after transplantation compared with younger patients both before and after adjusting for potential confounders. Compared with recipients aged 18–49 years, the adjusted hazard ratio increased to 1.16 for ages 50–59 years, 1.34 for ages 60–64 years, 1.61 for ages 65–69 years, and 1.87 for ages ≥70 years. Survival probability at 5 years posttransplant progressively declined from 0.78 in the 18–49-year age group to 0.62 in the ≥70 years age group. Other studies also showed 5-year survival is generally 10 to 20% lower in patients aged 60 or older to 70 years than in younger recipients [2, 8]. Watt et al. reported advanced age is significantly associated with the risk of death due to cardiovascular events and malignancy in liver transplant patients [18].

It is reported that older recipients have increased bone loss due to age and increased incidence of bone fractures after liver transplantation [2]. Durand et al. recommended that all patients should be advised to perform weight-bearing exercise, take vitamin D, and calcium supplements, and have bone density examination at least every 1–3 years, depending on other risk factors (steroid therapy, prior bone loss, family history). Treatment with antiresorptive therapy should be considered in all patients with osteoporosis, recent fracture, or declining bone density [2]. Older age in itself should not limit access to liver transplant in older patients.

Immunosuppression in the Elderly

In general, older patients do not require higher maintenance immunosuppression. Older patients may not tolerate well to modern immunosuppression due to side effects including neurological side effects, infection, and malignancy.

Recently, Rana et al. reported that there were no significant gains in unadjusted long-term outcomes among 1-year survivors over the past 30 years [8]. Cause of death analysis suggests malignancy after transplantation is a growing problem and preventing recurrent hepatitis C with direct-acting antivirals (DDAs) may only have a limited impact. Furthermore, rejection leading to graft failure and death had a rare occurrence (1.7% of long-term deaths) especially when compared with the sequelae of long-term immunosuppression: malignancy (16.4%), nonrejection graft failure (9.8%), and infection (10.5%) ($P < 0.001$). They concluded that there have been no appreciable improvements in long-term survival following liver transplantation among 1-year survivors. Long-term sequelae of immunosuppression, including malignancy and infection, are the most common causes of death. This study highlights the need for better long-term immunosuppression management.

Future

Careful selections of the donor and recipient have made improvement of outcome in early phase of liver transplant [2–5]. However, long-term outcome is not improved in the last three decade as reported by Rana et al. [8]. They reported that malignancy and infection are the most common causes of death [8]. Watt et al. reported that common causes of death were graft failure, malignancy, cardiovascular disease, and renal failure [20]. Better long-term immunosuppression management and better management of diabetes, hypertension, and renal insufficiency may improve the long-term outcome after liver transplantation.

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23 Renal Transplantation in the Elderly

Thomas Diflo

History

For thousands of years, there have been reports of transplantation of organs and tissues. The patron saints of physicians, the twin brother physicians Cosmas and Damian, transplanted the lower leg of a recently deceased Moor onto the gangrenous stump of a Roman church officer, with apparent good graft function [1], one of the miracles used to support their canonization.

In the 1930s, YY Voronoy, in the Soviet Union, used a temporary kidney transplant onto the brachial vessels of a patient who had gone into renal failure from mercury poisoning, in order to reverse the patient's anuria [2]. On December 23, 1953, Dr. Joseph Murray and his team at the Peter Bent Brigham Hospital began the modern era of transplantation when they performed the first successful living donor kidney transplant between two identical twins, the 23-year-old Herrick brothers [3].

Dr. Murray received the Nobel Prize in Medicine and Physiology in 1990 for this groundbreaking effort. For several years thereafter, given the small number of identical twin pairs, one of whom required transplantation, there were not many transplants performed. Once the immune response was better understood and appropriate medications to alter that response were discovered or developed, transplantation became a more routine therapy.

Throughout the 1960s and 1970s, the only immunosuppressive medications available were steroids and 6-mercaptopurine or its synthetic analog, azathioprine. Jean Borel, then a scientist at Sandoz, presented his studies of cyclosporine A (CyA) at the British Society of Immunology [4, 5], and Sir Roy Calne, at the University of Cambridge, began his experimental work with CyA in humans [6]. The introduction of CyA for transplantation was earthshaking, and 1-year patient and graft survival after kidney transplantation virtually doubled overnight.

Since then, there have been numerous other medications introduced which have improved graft function and survival, including tacrolimus, mycophenolic acid, sirolimus, and several monoclonal antibodies that work against specific portions of the immune response. Each of these introductions has allowed incremental improvements in patient and graft survival, but none have been as seminal as the introduction of cyclosporine.

In the 1960s and 1970s, transplantation was essentially unregulated. The lawful donation of tissues or organs was codified by the 1968 Uniform Anatomical Gift Act (UAGA) [7]. At the same time, a group convened at Harvard University to define brain death [8]. The 1980 Uniform Determination of Death Act defined

T. Diflo (✉)
Department of Surgery, New York Medical College, Westchester Medical Center, Valhalla, NY, USA
e-mail: Thomas.Diflo@wmchealth.org

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death: “[A]n individual who has sustained either (1) irreversible cessation of circulatory or respiratory functions, or (2) irreversible cessation of all functions of the brain, including the brain stem, is dead” [7]. This allowed the procurement of viable organs from heart-beating cadavers.

In 1984 Senator Al Gore of Tennessee sponsored Public Law 98–507, the National Organ Transplant Act (NOTA) [9], which was passed into law. This Act established the Organ Procurement and Transplantation Network (OPTN), which is run by the Secretary of Health and Human Services. The law also established the Scientific Registry of Transplant Recipients (SRTR), as the central federal agency for data collection and analysis for all of the transplant programs in the country. In addition, prohibited was “the exchange of organs for transplantation for valuable consideration” [9] where “valuable consideration” is generally interpreted to mean money or property. The OPTN conducts the day-to-day management of transplantation, and, since its inception, the only OPTN has been the United Network for Organ Sharing (UNOS).

In subsequent years, there have been numerous additional laws, amendments, and changes to the rules that govern transplantation. From a practical point of view, all current regulatory policies are maintained by UNOS. The Unites States has been split up into 11 regions for the purpose of organ allocation and sharing. At the moment, except for some special circumstances, the kidneys are allocated first locally, then regionally, and then nationally.

The federal government, particularly its insurance endeavors, is represented by the Centers for Medicare and Medicaid Services (CMS). CMS’s oversight of transplantation became more important after Public Law 92–603 amended the Social Security Act to provide Medicare coverage for most end-stage renal disease patients [10]. Once the Medicare program became responsible for dialysis and renal transplantation services, CMS developed a keen interest in the finances of transplantation and the performance of individual transplant centers.

The Scope of the Issue: Renal Failure and Transplantation in the Elderly

For the purposes of this chapter, we will define “elderly” as age 65 or greater. There is no doubt that transplantation is the preferred therapy for end-stage renal disease (ESRD) for those patients who can tolerate it, with significant improvements in overall health, quality of life, and huge financial advantages for the medical system. Worldwide, ESRD is a growing problem, particularly in the older population. In the United States, 50% of new ESRD patients annually are over the age of 65, and 33% are older than 70 [11, 12], and in Scandinavia, the incidence of new ESRD in elderly patients increased from 42% in 1990 to 65% in 2013 [13]. In the United States in 1992, only 4.2% of all kidney transplants were done on elderly patients, but this proportion increased to 17.2% in 2012 [13].

Patient and Graft Survival in the Elderly

One unfortunate, although perhaps not unexpected, fact about this is that both patient and graft survivals are inferior in the elderly when compared to younger patients. There is a significantly higher rate of death with a functioning graft, and cognitive impairment leads to more medication regimen nonadherence and rejection [14]. A study of overall mortality and death from infectious complications showed a linear increase in mortality over 10-year age increments but an *exponential* increase in deaths related to infection, with a fivefold increase in elderly recipients versus those younger than 30 [15]. Recipients over the age of 80 had a 30-day post-transplant mortality almost twice as high as those in their 60s (2.5% vs. 1.5%), as well as inferior 2-year survival (73% vs. 89%) [16]. A British study showed 4-year mortalities of 5.8% in patients younger than 50, 22% for those in their 60s, 32% in the 70s, and 45% in octogenarians [17]. All of this bad news needs to be tempered with the fact that 50% of transplant candidates over the age of 60 will die while on the waiting list [18].

While the results of transplantation for these patients are inferior to those of younger patients, it is perhaps more relevant to compare the results for patients who remain on the list to those who are transplanted. Transplant recipients over the age of 70 have a 41% lower overall risk of death compared to those who remain on dialysis on the list [19]. A French study showed similar results for patients over the age of 60 [20]. A European Consensus Statement from 2016 [21] concluded that selected elderly ESRD patients benefit significantly from transplantation, and age alone should not be a contraindication to transplantation. They did recommend careful screening for cardiovascular disease and cancer, assessing frailty, doing cognitive testing, and encouraging living donation.

Another interesting observation regarding elderly patients is the effects of an aging immune response [22]. As patients age, they become progressively less immunocompetent, which has salutary implications for the amount and degree of immunosuppression that they require.

While there are epidemiologic arguments both for and against transplanting elderly patients, perhaps it is more useful to assess what factors influence transplant success, positively and negatively. A recent study from the University of Minnesota showed strong predictors of graft loss in the elderly which included pre-transplant sensitization (panel reactive antibody [PRA] >10%), a history of congestive heart failure, delayed graft function, and acute cellular rejection [23]. A study from Johns Hopkins looked at a multivariate analysis of numerous pre-transplant patient factors and developed a risk prediction model which they then validated prospectively [24]. Perhaps one of the most important factors that need to be assessed before transplant is frailty.

Frailty

The importance of frailty in medical outcomes has been recognized since Fried's landmark "Frailty in Older Adults: Evidence for a Phenotype" [25]. There have been numerous studies of the effects of frailty on surgical and medical recovery, outcomes, and mortality. Clearly, not all elderly patients are frail, and not all frail patients are elderly. There is, however, an increasing incidence of frailty in cohorts of older patients.

There are interesting reciprocal effects of frailty and transplantation – frailty affects transplant outcomes, and transplantation influences frailty. A study from the Brigham and Women's Hospital noted that at least 15% of patients over the age of 65 are frail and that frailty in kidney recipients led to a twofold increase in the rate of delayed graft function, a significant increase in length of stay, and a similar increase in early readmissions [26, 27]. These are all causes for concern, but the increase in length of stay is perhaps the most alarming. Another study from Johns Hopkins showed that, in frail kidney recipients, each week of increased length of stay resulted in a 1.55-fold increased mortality risk [28]. On a more positive note, the same group has also looked at changes in frailty after renal transplantation and found that, while frailty worsens across the board shortly after transplantation, it generally improves to better than baseline by 3 months [28].

Evaluation for Transplantation

A recent survey of US transplant programs revealed that most programs do not have a specific age cutoff above which they will not evaluate a patient, and those that do have an age limit generally set it at 80 [29]. A French study on decision-making in whether to refer elderly patients for transplant evaluation created a scoring system based on such variables as age, diabetes mellitus, vascular disease, chronic obstructive pulmonary disease, cognitive deficits, and mobility. This generated a score from 0 to 56 points. Patients were then divided into quintiles, with Group I representing ≤6 points, up to Group V, representing ≥18 points. They found that patients in Group I had a post-transplant 3-year mortality of 30% and Group V had a 3-year mortality of 83% [30]. Such objective evaluation is useful in the decision whether to list a patient or not.

The basic requirements for transplant evaluation do not vary based on age. Demographic information, blood type, human leukocyte antigen (HLA) typing, HIV status, and hepatitis serologies are all required, as well as standard laboratory tests such as a complete blood count, comprehensive metabolic panel, prothrombin time, and aPTT. In order to be placed on the active transplant list, a patient must have a GFR of less than 20 mL/min/1.73m^3. In addition, the medical evaluation will include an EKG and chest X-ray and a PSA for men. Other routine evaluations are a colonoscopy for anyone over the age of 50 and Pap smear and mammography for all women.

The requirements for cardiac testing vary from center to center, but certainly all elderly potential transplant recipients will require at least an echocardiogram and a pharmacological stress test. Unless the potential recipient is in excellent physical condition, it is unlikely that he or she would be able to undergo treadmill testing. An alternative modality would be a dobutamine stress echo. After noninvasive testing, all elderly patients should be evaluated by a cardiologist, preferably one who has experience in working with a transplant team.

Whether to pursue cardiac catheterization for evaluation will vary from patient to patient. Certainly anyone with symptoms of angina or shortness of breath with moderate effort should be referred for catheterization. A positive result on noninvasive cardiac evaluation would also lead to a recommendation for catheterization. The issue of pursuing catheterization for asymptomatic patients who have longstanding diabetes mellitus is one that continues to be a topic of debate between cardiologists and transplant physicians. It is our practice to recommend catheterization for all such patients.

An additional layer of scrutiny that is worthwhile in the elderly candidates is evaluation by an anesthesiologist who is familiar with transplantation. He or she can help with risk stratification and recommend perioperative management strategies such as the use of Swan-Ganz pulmonary artery catheters at the time of surgery.

It is also useful to perform a non-contrast computed tomography (CT) scan of the abdomen and pelvis in all elderly candidates. Any patient with longstanding renal failure has an increased risk of renal malignancies, and the CT can help screen for these tumors. Probably the most useful aspect of these studies is in evaluating the degree and extent of calcification in the iliac arteries, which will help in preoperative planning. Any patient with overt peripheral vascular disease should also be evaluated by a vascular surgeon and have, at the minimum, noninvasive pulse volume recordings and arterial Dopplers. It is also worthwhile to screen these patients with a duplex ultrasound of the carotid arteries to assess the extent of cerebrovascular disease.

The CT scan, in combination with noninvasive maneuvers such as grip strength, can be helpful in evaluating sarcopenia in transplant candidates [31]. This leads to the wider consideration of measuring frailty in elderly candidates. As noted previously, frailty has significant deleterious effects in transplant patients. It appears appropriate to incorporate formal frailty evaluations in all elderly candidates, either by using Fried's schema [25] or some other validated frailty screening tool. Those patients who are deemed moderately or severely frail are likely not appropriate candidates for transplantation.

Cognitive dysfunction also has important negative effects on the outcomes after transplantation [14]. A recent study showed that all-cause graft loss was increased more than fivefold in recipients with moderate or severe cognitive impairment [32]. Therefore, it is appropriate that all elderly candidates be evaluated with (at least) a modified Mini-Mental Status Exam and/or consultation with a dedicated transplant psychiatrist.

Technical Considerations and the Perioperative Period

As mentioned before, patients with renal failure with longstanding hypertension and especially diabetes have a significant risk of atherosclerotic disease. Review of the abdominal-pelvic CT scans with transplant surgeons and radiologists is crucial for operative planning regarding placement of the renal graft, and which vessels are appropriate for arterial anastomosis. It has been our observation that even patients with heavily calcified common iliac arteries frequently have uninvolved sections of their external iliac arteries which will allow for safe anastomosis.

The preoperative evaluation by the cardiology team and the anesthesiologists will also help to dictate what type of hemodynamic monitoring is appropriate in the perioperative period. Those patients with significant cardiac disease may benefit from Swan-Ganz catheterization for the surgery and for several days afterward. Depending on the facilities available for postoperative care at one's institution, it is advisable that immediate postoperative care for elderly transplant recipients be provided in an intensive care setting, rather than a postoperative unit or floor bed.

Immunosuppression

Elderly patients tend to be less immunocompetent than younger recipients [22]. Most transplant centers use some sort of induction therapy at the time of transplantation in addition to steroids. In all cases, the induction consists of either an IL-2 receptor blocker (basiliximab [Simulect©, Novartis]), a rabbit anti-thymocyte globulin (Thymoglobulin©, Sanofi Genzyme), or another lymphocyte-depleting agent (alemtuzumab [Campath©, which is FDA approved for the treatment of B-cell CLL, but available for transplantation through a registry]). Perhaps not surprisingly, induction with alemtuzumab in elderly recipients is associated with increased graft loss and death [33], which speaks against use of this agent. In low immunological risk recipients, either no induction agent or the use of basiliximab is reasonable. In high-risk recipients, anti-thymocyte globulin, perhaps in a low-dose protocol, appears appropriate.

Standard postoperative immunosuppression in the United States consists of tacrolimus, a mycophenolic acid or sodium agent, and steroids. Given the increased chances of death from infection [15], careful monitoring of drug levels and rapid decrease in dosing of medications are crucial. Interestingly, it was the addition of mycophenolate to the tacrolimus regimen that had the greatest additive effect on graft survival, and it appears that steroids are of less importance. This has led to some recommending rapid weaning and elimination of steroids in the elderly recipient [11]. Of course, the specter of rejection and graft loss, as well as potential medication nonadherence, necessitates very close follow-up of the elderly transplant patient.

Outcomes

Several years ago, UNOS mandated that the "best" deceased donor kidneys be allocated to the youngest recipients, using the concept of maximizing life-years after transplant, which has had the reciprocal effect of allocating older, "worse" donor kidneys (so-called expanded criteria donors or ECDs) to older recipients. Intuitively, this is a reasonable argument, although it initially caused some controversy in the transplant community and in society at large. Nevertheless, it is interesting to look at the overall renal transplant outcomes in the elderly population.

Despite some of the dire results presented in this chapter, many elderly transplant recipients do quite well. Compared to continuing on dialysis, transplant recipients over the age of 70 have a 59% reduction of death rates [19]. Even elderly recipients of ECD kidneys had a 40% reduction in death rates compared to dialysis [34]. However, the transplanting of ECD kidneys to elderly recipients has had mixed results. A Eurotransplant study of preferentially allocating kidneys from donors over the age of 65 to elderly recipients resulted in a doubling of the number of such kidneys available for transplantation and a decrease in waiting time for the recipients. In addition, there was a significant decrease in cold ischemic time and delayed graft function, with no adverse effect on graft or patient survival [35]. A US study of age-matching in elderly donors and recipients showed lower rates of rejection (50% of the rate in a younger cohort) and improved death-censored survival [22]. Another US study showed that the results of transplanting ECD kidneys into recipients over the age of 70 were no different than through the use of standard-criteria kidneys [36]. On the other hand, an older US study showed that allocation of the highest-risk kidneys to elderly recipients had the worst results of all cohorts [37].

Recently at our center, we have begun to use kidneys from hepatitis C-positive donors in hepatitis C-negative recipients, with postoperative antiviral treatment as needed. We started with elderly recipients and had excellent results, which has led us to expand this program to younger recipients {unpublished data}. It is certainly worthwhile to consider the more widespread use of these kidneys in elderly recipients.

In all patients, the recipient of a living donor kidney is far and away better off than the recipient of almost any deceased donor kidney. Elderly recipients tend to receive fewer living donor transplants than younger patients. This may be partially related to the relative unavailability of living donors for these patients. A study out of UCLA assessed the outcomes of elderly recipients who had older living donors, over the age of 50. They found that living donation from this older donor group showed outcomes superior *to any deceased donor cohort*. In addition, the only recipient cohort that did better was elderly recipients of young living donors [37]. We have successfully used donors up to the age of 68 at our center. Given the excellent outcomes for elderly recipients of older living donor kidneys, it is certainly appropriate to consider such donor-recipient pairs.

Conclusions

Just as the population at large is aging, so too is the elderly population with renal failure. 50% of new ESRD patients annually are over the age of 65, and 33% are older than 70. Renal transplantation remains the optimal treatment for ESRD.

There are a number of additional considerations in evaluating elderly patients for transplantation. Long histories of hypertension and diabetes necessitate close attention to the possibilities of peripheral vascular and cardiovascular disease. All potential elderly candidates will require evaluation by a cardiologist, and many will require cardiac catheterization. Since frailty is a significant concern in the elderly population, all elderly candidates will require a frailty assessment. Similarly, objective cognitive assessment, preferably by a transplant psychiatrist, should be part of every elderly candidate's evaluation.

The relative decrease in immune function and the increased risk of post-transplant infectious death in elderly recipients require careful immunosuppressive management. It is inadvisable to use alemtuzumab for induction during transplantation, but basiliximab or low-dose antithymocyte globulin appears safe and effective. Postoperatively, immunosuppression with tacrolimus and mycophenolate, plus or minus steroids, has the best results, with close follow-up.

Although some of the data are contradictory, it appears that the use of ECD kidneys in elderly recipients is safe and effective, particularly in recipients over the age of 70. Any kidney, whether a standard-criteria or ECD, confers significant survival advantage over remaining on dialysis. Hepatitis C-positive kidneys can be safely and successfully transplanted into hepatitis C-negative recipients. Finally, while transplantation is the gold standard for the treatment of ESRD, living donation is the gold standard of transplantation. Elderly recipients have the best results with young living donor kidneys, but results with older donors are also excellent.

As the ESRD population ages, more and more elderly patients will present for transplantation. With careful evaluation, management, and follow-up, many of these patients can be transplanted safely and successfully.

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24 Hepatopancreaticobiliary Surgery in the Elderly

Clara Angeles, Danny Lascano, and Gregory Veillette

Hepatopancreaticobiliary (HPB) surgery is a formidable challenge even in the young, healthy patient. These are typically long, difficult cases with the potential for catastrophic complications. Furthermore, the recovery from these surgeries places a huge physiologic and metabolic strain on the patient, which is oftentimes more demanding than the actual procedure. Therefore, the decision-making process involved in proceeding with HPB surgery in the elderly patient is extensive and extremely difficult. Failure to carefully select which patients to offer surgery will lead to significant harm and potentially death of the patient. The surgeon must have a good understanding of the patient's actual life expectancy, natural history of the disease process, likelihood of complications, and whether or not the patient can get through the surgical procedure and its potential complications.

Our commitment as surgeons and physicians is twofold: first to try and prolong life and second to improve/maintain the quality of life. When dealing with the elderly population, the bang for the buck may not be as large as compared to the younger population, in terms of prolongation of life. Therefore it is absolutely essential for the surgeon to understand both the natural history of the disease process with surgery and the natural history of the disease process without surgery and to carefully weigh the risk/benefit ratio for each particular patient.

One of the most important principles in the management of the elderly is the understanding that these patients lack the physiologic reserve that is typically seen in the younger patient. Therefore, the decision to operate or to not operate must be carefully calculated to consider the possible sequelae of each approach and determine which will offer the lowest strain to the patient. For example, the physiologic strain of a laparoscopic or open cholecystectomy is much less than a recurrent bout of pancreatitis or cholangitis from recurring choledocholithiasis. A common response from the surgeon when faced with operating on the elderly patient is "they are not going to tolerate the operation" or "they are too old for surgery." Unfortunately, oftentimes this statement is completely false and is not based on any objective data. This type of expectant management may suffice for certain types of surgical pathology; however, when dealing with benign and malignant disease processes of the liver, biliary tree, and pancreas, the outcomes of watchful waiting and/or nonoperative management can be devastating.

C. Angeles · D. Lascano
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

G. Veillette (✉)
Section of Hepatobiliary and Pancreatic Surgery, Department of Surgery, Westchester Medical Center, and New York Medical College, School of Medicine, Valhalla, NY, USA
e-mail: Gregory.Veillette@wmchealth.org

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Physiologic Changes in the Elderly

Aging is associated with changes in the physiology and morphology of the organs in the immune and hepatopancreaticobiliary system. There are global variations that affect host defense mechanisms, and there are changes in each organ that increase the likelihood of certain pathologies.

Aging is associated with a loss of hepatocytes secondary to a decrease in hepatic blood flow [1]. This impairs the regeneration capability of the liver and results in an inability to recuperate from damage caused by resection, trauma, toxins, infections, and other insults. Aging itself is considered a risk factor associated with liver carcinogenesis and the development of hepatocellular carcinoma. Some genetic changes normal to the aging process, such as aberrant DNA methylation and shortening of telomere length, increase the risk of HCC development [2]. In addition, there are alterations in the structure of the bile ducts as well as a proliferation of the bile ducts that affects biliary and cholesterol metabolism [1, 2]. These changes result in an imbalance in the cholesterol saturation of bile which may be linked to a higher incidence of formation of cholesterol gallstones.

Gallbladder disease is common in the elderly. There are multiple physiologic changes in the motility and emptying of the gallbladder that make it prone to pathology. As explained above, aging is associated with a propensity to form gallstones and with greater probability of this causing disease [1, 2]. Multiple studies have also elucidated that in the elderly (animals and humans) there is a decreased sensitivity of the gallbladder to the enzyme cholecystokinin (CCK), its main stimulus for contraction [1, 3, 4]. Furthermore, there are increased serum concentrations of pancreatic polypeptide (PP), a hormone that inhibits the secretion of bile from the liver and gallbladder [1–4]. These all result in further formation of gallstones – due to stasis – and inability to utilize stored bile.

The pancreas undergoes a wide variety of pathological changes in the elderly. These are concerning, as they not only increase the likelihood of benign pathologies but can also lead to neoplastic degeneration. There is an increased fatty replacement and fibrosis, causing loss of volume of pancreatic cells, higher incidence of pancreatic steatosis, as well as a decreased in pancreatic exocrine function [5, 6]. Furthermore, with advancing age, there is lymphoplasmacytic infiltration, amyloid deposition, and development of intraepithelial neoplastic changes, making the risk of developing pancreatic cancer higher in the elderly [1, 5, 6].

Benign Biliary Disease in the Elderly

Biliary disease is very common in the general population. It is estimated that 18.8% of females and 9.5% of males have asymptomatic gallstones [4]. The prevalence of gallstones at 70 years of age increases to 24% for females and 15% for males and at 90 years of age to 35% and 24% for males and females, respectively [7]. Moreover, age is also a risk factor for developing symptoms from biliary disease. The risk of developing biliary symptoms for patients <65 years of age is approximately 15% at 10 years and 18% at both 15 and 20 years [4]. However, in older individuals, gallstone disease tends to be more virulent [1]. Older patients have increased risk of gangrene and perforation of the gallbladder. Other complications from gallstone disease such as choledocholithiasis, cholangitis, and pancreatitis are also more common and complex in the elderly [1, 7, 8].

After an initial episode of biliary colic, 20–40% of patients will experience recurrent episodes [9]. Approximately 14% will develop acute cholecystitis within 1 year, 5% will develop gallstone pancreatitis, and 5% will develop common bile duct stones [7, 9]. For this reason, the benefits of early cholecystectomy in symptomatic cholelithiasis have been clearly established in the general population [4, 7]. However, in older patients, the management of symptomatic cholelithiasis is handled differently. The decision to perform elective cholecystectomy is complicated by multiple competing risks, such as comorbidities, previous surgeries, medications, frailty, and fear. Bergman et al. analyzed the management of symptomatic gallstones in the elderly and found that there are marked differences in the management strategies between all age groups and specifically within the elderly group. In patients with symptomatic gallstones that were 65–74 years old, the incidence of surgery was 87.4%, compared to 63.5% for those 75–84 years of age, and only 22.1% for patients over 85 years old. He determined that with advancing age the tendency is toward a nonoperative management [9]. On the other hand, the number of patients requiring urgent admission also rose sharply with age, more than doubling when the youngest group was compared with the oldest group. Furthermore, open cholecystectomy was performed more often in the older groups, possibly in part because of greater disease severity or delayed operative management [10, 11]. This tendency for nonoperative management in the elderly could be leading to more urgent/emergent presentations with advancing age. If symptomatic cholelithiasis was treated similarly in all age groups, we may be able to decrease the incidence of emergency gallbladder surgery in the elderly.

Emergency Biliary Surgery in the Elderly

Acute cholecystitis, choledocholithiasis, cholangitis, and gallstone pancreatitis are typical indications for surgery; however in the elderly population, these conditions don't necessarily lead to a surgical intervention. Emergency gallbladder surgery has been associated with complication rates ranging from 44 to 66% and mortality rates as high as 10–19% [11]. Consequently, there is a tendency to treat the aging population nonoperatively. Acute cholecystitis in a patient over 65 years of age with multiple comorbidities is often treated (inappropriately) with a percutaneous cholecystostomy tube [8]. Cholangitis or choledocholithiasis is often managed by ERCP or percutaneous transhepatic biliary drainage [11]. Cholecystectomy is often delayed in gallstone pancreatitis. Some of these interventions may be denying older patients the appropriate timely surgical intervention.

Nowadays, the mortality associated with gallbladder surgery in this population is far lower than what has been historically reported. McKay et al. performed a population-based analysis of the morbidity and mortality of gallbladder surgery in the elderly and found that the 30-day mortality rate associated with gallbladder surgery in elderly patients was 1.3%. Among patients who underwent urgent/emergency surgery, the rate was only 1.6%, and it was 0.7% for patients who underwent elective surgery [11]. In addition, Tucker et al. examined administrative data from the American College of Surgeons National Surgical Quality Improvement Program for 23,582 patients who underwent cholecystectomy, comparing the use of open vs laparoscopic cholecystectomy. They found that elderly patients (>65 years) were more likely to undergo open cholecystectomy than younger patients. They also reported a higher 30-day postoperative mortality in older patients for both open and laparoscopic procedures (mortality rates of 2.7 and 0.7 versus 1.3 and 0.3%, respectively). They also elucidated an improved outcome in the laparoscopic group [12].

Symptomatic benign gallbladder disease should be treated early in elderly patients. The sequelae from nonoperative management of biliary disease (cholangitis, pancreatitis, cholecystitis) can be fatal in older individuals, and it is important to recognize the appropriate indications for surgery.

Gallbladder Cancer in the Elderly

Gallbladder cancer (GBC) is a disease of the elderly; the average age at diagnosis is 71 years of age [13]. The most significant risk factors for development of GBC are advanced age, female sex, cholelithiasis, porcelain gallbladder, gallbladder polyps, and obesity. Other less common risk factors are chronic infection with *Salmonella* species or *Helicobacter pylori* and anomalous pancreatobiliary duct junction [13]. GBCs are usually diagnosed on pathologic examination after cholecystectomy. Approximately 1 in 250, or 0.7% of laparoscopic cholecystectomies, will yield a pathologic diagnosis of incidental gallbladder cancer. The likelihood of malignancy increases in patients with polyps. Solitary polyps greater than 1 cm and sessile have the highest probability of cancer and should prompt surgery. For the remainder of GBC diagnosed preoperatively, the typical presenting symptoms are jaundice, abdominal fullness, and weight loss [13, 14].

Gallbladder cancer is rare and more common among women. The CDC reports an incidence of 1.4 cases per 100,000 women and 0.8 cases per 100,000 men. It carries a very poor prognosis with overall 5-year survival of 50% for Stage I cancers and 3% for Stage IV cancers [13]. Incidental gallbladder cancers are often diagnosed at an earlier stage and, hence, usually have improved survival.

Surgical resection offers the only potentially curative therapy for GBC. Current guidelines recommend cholecystectomy alone for a T1a lesion (cancer involves the lamina propria without invasion of the muscular layer). For T1b lesions or higher (cancer involving the muscular layer), an extended or radical cholecystectomy should be performed. This includes cholecystectomy with resection of liver segments IVb and V and a portal lymphadenectomy, to obtain negative margins. While extended resection has resulted in improved survival, recurrence rates are high and can occur at distant sites [13]. Since GBC has such a very poor prognosis, all efforts should be focused on early detection and aggressive resection. Although gallbladder cancer is a rare entity, elderly patients with benign, asymptomatic gallbladder diseases such as cholelithiasis and polyps should be thoroughly evaluated for their risk of developing GBC and offered an elective cholecystectomy, if warranted. Furthermore, those patients who present with resectable GBC should be offered radical resection, if feasible.

For advanced gallbladder cancer, the role of adjuvant therapy is receiving significant attention. This is important in the elderly population if they need to undergo a more limited resection [14]. Kasumova et al. set out to investigate the role of adjuvant therapy in T2 and T3 lesions based on the type of resection. In their study of 6825 individuals, patients who underwent extended cholecystectomy with adjuvant therapy had the longest median overall survival (22.4 and 23.3 months, respectively). Surprisingly, patients who underwent simple cholecystectomy with adjuvant therapy demonstrated a survival advantage relative to those who underwent extended cholecystectomy alone. These findings suggest that for select patients, including elderly patients, who are high-risk candidates for extensive surgery or for those in whom a complete curative resection is not possible, simple resection followed by adjuvant therapy should be considered [14].

Liver Cancer in the Elderly Patient

Primary liver cancer in the adult typically refers to either hepatocellular carcinoma (HCC, hepatoma) or cholangiocarcinoma (CCA), while secondary liver cancers include metastatic tumors such as colorectal cancer or neuroendocrine tumors. There are also benign solid (hemangioma, adenoma, and focal nodular hyperplasia) and cystic (simple, cystadenoma, infectious) lesions of the liver that may require surgical management.

Hepatocellular carcinoma (HCC) accounts for 85–90% of all primary liver cancers [15]; it ranks fifth among the most prevalent cancers worldwide and is the third most common cause of cancer-related death [15–17]. The main risk factors for developing HCC are chronic infection with hepatitis B virus (HBV), hepatitis C virus (HCV) infection, aflatoxin, hemochromatosis, and alcoholic and biliary cirrhosis [16]. The largest single risk factor for developing HCC worldwide is the presence of cirrhosis [16, 17]. HCC is more common in the elderly; in the United States, HCC incidence peaks above the age of 70 years [16]. In the coming years, there is expected to be an increase in the number of cases of HCC. This is due to a number of reasons: (1) the increased longevity of the population; (2) the rising incidence of liver cirrhosis unrelated to hepatitis viruses, such as nonalcoholic steatohepatitis (NASH) cirrhosis which can lead to HCC over a long period of time; and (3) some antiviral therapies, such as nucleoside analogs for chronic Hep B and interferon for chronic Hep C infections, have now been possibly linked to the development of HCC; their delayed effect will be seen in the coming years [16].

The management of HCC in the elderly is difficult, since the vast majority of HCCs occur within the cirrhotic liver. Typically, the armamentarium for the management of HCC includes liver transplantation, surgical resection, local-regional treatments (TACE, microwave, Y-90), chemotherapy, or palliative measures [17]. The general algorithm begins with consideration of curative options, either liver transplantation or surgical resection. Those patients with metastatic disease (bone, lung) should not be considered for these treatment options and should only be offered systemic chemotherapy, with local-regional treatment only for palliative purposes [17, 18]. Liver transplantation is considered in those patients who fall within the Milan criteria: single lesion less than 5 cm or up to three lesions less than 3 cm. Patients within Milan criteria are eligible to be listed for liver transplantation [19, 20]. However, once listed, the typical waiting times can be as long as 2–3 years, depending on the region in the country. Therefore, these patients need to undergo treatment with local-regional therapies to keep their tumor burden within Milan criteria until they can get a liver transplant. Patients who fall outside of Milan criteria at initial presentation, or while waiting for liver transplantation, are sometimes eligible to undergo down staging treatment to get their tumors to within Milan criteria, at which time they are eligible to be listed for liver transplantation [21, 22].

Liver transplantation is an enormous operation and therefore carries substantial surgical risk. Furthermore, there are many short- and long-term issues that come along with transplantation, mainly centered on the need for lifelong immunosuppression therapy. While liver transplant is feasible in the elderly population, it is usually not considered, given the significant risk of surgery, coupled with the huge scarcity of liver allografts. Therefore, the only potential curative option for HCC in the elderly patient is surgical resection.

Unfortunately, the vast majority of patients with HCC have underlying cirrhosis. This adds an extra layer of complexity to the surgical planning and decision-making. First, the cirrhotic liver does not have the regenerative or reparative ability of a non-cirrhotic liver [23–26]. Therefore, the amount of liver that can safely be resected is much less in the cirrhotic [24]. The use of liver volumes (from CT scan or MRI) to determine the future liver remnant and/or the use of ICG-clearance to determine total liver function are essential when considering surgical resection in the cirrhotic patient [27–29]. Second, many patients with cirrhosis have some degree of portal hypertension. Many times, the degree of portal hypertension alone may preclude liver surgery, but even if mild, evidence for portal hypertension (ascites, varices, hepatic encephalopathy) may signal the high risk for liver decompensation after resection [30, 31]. The use of scoring systems to assess the degree of liver dysfunction and portal hypertension are important adjuncts (MELD score and Childs-Pugh-Turcotte CPT score).

Cholangiocarcinoma is classically divided into two types: intrahepatic and extrahepatic. The extrahepatic lesions are divided into three subtypes: proximal (hilar or Klatskin tumors), middle, and distal. Surgery, with an R-0 resection, is the only curative option for all types of cholangiocarcinoma [32]. Intrahepatic cholangiocarcinoma is managed with liver resection, while distal cholangiocarcinoma requires a pancreaticoduodenectomy (Whipple procedure). The surgical management of middle and proximal cholangiocarcinoma depends on the extent of longitudinal spread along the biliary tree. While partial extrahepatic bile duct resection is necessary, a concomitant pancreaticoduodenectomy (for middle lesions) or liver resection (for hilar lesions) is often required [33]. Liver transplant has been studied for both intrahepatic and hilar cholangiocarcinoma. Currently, liver transplantation is not recommended for intrahepatic cholangiocarcinoma [34, 35] and is only recommended for a very select group of hilar cholangiocarcinoma [36].

Metastatic colorectal cancer (CRC) is the most common malignant lesion for which hepatectomy is considered in the United States [37]. The outcomes with aggressive surgery, as well as improvements in chemotherapy, have substantially increased survival in patients with advanced stage colorectal cancer [37–39]. The surgical management for metastatic CRC should be very closely orchestrated with medical oncology. Several factors have been shown to impact prognosis with hepatectomy for metastatic CRC. These include the number and size of the lesions, CEA level, time interval of development of liver metastases, and nodal status of the primary tumor [38]. However, the most important factor to consider when planning liver surgery for metastatic colorectal cancer is the ability to resect the entire tumor burden. Good quality, liver-dedicated, imaging is essential to assess tumor burden and to plan treatment. Unlike HCC, patients with metastatic colorectal cancer are typically not cirrhotic [39]. Nonetheless, it is critical to assess the liver for steatosis secondary to chemotherapy (CASH – chemotherapy-associated steatohepatitis). Hepatic steatosis is an injury pattern that can progress to fibrosis and even cirrhosis. Furthermore, similar to the cirrhotic liver, the injured fatty liver cannot regenerate and repair itself like a normal liver. Therefore, the detection of fatty damage to the liver is critical if considering any type of liver resection [40–44].

The technical aspects of liver surgery are similar for elderly patients, as they are for young patients. However, there are some essential considerations required when planning hepatectomy in the elderly. First, is the quality and status of the underlying liver. This will dictate how much liver can safely be resected. A normal, healthy liver can tolerate up to a 70–75% resection, while a cirrhotic liver may not tolerate even a 20–30% resection [45–46]. There is no magic number, and this must be individualized based on the degree of liver damage and dysfunction. There are several modalities to determine the underlying liver function and quality, including physical exam, serum liver function testing, cross-sectional imaging with volumetrics, liver biopsy, and ICG-clearance testing. The physical exam should be aimed at assessing for signs of liver disease (hepatomegaly, jaundice, cachexia, peripheral edema) and for signs of portal hypertension (ascites, splenomegaly, spider telangiectasia, superficial varices, encephalopathy, and gynecomastia). Serum liver function testing is the most basic investigation and should include markers for hepatocyte injury (AST, ALT), cholestasis (alkaline phosphatase, GGT), portal hypertension (platelet count, serum sodium), and true liver function (bilirubin, albumin, PT/INR). Also, if the history suggests risk factors, serum testing for viral hepatitis should be obtained. Liver-dedicated, triple-phase cross-sectional imaging with either CT scan or MRI should be performed on all patients. This will show evidence for any underlying liver abnormality (steatosis, cirrhosis, hepatomegaly) and for signs of portal hypertension (splenomegaly, varices, ascites, shunts). It is also critically important to assess the relationship of the tumor(s) to the inflow and outflow vessels, as well as surrounding structures (colon, diaphragm, stomach, duodenum) [46]. Liver volumes can be easily calculated using special radiologic software, which allows for determination of the future liver remnant based on the type and extent of resection [31]. If there are any concerns about the amount of liver to be resected, coupled with concerns about the quality of the underlying liver, a biopsy should be performed to rule out any pathology in the non-tumorous liver. Indocyanine green (ICG) clearance testing is very popular in Eastern countries and is an excellent test for preoperative assessment of liver function [29].

Once the adequate extent of resection is determined and deemed safe (in terms of future liver remnant), the hepatectomy should be done as meticulously as possible. The use of low CVP anesthesia during parenchymal transection is extremely beneficial in preventing excessive blood loss. The vast majority of liver resections (even in patients with cirrhosis) should be done with minimal to no blood transfusion requirements [47–50]. Knowledge of the patient's liver anatomy, careful dissection of the vasculature and biliary tree, and precise parenchymal transection will provide the best opportunity to avoid devascularization of remaining liver segments, excessive blood loss, and bile leaks.

One of the most critical components to successful liver surgery in the elderly is the

Table 24.1 Overview of the current literature

Author	Year	n	Morbidity (%)	Mortality (%)
Caratozzolo et al. [16]	2007	>70 $n = 51$ <70 $n = 93$	25% 10%, $p = 0.001$	0% 0%
Aldrighetti et al. [5]	2003	>70 $n = 32$ <70 $n = 95$	9% 22%, $p = 0.2$	0% 1%
Cho et al. [19]	2011	>70 $n = 75$ <70 $n = 75$	44% 33%, $p = 0.241$	0% 0%
Ferrero et al. [18]	2005	>70 $n = 64$ <70 $n = 177$	23% 42%, $p = 0.007$	3% 10%, $p = 0.113$
Cescon et al. [4]	2003	>70 $n = 23$ <70 $n = 99$	39% 32%, $p = 0.53$	0% 2%
Mann et al. [20]	2007	>70 $n = 49$ <70 $n = 142$	31% 19%, $p = 0.07$	0% 2%
Ijtsma et al. [13]	2008	>60 $n = 93$ <60 $n = 93$	47% 31%, $p = 0.024$	11% 2%, $p = 0.017$
Takahshi et al. [17]	2012	>80 $n = 21$ <80 $n = 410$	57% 46%, $p = 0.372$	5% 2%, $p = 0.332$
Adam et al. [12]	2010	>70 $n = 1624$ <70 $n = 6140$	32% 29%, $p < 0.001$	4% 2%, $p < 0.001$
Lee et al. [21]	2012	>70 $n = 61$ <70 $n = 90$	28% 14%, $p = 0.042$	
Menon et al. [22]	2006	>70 $n = 127$ <70 $n = 390$	31% 33%, $p = 0.22$	8% 5%, $p = 0.32$
Shirabe et al. [23]	2009	>80 $n = 43$ <80 $n = 307$	26% 22%, $p = 0.56$	0% 1%, $p = 0.99$

From Andert et al. [79], with permission

postoperative management [51]. Several studies have demonstrated that complex hepatobiliary surgery can be done safely in the elderly but with an overall higher morbidity and mortality (Table 24.1 and Fig. 24.1). Much of the morbidity, and subsequent mortality, is due to the inability of the elderly to tolerate the physiologic insults that are inherent to major liver surgery. Importantly, while the elderly patient may not necessarily be at any higher risk to develop certain complications, their ability to overcome a complication is what leads to further morbidity and increased mortality. For example, an 85-year-old male undergoes a right hepatectomy through a right subcostal or chevron incision. Postoperatively, he has significant pain that precludes him from taking deep breaths and clearing his secretions, leading to atelectasis, pneumonia, and a systemic inflammatory response syndrome. This scenario is extremely common after any major hepatobiliary surgery, and while the young patient could tolerate this without any difficulty, this could be a fatal event for the elderly patient.

The more common complications in the elderly include delirium, infection and cardiopulmonary decompensation [1, 47, 49, 51]. Therefore, the postoperative management must include cardiac optimization, careful fluid management, adequate pain control, avoidance of delirium-inducing medications, aggressive pulmonary toilet, prevention of aspiration, early and frequent ambulation, and good nutrition.

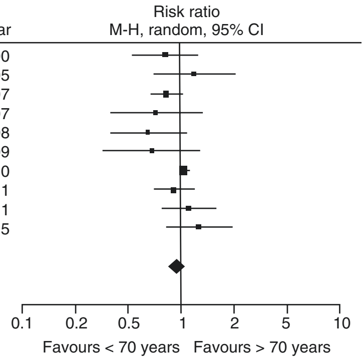
Pancreatic Cancer in the Elderly Patient

Pancreatic adenocarcinoma carries a dismal prognosis. Typically, these cancers present with painless jaundice (for pancreatic head/uncinate tumors), abdominal/back pain (for body and tail lesions), and unintentional weight loss. Unfortunately, by the time a patient with pancreatic cancer presents with symptoms, the majority of tumors are either locally advanced (involving the major visceral vessels) or metastatic [52, 53]. The median survival for untreated pancreatic

a

Study or subgroup	Patients aged <70 years Events	Total	Patients aged >70 years Events	Total	Weight	Risk ratio M-H, random, 95% CI	Year
Brand et al.	39	126	16	41	6.4%	0.79 [0.50, 1.26]	2000
Nagano et al.	35	150	12	62	4.3%	1.21 [0.67, 2.16]	2005
Figueras at al.	164	488	66	160	17.2%	0.81 [0.65, 1.02]	2007
Mazzoni et al.	21	144	11	53	3.4%	0.70 [0.36, 1.36]	2007
Mann et al.	27	142	15	49	4.9%	0.62 [0.36, 1.07]	2008
Tamandl et al.	18	174	11	70	3.1%	0.66 [0.33, 1.32]	2009
Adam et al.	2,958	6,140	747	1,624	32.7%	1.05 [0.99, 1.11]	2010
Cannon et al.	105	220	31	59	13.3%	0.91 [0.69, 1.20]	2011
Kulik et al.	115	719	27	190	8.4%	1.13 [0.76, 1.66]	2011
Nomi et al.	34	62	13	31	6.2%	1.31 [0.82, 2.10]	2015
Total (95% CI)		8,365		2,339	100.0%	0.94 [0.83, 1.07]	
Total events	3,516		949				

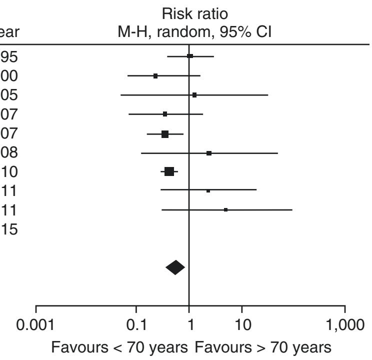
Heterogeneity: Tau² = 0.01; Chi² = 14.08, df = 9 ($p = 0.12$); $I^2 = 36\%$
Test for overall effect: Z = 0.94 ($p = 0.35$)



b

Study or subgroup	Patients aged <70 years Events	Total	Patients aged >70 years Events	Total	Weight	Risk ratio M-H, random, 95% CI	Year
Fong et al.	19	449	5	128	15.2%	1.08 [0.41, 2.84]	1995
Brand et al.	3	126	3	41	7.3%	0.33 [0.07, 1.55]	2000
Nagano et al.	1	150	0	62	2.0%	1.25 [0.05, 30.31]	2005
Mazzoni et al.	3	144	3	53	7.2%	0.37 [0.08, 1.77]	2007
Figueras et al.	13	488	12	160	20.4%	0.36 [0.17, 0.76]	2007
Mann et al.	3	142	0	49	2.3%	2.45 [0.13,46.56]	2008
Adam et al.	101	6,140	62	1,624	38.7%	0.43 [0.32, 0.59]	2010
Kulik et al.	9	719	1	190	4.5%	2.38 [0.30, 18.66]	2011
Cannon et al.	9	220	0	59	2.5%	5.16 [0.30, 87.66]	2011
Nomi et al.	0	62	0	31		Not estimable	2015
Total (95% CI)		8,640		2,397	100.0%	0.56 [0.36, 0.89]	
Total events	161		86				

Heterogeneity: Tau² = 0.12; Chi² = 11.04, df = 8 ($p = 0.20$); $I^2 = 28\%$
Test for overall effect: Z = 2.46 ($p = 0.01$)



c

Study or subgroup	Patients aged <70 years Events	Total	Patients aged >70 years Events	Total	Weight	Risk ratio M-H, random, 95% CI	Year
Fong et al.	274	449	83	128	141.1%	0.94 [0.81, 1.09]	1995
Brand et al.	100	126	34	41	11.2%	0.96 [0.81, 1.13]	2000
Nagano et al.	71	150	41	62	5.1%	0.72 [0.56, 0.91]	2005
Figueras et al.	268	488	102	160	15.2%	0.86 [0.75, 0.99]	2007
Mazzoni et al.	89	144	37	53	6.4%	0.89 [0.71, 1.10]	2007
Mann et al.	81	142	34	49	5.6%	0.82 [0.65, 1.04]	2008
Tamandl et al.	99	174	43	70	6.0%	0.93 [0.74, 1.16]	2010
Kulik et al.	446	719	131	190	24.7%	0.90 [0.80, 1.01]	2011
Cannon et al.	143	220	47	59	11.8%	0.82 [0.69, 0.96]	2011
Total (95% CI)		2,612		812	100.0%	0.88 [0.83, 0.93]	
Total events	1,571		552				

Heterogeneity: Tau² = 0.00; Chi² = 6.12, df = 8 ($p = 0.63$); $I^2 = 0\%$
Test for overall effect: Z = 4.48 ($p < 0.00001$)

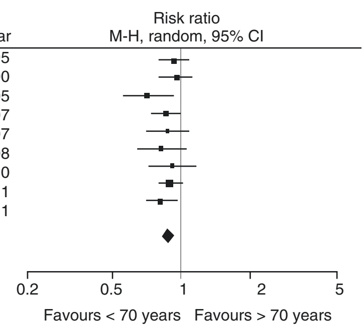


Fig. 24.1 (**a**) Postoperative morbidity for liver resection for CRLM in patients aged <70 years and patients aged >70 years. (**b**) Postoperative mortality for liver resection for CRLM in patients aged <70 years and patients aged >70 years. (**c**) Five-year survival for liver resection for CRLM in patients aged <70 years and patients aged >70 years. *CRLM* colorectal liver metastases, *M-H* Mantel-Haenszel. (From van Tuil et al. [80], with permission)

cancer is 8–12 months for locally advanced disease and 3–6 months for metastatic disease [53, 54]. Current chemotherapeutic regimens can offer several months of improvement in overall survival but must be weighed with the quality of life during the chemotherapy [55–57]. Only 10–20% of patients with pancreatic cancer have resectable disease at presentation. Despite huge improvements in mortality rates after pancreatic surgery, survival of pancreatic cancer remains poor, even with complete resection. The 5-year survival for a resected, node-negative pancreatic cancer is 25–40% but only 10–15% for a resected, node-positive tumor [52, 58, 59].

The surgical options for pancreatic cancer are based on the location of the tumor. In general, tumors of the pancreas either involve the head and uncinate process (which are to the right of the portal/mesenteric vein) or they involve the body and tail (which are to the left of the portal/mesenteric vein). Therefore, the vast majority of surgery for pancreatic lesions requires either resection of the head and uncinate process (pancreaticoduodenectomy) or resection of the body and tail (distal pancreatectomy). Sometimes, tumors in the body of the pancreas may extend over to the right side of the vessels. This may require extended resection or potentially a central/middle pancreatectomy. Enucleation of some pancreatic tumors is feasible but should never be offered for pancreatic adenocarcinoma [60, 61].

Pancreaticoduodenectomy (Whipple procedure) is the quintessential general surgical procedure. It involves resection of the duodenum, head and uncinate process of the pancreas, and the distal portion of the common bile duct. The shared blood supply and the intricate anatomic relationship of the pancreaticobiliary tree preclude isolated resection of a single structure. Furthermore, the intimate relationship of the duodenum and pancreas to the mesenteric vasculature (common hepatic artery, superior mesenteric artery, and vein) makes resection of these structures very treacherous. The reconstruction after resection requires establishing continuity of the pancreas, biliary tree, and stomach. This is accomplished by performing three separate anastomoses to the proximal jejunal limb, all of which have the potential for leakage [62]. In particular, the pancreatic anastomosis tends to be the most difficult and sinister. The soft nature of the pancreatic parenchyma, coupled with the small size of the pancreatic duct, makes for a high likelihood of leak (fistula). Leakage of pancreatic fluid can initiate autodigestion of local tissue, leading to intra-abdominal collection, sepsis, and massive bleeding [63, 64].

Historically, the Whipple procedure carried substantial morbidity, with mortality rates as high as 25%. Over the past 30 years, in experienced hands, the Whipple procedure has become a straightforward procedure, with acceptable mortality rates of only 2–3%. This significant improvement in mortality is the result mainly from mastery of the surgical technique, as well as improved postoperative management [62, 65]. However, despite this, the morbidity remains as high as 40%, with delayed gastric emptying and pancreatic leak as the most common complications [62–65]. Distal pancreatectomy does not require any type of enteric reconstruction, which makes it technically less demanding than pancreaticoduodenectomy and results in a lower mortality [66]. However, distal pancreatectomy still carries substantial morbidity, with pancreatic leak/fistula rates as high as 30–35% [66, 67].

The outcomes of pancreatic surgery in the elderly are acceptable, despite most studies showing a higher morbidity and mortality (Figs. 24.2 and

Study or Subgroup	≥80 Events	≥80 Total	<80 Events	<80 Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Beltrame 2015	0	23	14	362	7.4%	0.51 [0.03, 8.84]
Belyaev 2013	9	76	43	1705	13.6%	5.19 [2.43, 11.09]
Gangl 2014	0	9	5	99	4.0%	0.90 [0.05, 17.64]
Hatzaras 2011	1	27	18	490	7.6%	1.01 [0.13, 7.85]
khan 2010	1	53	6	564	4.3%	1.79 [0.21, 15.14]
M. Lee 2010	4	74	27	703	20.5%	1.43 [0.49, 4.21]
Makary 2006	8	207	42	2491	26.0%	2.34 [1.09, 5.06]
Melis 2012	1	25	1	175	1.0%	7.25 [0.44, 119.76]
Oguro 2012	1	22	5	539	1.6%	5.09 [0.57, 45.48]
Sohn 1997	2	46	10	681	5.1%	3.05 [0.65, 14.35]
Tani 2009	0	25	8	310	5.4%	0.70 [0.04, 12.44]
Usuba et al 2014	0	10	2	50	3.6%	0.92 [0.04, 20.69]
Total (95% CI)		**597**		**8169**	**100.0%**	**2.22 [1.48, 3.31]**
Total events	27		181			

Heterogeneity: $Chi^2 = 9.79$, df = 11 (P= 0.55); $I^2 = 0\%$
Test for overall effect: Z = 3.87 (P= 0.0001)

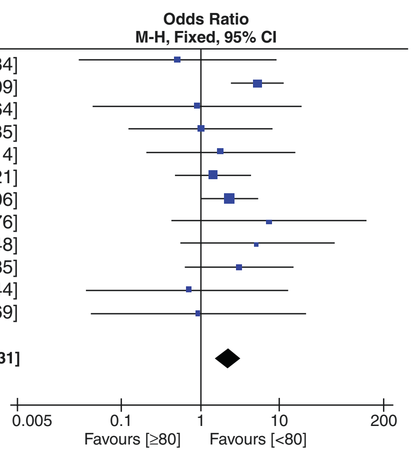


Fig. 24.2 Thirty-day mortality forest plot. Forest plot of comparison of 30-day mortality in patients aged 80 or over versus patients younger than 80. (From Kim et al. [81], with permission)

Study or Subgroup	≥80 Events	Total	<80 Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
Beltrame 2015	10	23	145	362	5.6%	1.15 [0.49, 2.70]
Hatzaras 2011	14	27	289	490	8.4%	0.75 [0.34, 1.63]
khan 2010	27	53	209	564	10.2%	1.76 [1.00, 3.10]
M. Lee 2010	35	74	359	703	20.8%	0.86 [0.53, 1.39]
Makary 2006	104	197	984	2491	39.3%	1.71 [1.28, 2.29]
Melis 2012	17	25	77	175	3.6%	2.70 [1.11, 6.60]
Oguro 2012	6	22	52	539	1.7%	3.51 [1.32, 9.37]
Sohn 1997	26	46	270	681	8.6%	1.98 [1.08, 3.62]
Usuba et al 2014	5	10	20	50	1.9%	1.50 [0.38, 5.86]
Total (95% CI)		**477**		**6055**	**100.0%**	**1.51 [1.25,1.83]**
Total events	244		2405			

Heterogeneity: Chi² = 15.08, df = 8 (P= 0.06); I^2 = 47%
Test for overall effect: Z = 4.30 (P < 0.0001)

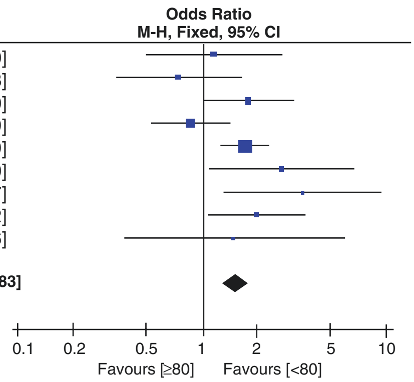


Fig. 24.3 Overall postoperative complication in octogenarians or older vs young patients forest plot. Forest plot of comparisons of overall complications after the operation in both age groups. (From Kim et al. [81], with permission)

Table 24.2 Summary of results of meta-analysis

Outcome	Number of studies	Participants aged 80 and over	Participants aged less than 80	Odds ratio fixed [95% CI]	Statistical difference
30-day mortality	12	597	8169	2.22 [1.48, 3.31]	$p < 0.001$
ASA ≥3	6	1191	11,442	2.33 [1.98, 2.74]	$p < 0.001$
Overall complications	9	477	6055	1.51 [1.25, 1.83]	$p < 0.001$
Postoperative pancreatic fistula	9	492	6940	0.99 [0.73, 1.34]	$p = 0.93$
Delayed gastric emptying	7	413	6266	1.77 [1.35, 2.31]	$p < 0.001$
Bile leak	5	351	4653	1.33 [0.77, 2.30]	$p = 0.30$
Postoperative hemorrhage	5	143	2526	1.44 [0.59, 3.53]	$p = 0.42$
Wound infection	4	339	4927	1.16 [0.79, 1.70]	$p = 0.45$
Reoperation	8	472	6581	1.28 [0.86, 1.89]	$p = 0.23$
Postoperative cardiac events	3	259	3291	3.24 [1.89, 5.56]	$p < 0.001$
Postoperative pneumonia	7	1416	14,684	1.72 [1.39, 2.13]	$p < 0.001$
Mean length of stay	5	765	7814	2.23 [1.36, 3.10]	$p < 0.001$

From Kim et al. [81], with permission

24.3). However, given the dismal prognosis of pancreatic cancer, the increased risk of surgery is outweighed by the survival benefit gained from tumor resection [68–70]. Similar to major liver surgery in the elderly, there are a higher number of cardiac and pulmonary complications after pancreatic surgery, with an equal number of pancreatic and biliary leaks (Table 24.2). Other patient factors that impact adverse outcomes after pancreaticoduodenectomy include American Society of Anesthesiologist class, low serum albumin levels, significant weight loss, and significant intraoperative blood transfusion requirement [71–76]. This suggests that poor functional status and underlying comorbidities contribute to the increased mortality in the elderly population, rather than age alone. Hence, a prehabilitation program may address both the frailty and nutritional aspects so as to optimize patients for surgery and improve their outcomes and may improve failure to rescue rates. Nakajima et al. show that of 76 patients who underwent prehabilitation had a decreased median length of stay of 23 days, in comparison to 30 days for those without prehabilitation [77]. This program was particularly unique in comparison to most American prehabilitation programs in that it incorporated leucine-rich essential amino acid supplements and supervised exercise therapy before their surgery. A small pilot study looked at the impact of prehabilitation on functional status and length of stay following pancreatic surgery and showed that mean length of stay was decreased to 12.6 days from 13.2 days [78].

Conclusion

Hepatopancreaticobiliary surgery can be done safely in the elderly patient. These are complex operations that require a multidisciplinary approach to the perioperative management of these patients. Careful preoperative planning, medical and nutritional optimization, meticulous surgical technique, and exceptional postoperative care are the key elements to successful outcomes. Age alone should never preclude the opportunity for elderly patients to undergo surgical procedures that can prolong life and/or improve quality of life.

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Plastic Surgery in the Elderly

25

Kaveh Alizadeh and Ashraf Elzanie

The longer I live, the more beautiful life becomes. – Frank Lloyd Wright

Introduction

As the population of the United States continues to age, there is an increasing demand for plastic surgery among the elderly population. The American Society of Plastic Surgeons reported a year to year 2% increase in procedures by patients over the age of 55 to 4.2 million cosmetic procedures in 2018 alone [1]. By 2050, the United States is expected to accelerate its elderly population growth of people 65 or older to 88.5 million people from its current 50 million today [2]. With age, there is an increasing demand for reconstructive surgeries such as wound care, tumor removal, and cancer reconstruction. ASPS statistics reveal a 29% increase in breast reconstruction alone with over 101,000 cases performed in 2018 [1]. The fastest rising trend in plastic surgery is the demand for post-bariatric body lifts with arm and lower truncal lift accounting for 5000% increase in numbers over the past two decades. With a third of Americans obese, there is no doubt these interventions will continue to rise. Furthermore, media and global access drive the celebrity culture and medical tourism which in turn have created a disproportionate demand for "minimally invasive" procedures that have made "60 is the new 40 years of age" culture and have contributed to the $40 billion plastic surgery global market. Therefore it is important to understand the plastic surgery principles surrounding the aging needs of the elderly

K. Alizadeh (✉) · A. Elzanie
Westchester Medical Center, Valhalla, NY, USA
e-mail: Kaveh.Alizadeh@wmchealth.org

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population as it pertains to economic impact, improved outcomes, and the health of our society.

Biological Factors of Skin Aging

Over the past decade there has been tremendous amount of published literature focused on aging. With regard to plastic surgery, we are interested in factors that cause aging of the skin, muscle, bone, tendons, and peripheral nerves.

Extrinsic Factors

By far the most damaging external factor that can lead to “premature aging” is considered to be exposure to the sun. UVA and UVB rays of the sun can lead to free radicals which can directly damage the dermal layer, impair DNA repair of the skin, and suppress the immune mediated defense of the skin mediators. The buildup of damaged elastin at the dermal layer, combined with increased collagen breakdown and lack of repair, leads to uneven epidermal thickening and dermal thinning of the skin called solar elastosis which then further exacerbates the morphology of the skin with vessels that come close to the surface known as telangiectasia, and congregation of pigment-producing melanocyte cells called solar lentigo and dyschromia. Other factors that play a large role in the aging of the skin include dehydration, wind (primarily through dehydration), cold exposure, and smoking. Guyuron et al. studied the role of smoking in facial aging and found that a 5 year history of smoking can cause a noticeable difference in the appearance of aging in identical twins [3]. Similarly Ichibori and colleagues studied 67 pairs of Japanese monozygotic twins and found that cigarette smoke and sun exposure were the primary factors to worsen facial texturing [4] (Fig. 25.1).

Fig. 25.1 Facial changes caused by smoking: a comparison between smoking and nonsmoking identical twins. (Reprinted with permission from Plast Reconstr Surg. 2009;123(4):1321–31)

Fig. 25.2 The aging of French actress Bridget Bardot over a 50 year period revealing the intrinsic and extrinsic forces at play in aging with loss of facial definition and diamond shape and descent of soft tissue in the neck

Another major noted factor for aging on our planet is the presence of gravity. Gravity places forces on our body which require a counterforce directed by our muscles, bones, tendons, and ligaments. Over time, with repetitive motion of these activities, a typical pattern of aging emerges in the face which has been well documented by investigators [5–7].

In a series of carefully reported studies of computed tomography scans of various age groups, Kahn and his team have shown that there is definitive changes in facial skeleton over time as the glabellar and maxillary angle in both the male and female subjects decrease with increasing age while there is a significant increase in pyriform aperture area from the young to the middle age group for both sexes. The pyriform and orbital aperture width and surface area increases significantly with age for both sexes. Mandibular length and height both decrease significantly for each sex while the mandibular angle significantly increases with age for both sexes. Coupled with Mendelson's work which showed increased descent of mid cheek soft tissue and loss of malar and mandibular ligament support, we can start to put together a predictable pattern of facial aging in all humans [8]. One cannot help but wonder about the circular nature of life since these facial patterns are very similar to the morphology of a baby's face (Fig. 25.2).

Intrinsic Factors

The ability of the skin to age well also depends on a multitude of factors including collagen which provides the structure foundation of the extracellular matrix (ECM) in the dermis. There are two major subtypes of collagen in the human skin: Type I collagen forms up to 90% of the skin while type III is responsible for about 10% of the dermis. El domiyati et al. have shown that human skin which primarily contains type I and III collagen can maintain its proportion well into the eighth decade of life unless interrupted by extrinsic factors [9], while Lovell and his team have suggested that the intrinsic effects of aging are primarily related to the inhibited synthesis of type I collagen [10]. Collagen, which is a major component of ECM, becomes fragmented and unevenly distributed due to increased activity of matrix metalloproteinases, and reactive oxygen species disrupt the normal signaling mechanism of transforming growth factor-β during aging.

The reduction in the amount of collagen hinders the mechanical interaction between fibroblasts and the ECM, and consequently leads to the deterioration of fibroblast function and further decrease in the amount of dermal collagen. Other ECM components, including elastic fibers, glycosaminoglycans (GAGs), and proteoglycans (PGs), are also negatively affected by aging. Dermal elastin which primarily stores energy for skin recoil and hyaluronic acid which gives its turgor decrease in intrinsically aged skin giving the typical appearance of dry skin that does not bounce. There is plenty of evidence that supports the loss of all these major components of the skin from ongoing protein glycation and inherent inflammatory damage [11–16].

There is also loss of muscle mass, and declining strength with age as nearly 30% of muscle mass is lost by the ninth decade of life [17]. This is likely due to decreased muscle build with lower body protein and increased expression of inflammatory factors leading to skeletal muscle catabolism with concomitant increased apoptosis and decreased mitochondrial function.

Age-related changes in bone involve reduced calcium and phosphate metabolism with resultant loss of mass and mineral content, increased marrow fat content, and altered response to growth factors and hormones [18]. Osteoblasts, osteoclasts, and osteocytes, like most other stem and progenitor cells, slow their activity leading to osteoporosis and skeletal fragility, increasing susceptibility to fractures [19]. The decline in structure and function of aged tendons results from degeneration of tenocytes and collagen fibers, accumulation of lipids and ground substance, and calcium deposits. Tenoblast metabolic activity also decreases which results in tensile strength loss, stiffness, and increased susceptibility to damage.

Within the peripheral nervous system, there is impaired regeneration of neurons which accumulate lipofuscin granules, with subsequent axonal loss, demyelination, and synapse number reduction and attenuated growth factor response [20]. These changes result in age-related declines in nerve conduction velocity, muscle strength, sensory discrimination, and autonomic responses and lead to poorer outcomes in reinnervation following peripheral nerve injury in the aging population [21] (Fig. 25.3).

Along with the molecular changes, there is a remarkable change that also happens in the facial soft tissue. Pesa and his colleagues have published a series of papers that have shown the intricate nature of the facial fat compartments and their relative contribution to aging over time. We now have a better understanding of why aging happens in such a predictable pattern in the periorbital area followed by fat involution in distinct compartments of the cheeks and lower face [23–25]. Even more fascinating is the knowledge about why men seem to age “slower” than women. MRI studies have shown that women tend to lose their diamond facial shape

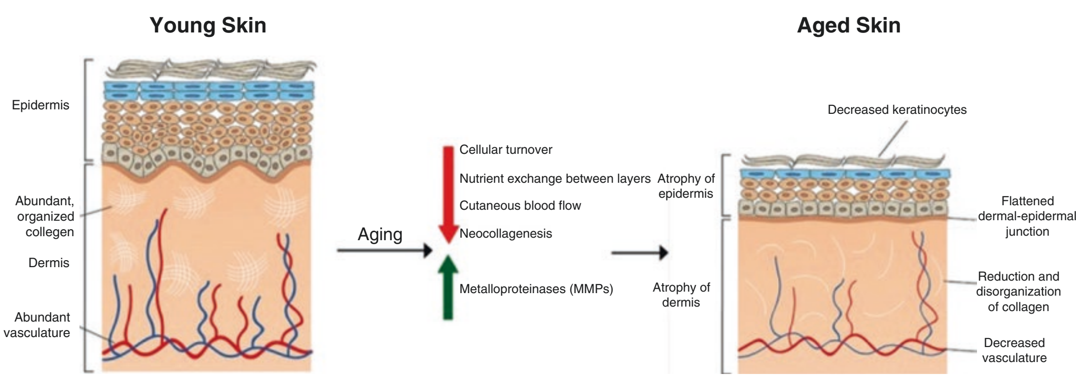

Fig. 25.3 Skin aging. Decreased cellular turnover and inefficient nutrient exchange between the different layers occurring with aging result in atrophy of both the epidermis and dermis. The decrease in collagen number and organization result from decreased production of collagen as well as increased breakdown by metalloproteinases. A reduction in the vasculature is also seen leading to inefficient cutaneous blood supply [22]

with time whereas men maintain their square shape as they age [26]. The result is that both men and women age with square-shaped faces as the bones resorb and soft tissue descend into jowls and lower neck. However, our brains perceive that women's faces lose their rejuvenated appeal as they lose their diamond shape (Table 25.1).

Physical Exam and Analysis

Armed with the knowledge of intrinsic and extrinsic factors of aging, it is important to evaluate the patients carefully based on these known parameters and document it carefully before one undertakes any surgery on the elderly. The Table 25.2 below shows what the surgeon needs to evaluate and document prior to operating on the geriatric patient.

Table 25.1 Changes in dermal extracellular components in the aging process

Photoaging	Components	Intrinsic Aging
Decreased and fragmented	Collagen	Decreased and fragmented
Abnormally accumulated (SE)	Elastic fiber	Decreased
Increased in SE region	Hyaluronic acid	Not changed
Increased	Total sulfated GAGs	Decreased
Increased in SE region	Versican	Not changed?
Not changed	Biglycan	Decreased
Decreased in SE region	Decorin	Not changed?

GAG glycosaminoglycan, *SE* solar elastosis
Source: Shin JW, Kwon SH, Choi JY, et al. Molecular Mechanisms of Dermal Aging and Antiaging Approaches. Int J Mol Sci. 2019;20(9):2126. Published 2019 Apr 29. https://doi:10.3390/ijms20092126

Planning for Plastic Surgery

It is important to note that although many of the changes of aging manifest themselves in the cosmetic evaluation, we also need to be aware of the physiological aspects of aging that can affect the surgical outcome in the elderly patient. The core values of plastic surgery dictate that the physician first address the functional impairments, next focus on form, and finally maximize the aesthetic benefit of the operation for the patient. There are a number of important considerations in planning reconstructive surgery for the geriatric patient.

Breast Reconstruction

With the aging of the world, the prevalence of breast cancer among elderly women is increasing. Nearly half of all women who are diagnosed with breast cancer are over the age of 65. As a result, more elderly women require breast reconstruction.

Table 25.2 A check list of all these factors must be considered when evaluating the progression of aging in facial surgery

Differential aging of the body part
Skin state and scarring history
Photo damage, dyschromia, and telangiectasia
Bony structure and previous fractures
Status of teeth and dental surgery
Fat vs muscle soft tissue cover
Quality vs quantity of facial rhytids
Thickness vs oiliness of the skin
Elasticity vs hyaluronic acid component of skin
Differential soft tissue descent of the face
Motor vs sensory deficits

Historically breast reconstruction after mastectomy in elderly women has been examined in the form of autologous vs implant-based techniques. The options for autologous approach in the elderly have included pedicled transverse rectus abdominis myocutaneous (TRAM) flaps or latissimus flaps vs free tissue transfer with abdominal tissue or other distant sites that limit the donor site at the cost of longer operative time and hospitalization. The non-autologous approach has involved use of expanders and permanent implant prosthesis and acellular dermal matrix (ADM) to provide a reliable aesthetic outcome. The latest trend in breast reconstruction involves a skin and nipple sparing mastectomy followed by use of a pre-pectoral implant and ADM for lower pole control [27]. These cases often require a secondary fat grafting to the upper pole to provide for better symmetry (Fig. 25.4).

There have been limited studies examining elderly women using a direct-to-implant reconstructive approach. The appeals of this approach in this particular population come in the form of a single surgical procedure, no tissue expansion needed and fewer follow-up visits. This study was a retrospective chart review over 4 years. A total of 24 breasts in 19 elderly patients were analyzed who underwent direct-to-implant reconstruction [28]. This was compared to a significantly younger control group population that underwent tissue expander with subsequent implant. Between the two groups there was no significant difference between wound complication rates or failed reconstruction. However, older individuals had significantly lower number of drain days, length of stay, readmissions, and postoperative visits.

Torabi and colleagues examined 339 patients that underwent deep inferior epigastric perforator (DIEP) microsurgical tissue transfer flaps (285 non elderly vs 54 elderly patients) with primary outcomes of complete flap loss, partial flap loss, or return to OR and were able to demonstrate a higher prevalence of medical comorbidities such as diabetes and hypertension with age [29]. When compared to the nonelderly population, elderly patients had a higher rate of complete flap loss and wound complications. More specifically, patients in the elderly cohort demonstrated an odds ratio of 10.92 for complete flap loss and had significantly higher rates of wound dehiscence (24.1% vs. 8.4%) vs the younger cohort. Success rates of free flap reconstruction in both cohorts were compared and found to be similar (99.6% in the elderly population compared to 96.3% in the nonelderly population). The study concluded that autologous free flap breast reconstruction remains a viable option for elderly patients although age is an independent risk factor for complete flap loss.

Santosa and colleagues published a high evidence-level multicenter prospective study which showed patients over the age of 60 did not have increased complications compared to their younger cohorts, although they tended to get more unilateral and delayed pedicled autologous options [30].

Hand and Microsurgery

It is important to preclude comorbidities such as vascular disease, smoking, and injury mechanism when analyzing the role of age in hand and microsurgery outcomes. Retrouvey took on this task when his team analyzed 284 patients that underwent finger reimplantation or revascularization with 32 of these patients over 60 years old [31]. Approximately half of the total population measured underwent revascularization alone while the other group underwent revascularization with reimplantation of the digit. When comparing the two populations, the older group had higher ASA scores and had more associated comorbidities. Overall a total of 88 patients had reimplanted digit failure or thrombosis of revascularization. Furthermore, this encompassed a total of 12 failures within the elderly group. When a multivariate logistic regression was performed, this showed that older patients did not experience major complications or failure rates when compared to younger age groups; however, they had higher rates of minor complications such as wound infections. Therefore, based on the data gathered from this study, ASA class and age should not preclude elderly patients from undergoing digital revascularization or reimplantation. The results of this

Fig. 25.4 (**a**) (front view) and (**b**) (side view) This patient was diagnosed with ductal cell carcinoma and required a skin and nipple sparing mastectomy followed by immediate implant reconstruction with acellular dermal matrix for lower pole support. (**c**) (front post-op) and (**d**). (Side view post-op) Patient is seen 4 months post reconstruction after having undergone an intermediary fat grafting session to the upper and medial poles to improve her projection and symmetry

study were corroborated by Barzin et al. in the *Journal of Hand Surgery* [32]. On the other hand (pun intended), Kwon et al. found that patients over age 70 had worse functional recovery than their younger cohorts with longer rehabilitation parameters [33]. Similarly, studies on tendon repair have found that older patients are more likely to require reoperation after flexor tendon repair [34, 35].

Microsurgical literature is more controversial with regard to the effect of aging on outcomes. A systematic review incorporated a total of 45 articles including 115 patients [36]. Majority of the included individuals were male and the mean age for this population was 73. Mean flap size was 598 cm^2 which ranged from 82 to 2500 cm^2. Only two of the 115 cases reported flap failure and the mortality rate for this population was 0.9 percent. Total complication rate for patients undergoing microvascular reconstruction was reported to be 22%. However, when stratified by flap type, there was no significant difference in complication rate. This study concluded that for microvascular reconstruction for complex scalp defects, age is not a risk factor for flap failure.

Üstün et al. [37] performed a systematic review and meta-analysis of free flaps in elderly patients. They found no difference in elderly versus young flap success rates or surgical complications; however, they did find significantly more medical complications and mortality in elderly patients. Jubbal's team analyzed 5951 cases of free tissue transfer and when controlling for comorbidities found that age itself was not significantly associated with complications. Age was significantly associated with increased mortality. As such, the authors recommended assessment of "physiological" age instead of chronological age in assessing patients for free tissue reconstruction [38].

Lower extremity reconstruction in the elderly is more complex due to peripheral artery disease and diabetes which makes it a better candidate for microsurgery where studies have found no difference in complication rates in patients >65; however, these patients required a higher rate of ICU admission [39–41].

Serletti et al. examined 100 patients >65 years retrospectively and found that chronological age did not predict flap complications [42]. However, higher ASA scores and length of operative time were significant predictors of postoperative surgical morbidity. Another literature review of head and neck free flap reconstruction found no difference in flap success, or mortality rate in elderly patients based on chronological age [43].

A large retrospective cohort study examined 211 patients 70 years or older at a single institution who underwent free tissue transfer. Although surgical complication rates were similar between the two groups (using rectus abdominis 32.7%, radial forearm 25.6%, jejunum 17.1%, fibula 18.1%, and latissimus dorsi 6.5%), there were significantly higher rates of medical complications in the octogenarian group when compared to septuagenarians. Furthermore, among this study's population it was identified that alcohol use, hypertension, and coronary artery disease were independent predictors of overall medical and surgical complications. Therefore, this study concluded that the elderly population must be carefully selected on the basis of medical comorbidities and overall functional status [44]. This was further illustrated by Chen et al. who showed a 37% surgical complication rate on their patient population over age 85 [45].

Facial Fractures

Facial fractures in the elderly are usually related to falls as opposed to trauma [46]. Atisha et al. found that elderly patients >64 years generally required significantly less operative intervention and also had fewer surgical complications [47]. Others have reported longer hospitalizations and rehabilitation [48]. The clinical correlation for management of these fractures in the elderly is usually a "watchful waiting" approach since one must also take into account the elderly patient's own wishes who may not want more surgery with plates and screws in their face for an improved aesthetic outcome.

Cosmetic Surgery

With the graying of the American population who want to keep looking young, there is an increased demand for cosmetic surgery among the elderly. A recent publication studies a total of

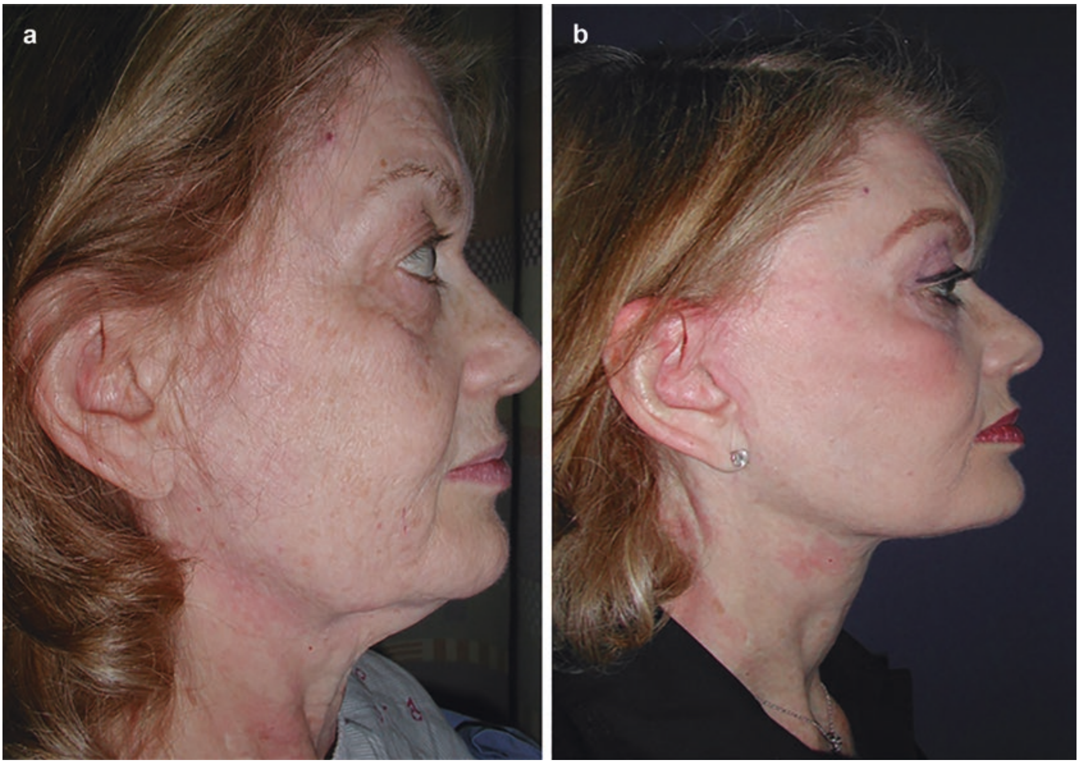

Fig. 25.5 (**a**) Sixty-year-old patient who presented for rhytidectomy and laser resurfacing to address her facial aging. (**b**) Same patient at age 70 returns 10 years post-op revealing increased facial skin aging with elastosis despite maintaining excellent skin contour of the neck

6786 elderly patients who underwent cosmetic procedures [49]. In the postoperative period, the overall complication rate was compared between elderly and younger populations and was found to have no statistical significant difference between the two groups. Furthermore, this was still true when stratified to octogenarians which showed no significant difference in complication rates among this population, although they had higher rates of postoperative infection and hematoma. This article concluded that there is no added risk to performing cosmetic procedures in the elderly, including octogenarians.

A single surgeon retrospective cohort study examined a total of 216 patients undergoing a face lift procedure. Patients were divided into an older cohort 65 and older with a total of 68 patients and a younger cohort under 65 years old with a total of 148 patients. Elderly patients' major and minor complication rates were not significantly different when compared to those in the younger age cohort with no mortality in either group. Based on these results, there was no significant difference in terms of outcomes measured from face lifts performed in the elderly and younger cohort [50].

Using a higher level of evidence, Karamanos et al. used NSQIP data to examine wound dehiscence from plastic surgery patients over a 5-year period and found that there was less than 1% dehiscence rate regardless of the age of the patient [51] (Fig. 25.5).

Abdominal Wall Reconstruction

Optimization of patients undergoing abdominal wall reconstruction for complex ventral hernias remains a complex issue. This particular cohort often presents with loss of abdominal domain, pain, difficulty performing routine physical activities in addition to being deconditioned, malnourished, and overweight. Furthermore, hernia repair and abdominal wall reconstruction of complex ventral hernias are major surgical procedures which induce further stress on the elderly population that may already have other comorbidities such as hypertension, cardiovascular disease, and diabetes. This cycle is initiated in the form of insulin resistance and proteolysis with further loss of lean body mass and the initiation of a catabolic state which leads to an impairment of immunologic function. Additional surgical adjuncts for abdominal wall closure such as implants and permanent mesh can act as a harbinger for chronic infection. However, based on previous literature there are preoperative modifiable risk factors that have been identified to reduce these effects. Obesity has been shown to be a significant risk factor for wound complications in the past. Previous studies have suggested that weight reduction with a BMI less than 40 is associated with better outcomes. A second modifiable risk factor is smoking cessation. With patients undergoing major reconstructive surgery, wound healing must be optimized. Negative effects of smoking in the form of reduction of blood and tissue oxygen tension levels as well as collagen formation lead to increased frequency of wound complications. Another modifiable risk factor includes glycemic control. It has been shown in previous studies that diabetics with a goal of HbA1c level of less than 6.5% preoperatively are associated with decreased rates of infection and other wound complications [52]. Sarcopenia is an additional modifiable risk factor that should be considered in this particular population. Sarcopenia when coupled with obesity has been shown to decrease overall survival as well as negative outcomes in the surgical as well as critical care settings. There are regimens available to counteract this detrimental disease process. Furthermore, these regimens are in the form of increased protein intake with combined resistance exercises which provide the best chance for preserving or regaining/maintaining functional status following complex hernia repair and abdominal wall reconstruction.

In terms of preoperative assessment of nutrition there is a lack of focus on preoperative nutritional optimization prior to surgery. It has been shown in previous studies that optimizing nutrition has been shown to decrease hospital stay, readmissions, and postoperative complications. There are a few tools available to clinicians to assess for nutritional status and who would benefit from nutritional intervention. One is in the form of body composition analysis which utilizes either bioelectrical impedance analysis or radiologic methods to determine body composition.

Giordano et al. used a propensity score and showed that abdominal wall reconstruction with acellular dermal matrix may result in more bulge/laxity rates in the elderly but does not significantly alter outcomes between populations over and under 65 years of age [53].

Pressure Ulcers

About 10% of elderly patients in hospitals will develop a pressure ulcer during hospitalization [54]. Much of this is related to chronic care protocols and procedures and lack of mobilization which would mean age should not be a factor. However, age and frailty are often intertwined, and Margolis et al. calculated the pressure ulcer probability of those >80 years were 4–20 times more likely to develop a pressure ulcer than the younger cohorts [55]. This makes it even more critical to make sure that the elderly patient is optimized from the nutritional and positioning standpoint while in an acute care setting.

Conclusion

Plastic surgery is always faithful to the principles of function, form, and cosmesis. The discipline is also unique in that the clinicians interact with all sexes, ages, and conditions from elective cosmetic surgery to acute posttraumatic reconstruction. With our novel understanding of the science of aging, it is imperative for the practitioner of plastic surgery to differentiate chronological age from frailty. The emerging published literature in the field shows that although one can safely operate on the elderly patient, the medical comorbidities must be thoroughly identified and discussed with the patients to make sure that the potential prolonged rehabilitation outcomes match the expectations and desires of the elderly patient. Armed with novel directions in the management of the elderly population, we can utilize "prehabilitation strategies" before major hospitalizations in order to improve outcomes, economic impact, and the health of our society.

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26 Drug Use in Elderly During Surgery: They Were Youngsters Once

James M. Feeney

As Americans live longer, growth in the number of older adults as a percentage of the population is unprecedented. In 2014, 14.5% (46.3 million) of the US population was aged 65 or older and is projected to reach 23.5% (98 million) by 2060 [1]. As people age, they tend toward increased contact with the medical community and acquire new diagnoses and treatments with increasing frequency. There are several reasons for this. People start a regimen of preventative care usually in middle age, mandating visits to a primary care physician more frequently than in their younger adulthood [2, 3]. Also, aging adults experience higher risk of chronic disease. In 2012, 60% of older adults managed two or more chronic conditions. According to the US Federal Interagency Forum on Aging-Related Statistics, the most common comorbidities include heart disease, cancer, chronic obstructive pulmonary disease (COPD), and diabetes mellitus.

These and other reasons combine to produce a higher rate of medication use in elderly patients, and that fact combined with the increasing rates of serious comorbidity and frailty complicates the performance of surgery in this population. Patients' experiences in the elective surgery realm demands planning surround perioperative optimization and medication use leading up to the day of surgery, multispecialty and multidisciplinary collaboration in the preoperative and postoperative phases, and close follow-up in the post-surgical, return to normal life phase. However, in the emergent setting, there is often not sufficient time to alter preoperative medication use or to mitigate chronic conditions optimally.

In this chapter, we will explore medication use in the elective perioperative period, including common pitfalls in preoperative and postoperative phases of care and including the resumption of preoperative care and home medication, with or without changes, as appropriate. However, first, we will briefly touch on the performance of emergent surgery in the geriatric population with multiple medications from chronic conditions.

Emergency Surgery in the Geriatric Population with Polypharmacy

Emergency surgery is increasingly common in the geriatric population, and therefore, surgery on the population with many medications is also increasingly common. In this sense, it is fairly straightforward: once the decision has been made that a patient needs an emergent operation, there are few indicators that surgery should be delayed or altered based on a patient's medication regimen. A few chronic conditions prohibit lifesav-

J. M. Feeney (✉)
Associate Professor of Surgery, Department of Surgery, Westchester Medical Center, and New York Medical College, School of Medicine, Valhalla, NY, USA
e-mail: James.Feeney@wmchealth.org

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ing surgery, and so in the emergent setting, the optimization of medication regimens is a moot point. However few, there are medications and chronic conditions that may prohibit even emergent surgery. Of these comorbidities, the most common is anticoagulation.

Prior to undertaking emergency surgery, anticoagulation should be reversed prior to the initial incision. In the case of warfarin, prothrombin complex concentrate (PCC) rapidly corrects INR and allows for safe surgery. It can be relatively rapidly administered and is reasonably cost-efficient and safe from interactions and side effects. The half-life of warfarin is approximately 1 week, but it is quite variable in cases of increased physiologic stress. This means that the efficacy of the drug extends beyond the factors used to reverse the therapeutic effect, so bleeding complications should be monitored closely in the postoperative period. Although the postoperative bleeding complications need close monitoring, the conditions for which anticoagulation was necessary preoperatively are also still presumably present, and so the decision to restart anticoagulation should be considered carefully, especially in cases of spinal, intracranial, cardiac, and vascular procedures, where postoperative bleeding can have rapidly disastrous effects.

Direct oral anticoagulants include rivaroxaban (Xarelto), apixaban (Eliquis), and dabigatran (Pradaxa). They are increasing in popularity in the past several years as prophylaxis against stroke. There are reversal agents for dabigatran (idarucizumab or Praxbind) and rivaroxaban and apixaban (andexanet alfa or Andexxa); however they are expensive ($3500–$49,500 per dose). Data for the use of PCC to reverse DOACs is very limited, although it has become commonplace in trauma settings. In many instances, because the half-lives of these agents are short, and in the cases when there is no reversal agent, delaying the operation, if prudent, may suffice.

Contrary to the case with anticoagulation, timely recognition of adrenal insufficiency may present an opportunity to improve the time to the operating room in patients presenting with surgical causes of sepsis or septic shock. Adrenal insufficiency is prevalent in 20% percent of patients admitted to ICU through the emergency department, and rapid treatment of adrenal insufficiency may color the decision to operate. Insufficient patients appear to be more severely ill, in shock, or with end-organ dysfunction, and these assessments may lead to a decision for lifesaving surgery even though they represent potential complications of an undiagnosed preexisting condition. Often, these patients have a history of glucocorticoid use for other conditions. Even if intermittent, past glucocorticoid use may predispose patients to adrenal insufficiency in times of increased physiologic stress. Treatment is fairly straightforward, with few added risks, and involves physiologic doses of glucocorticoids. In patients with circulatory collapse refractory to volume or pressors or in patients requiring pressors for no other apparent cause, adrenal insufficiency should be suspected and treated empirically where appropriate, especially after the use of etomidate for induction of anesthesia or intubation. These actions completely ameliorate the effect of the adrenal insufficiency and can allow surgery to proceed unabated. There is more discussion on treatment and recognition of adrenal insufficiency in the sections that follow.

Pharmacologic Preoperative Risk Mitigation in the Elective Geriatric Population

Perioperative Cardiac Risk Stratification and the Use of Perioperative Beta Blockade

Patients with known or suspected coronary artery disease may benefit from perioperative cardiac risk stratification. In patients with known CAD, the risk stratification involves a determination of whether the operation planned is high, intermediate, or low risk. Following that, the determination as to the patient's status is made, depending on the severity of the patient's disease. These factors help to determine the course of the anesthesia and surgery, but it should be plainly stated that there is no such thing as "cardiac clearance" for surgery; use of this term should be abandoned.

There are several methods of perioperative cardiac risk stratification, but perhaps the one backed by the largest data set is the NSQIP database risk model. It uses five factors to predict cardiac risk, with good predictive ability (C statistic 0.874) [4]. The five factors, based on multivariate regression analysis and validated in over 250,000 patients, are age, ASA class, creatinine, functional status, and the type of operation.

After patients are risk stratified, the decision for further testing or intervention should be pursued [5]. The American College of Cardiology and the American Heart Association Joint Task Force issued a guideline in 2014 that details the algorithm to pursue further testing or intervention prior to surgery, and that guideline is provided as Fig. 26.1. From a perioperative risk mitigation standpoint, it is essential to continue most home medications up to and including the morning of surgery and then to resume home medications as early as possible postoperatively. Occasionally, the perioperative evaluation process leads to the discovery of significant disease burdens in previously undiagnosed patients. In these patients, it is wise to stabilize newly discovered chronic disease, if at all possible, prior to surgical intervention for other problems. This includes the use of beta adrenergic receptor blockade, which in times past was added for the purpose of preventing perioperative cardiac events prior to surgery.

There is some data that suggests that, in fact, patients with a revised cardiac risk index >3 may benefit from addition of a beta adrenergic receptor antagonist prior to surgery, insomuch as there is a reduction in perioperative AMI. However, current evidence suggests that addition of beta adrenergic receptor antagonist to patients not chronically using this class of drug is usually unwarranted in the elective setting and more often results in increased mortality and stroke rates persisting up to 1 year after the combination of non-cardiac surgery and perioperative treatment with beta adrenergic receptor blockade [6]. Prior opinion and published literature supported the widespread use of beta adrenergic receptor antagonists, even in patients without known heart disease; however, currently, the data does not support the use of these medications prophylactically in the perioperative period, except in patients already prescribed these medications as part of their home regimen. In cases of newly discovered or uncontrolled congestive heart failure, the addition of beta adrenergic receptor blockade may be part of a regimen change intended toward future treatment, but the protective effects of beta blockers preoperatively are a myth that has been all but debunked.

Liver Disease

Patients with known liver disease, like those with known cardiac disease, should have their physiologic status optimized prior to elective surgery. This may include adjustment of chronic home medications to improve synthetic function or in the case of coagulopathy from liver disease supplementing with exogenous clotting factors at the time of surgery. Patients are typically stratified using the model for end-stage liver disease (MELD) scores or Childs-Turcotte-Pugh scores, and reducing these scores preoperatively may prevent postoperative complication rated [7]. Childs-Turcotte-Pugh class is easy to calculate from a few data points and thus has advantages; however, the MELD score is linearly correlated with outcomes postoperatively and therefore is a bit more precise [7]. The optimization in the preoperative period may involve addition or increases in the doses of potassium sparing or other diuretics, paracentesis, albumin infusion, and optimization of sodium intake. Patients with liver disease metabolize and/or excrete medications differently, and the postoperative care, covered later, should be done in a multidisciplinary approach to avoid overdose or toxicity.

Anticogulation and Elective Surgery

Anticoagulation is perhaps the most common medication that can influence patients' intraoperative and postoperative courses. Mitigating bleeding risk involves correcting or reversing anticoagulation as close to the onset of surgery as

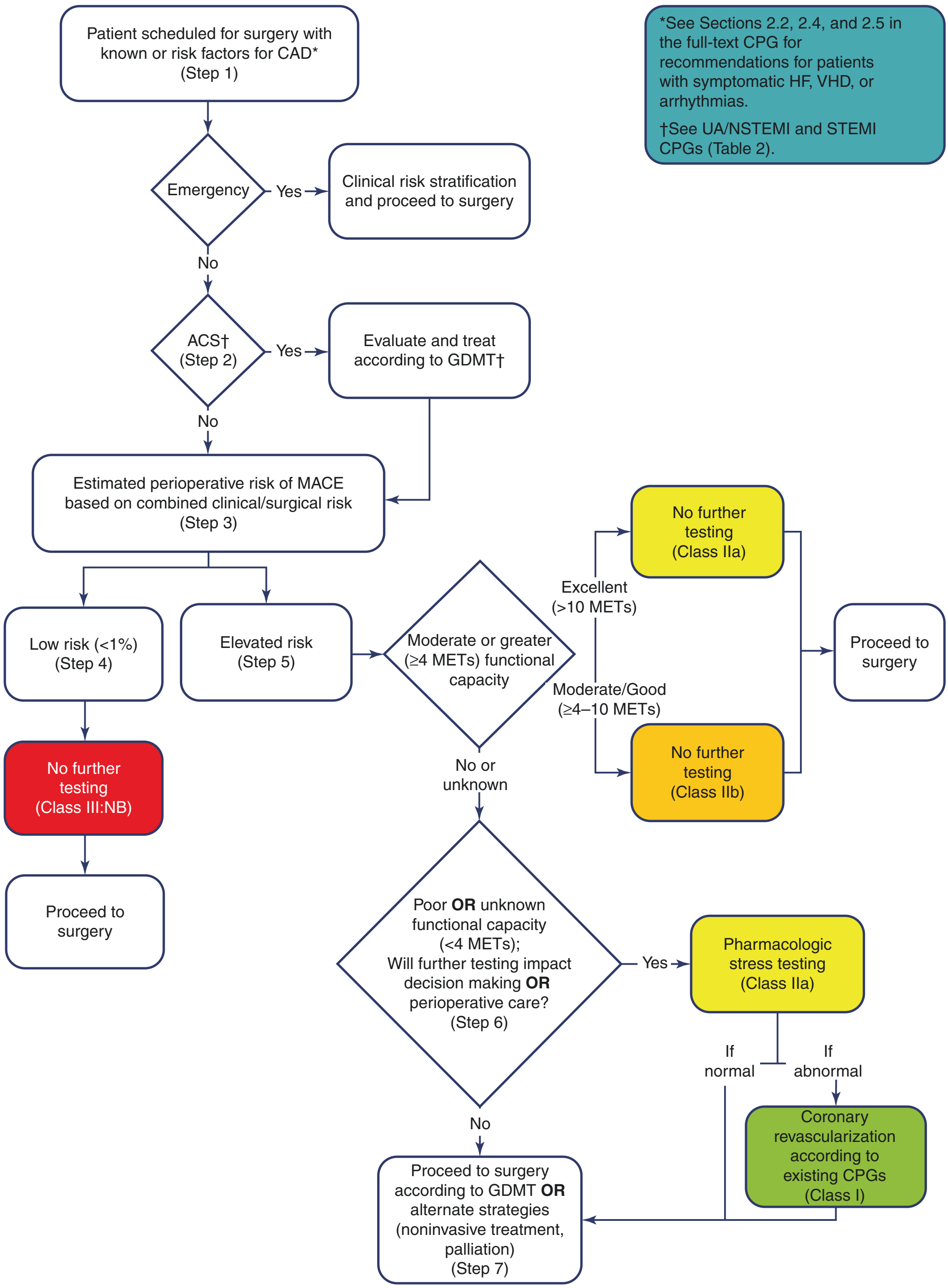

Fig. 26.1 Stepwise approach to perioperative cardiac assessment for CAD. (From Fleisher et al. [5] with permission)

practical and then restarting the medication once safe. There are four main classes of medications with anticoagulant properties: antiplatelet medications, heparins, warfarin, and direct oral anticoagulants (DOACs).

Heparins are, perhaps, the simplest to deal with in the perioperative period. Heparin injections should be discontinued 24 hours preoperatively and partial thromboplastin time (PTT) checked immediately before surgery. For this reason, many advocate switching warfarin daily dosing to injections with heparins preoperatively to protect against thrombosis or stroke in the immediate preoperative period, although the benefit of this strategy is not proven.

Antiplatelet agents include COX inhibitors, like aspirin; glycoprotein IIb/IIIa inhibitors, like abciximab, tirofiban, and eptifibatide; phosphodiesterase inhibitors like dipyridamole; and protease-activated receptor-1 antagonists (vorapaxar). Most of these medications, with the notable exceptions of aspirin and clopidogrel, are prescribed and used in the treatment of acute coronary syndrome, although a full familiarity with the mechanisms of actions is still required preoperatively for any patients taking these medications. Antiplatelet agents should be discontinued for at least 7 days prior to elective operative intervention, and if the risk of discontinuation outweighs the benefit of the elective surgery (e.g., in the case of recent coronary stenting or AMI), then the elective case should be postponed until the antiplatelet agents can be safely stopped.

Direct oral anticoagulants were initially approved by the US Food and Drug Administration in November 2011. The promises of a safer therapeutic window and an improved mitigation of stroke risk with less monitoring and fewer drug interactions made the drugs instantly appealing. However, the risks of intractable bleeding were hard to ignore, and physicians tempered their enthusiasm for the positive aspects of the drugs with caution for the bleeding risks [8–10]. Comparatively, the risks seemed similar to warfarin; however, most of the data in early phase III clinical trials dealt with incidence and prevalence of hemorrhage, not with outcomes [11]. Warfarin, the erstwhile gold standard for outpatient anticoagulation, has a narrow therapeutic index, and its efficacy is influenced by several other medications or even by changes in dietary habits [12, 13]. Once taken, warfarin is quickly absorbed through the gastrointestinal tract, and within 90 min it reaches maximal blood concentrations [14, 15]. The terminal half-life of warfarin is approximately 1 week [14]. However, its effective half-life is found to be between 36 and 42 h [15]. As a result of the narrow therapeutic window and long half-life, toxicity is a common finding and leads to increases in mortality and morbidity, as well as further exposure to transfusion and other blood products (e.g., cryoprecipitate, fibrinogen, or factors) as attempts to reverse coagulopathy become protocolized across institutions. As intensive as the management of warfarin can be, it was heretofore seen as a risk worth taking to mitigate the stroke risks that are so well characterized by the various stroke risk scoring systems, for example, CHADS2 [12, 13].

Concerns for the safety of patients prescribed warfarin led to the creation of DOACs as a novel therapeutic class. DOACs include the direct thrombin inhibitor, dabigatran (Pradaxa), and the direct factor Xa inhibitors rivaroxaban (Xarelto), apixaban (Eliquis), and edoxaban (Savaysa). Rather than inhibiting the synthetic pathway of coagulation factors as warfarin does, DOACs instead influence procoagulant enzymatic activity [16]. DOACs exhibit a linear relationship between plasma levels and anticoagulant effect and have similar pharmacodynamic properties to heparins, taking between just 1 and 4 h to reach peak plasma levels and having relatively short half-lives of 5–17 h [16].

Overall, DOACs have been advocated as preferred outpatient anticoagulants for their rapid onset, short half-life, and limited number of food and drug interactions [12, 16]. Because of the short half-life of DOACs, the manufacturers recommend no preoperative switching of anticoagulants (e.g., from DOACs to heparins) [17]; the industry suggests that in cases of elective surgery, it is enough for the patient to simply stop taking DOACs 24–48 h before operative intervention [16]. Additionally, though there is a lack of established antidotes for DOACs, in the case of emergency, according to the manufacturers, allowing for natural elimination is often sufficient [16]. There are antidotes for dabigatran, rivaroxaban, and apixaban, but these are extremely expensive, currently costing upward of $49,500 per dose.

Warfarin, however, has well-established protocols for reversal, most commonly including prothrombin concentrate complex (PCC), and vitamin K, vitamin K alone, or fresh frozen plasma and vitamin K infusion. For elective surgery, discontinuation of warfarin should be at least 1 week prior to the operative intervention, to allow for the synthesis of clotting factors to resume normally. For routinely anticoagulated patients, coagulation factors should be checked immediately preoperatively, and coagulopathy should be treated or the case delayed for any abnormalities [18].

Postoperative Considerations

Certainly, postoperative pharmacologic considerations carry a vast opportunity for untoward outcomes when treating geriatric patients. Geriatric patients may have organ dysfunction that is masked in the preoperative phase, and not well represented biochemically, for example, underlying liver, kidney, or heart dysfunction that is not manifested in daily life but becomes apparent postoperatively after significant physiologic stress. The old adage "start low and go slow" applies to treatments started in geriatric patients postoperatively, although there are several special circumstances that may require intervention and are unique to or more common in geriatric populations.

Delirium

Delirium is defined as an acutely altered and fluctuating mental status, with altered level of consciousness and disorientation [19]. It is quite common and often undiagnosed in the geriatric population, with an incidence ranging from 9% to 87% [19]. Risk factors for the development of delirium include older age, dementia, psychopathological symptoms, medical comorbidities, frailty, and functional impairment. Additionally, different operations lead to delirium at different rates, with low-risk procedures including cataract surgery (4%) and high-risk procedures including vascular surgery (36%) [20]. The risk factors are additive, and therefore, patients can be assessed and identified as having a higher risk for delirium postoperatively, so that supportive and environmental steps can be taken to mitigate the delirium, as much as possible [21].

The diagnosis of delirium is usually established with the use of assessment scales or tools, one of the most common being the confusion assessment method-intensive care unit (CAM-ICU) tool. This scoring system has well-established reliability and validity for assessing delirium [22]. Other popular tools include the Mini-Mental Status Exam, Informant Questionnaire for Cognitive Decline in the Elderly, and the Memorial Delirium Assessment Scale [21].

Treatment of delirium consists of addressing routine metabolic causes, including electrolyte abnormalities, glucose, oxygenation, and ventilation. Additionally, routine sources of sepsis should be sought and ruled out, including urosepsis, pneumonia, line sepsis, and surgical site infection. If found, these should be addressed quickly.

Finally, many common medications may cause or exacerbate delirium in elderly patients, including cimetidine, corticosteroids, diphenhydramine, belladonna, promethazine, warfarin, opiates, benzodiazepines, and antiparkinsonian medications. Additionally, ethanol withdrawal or withdrawal from other substances may often be confused with or exacerbate delirium. Careful history should identify patients at risk for ethanol withdrawal, and treatment for withdrawal should be accompanied by treatment with thiamine, to reduce the effects of Korsakoff's psychosis [21].

Treatment includes optimizing environmental and supportive measures, in addition to pharmacologic management. Environmental supports, such as hearing and vision aids nearby, attention to early resumption of enteral nutrition, sleep hygiene, patients out of bed, tubes and catheters removed, avoidance of dehydration and hypovolemia, family involvement and interaction, and attention to electrolyte abnormalities, have been demonstrated to reduce delirium from 15% to 10% [23].

Pharmacologic management included haloperidol, which is the treatment of choice for delirium [24], which is considered superior to benzodiazepines both for the avoidance of side effects attributed to benzodiazepines as well as superior outcomes in symptom management. Atypical antipsychotics are not superior to haloperidol but may be preferred for ease of administration, preferred route, or length of half-life [25]. Usually, loading doses of 2–5 mg repeated every 15 min while agitation persists. After the delirium is controlled, scheduled antipsychotic medication is prescribed over the next few days to prevent relapses [21].

Potential side effects of treatment of delirium that require monitoring include extrapyramidal side effects and prolonged QT syndrome. Daily EKC should be obtained to follow corrected QT (cQT) intervals, and if found to be greater than 440 ms in males and 460 ms in females, the haloperidol should be discontinued. Corrected QT interval is used because it is heart rate-independent [26].

Extrapyramidal side effects include acute dystonia, akathisia, drug-induced Parkinsonism, and Tardive dyskinesia. Acute dystonia typically occurs within minutes of atypical antipsychotic medication administration. It is characterized by painful convulsive movements of the neck, tongue, and body [26]. Usual treatment is anticholinergic drugs, including benzhexol or benztropine intramuscularly. Akathisia is a very distressing side effect that occurs usually days to weeks after taking antipsychotic drugs and is characterized by difficulty in keeping one's legs in place. Treatment includes reducing antipsychotic dose or beta adrenergic receptor blockers such as propranolol. Drug-induced Parkinsonism presents identically to Parkinson's disease. It includes muscle stiffness, pill rolling tremor, and bradykinesia. It typically begins several months after antipsychotic drug treatment. It is treated with benzhexol or other anticholinergic medications. Tardive dyskinesia is the most difficult side effect of atypical antipsychotics to treat. It typically begins years after chronic treatment with antipsychotic drugs. It is characterized by irregular movements of the tongue and face. The prognosis is usually poor [26].

In summary, delirium is a common and often underdiagnosed complication of the medical care of the geriatric patient, particularly in the postoperative patient. Diagnosing delirium starts with a search for the underlying cause and appropriate treatment. Environmental and supportive measures have modest success in reducing delirium, and treatment with atypical antipsychotics is the mainstay. Side effects of antipsychotics are often profound, so the duration of treatment should be limited as much as possible.

Adrenal Insufficiency

Adrenal insufficiency is a difficult problem to diagnose and is often not immediately obvious to treating physicians. The benefits of treating relative adrenal insufficiency in septic shock, sepsis, subarachnoid hemorrhage, and critical illness are well documented [27–29]. Especially well studied is the effect of treating relative adrenal insufficiency in cardiac surgery patients. Patients have less dependence of vasopressors and improved clinical outcome. In sepsis, the Surviving Sepsis campaign recommends treating vasopressor dependence after fluid resuscitation with empiric corticosteroids. This represents a paradigm shift over decades ago, when steroids were thought to be universally detrimental.

Patients chronically taking corticosteroids as outpatients should be suspected of relative adrenal insufficiency, even without biochemical proof of glandular dysfunction. These patients should be treated for relative adrenal insufficiency as a matter of routine [30, 31]. Early treatment with steroids clearly reduces mortality and decreases vasopressor use [31, 32], and in patients with hemodynamic instability, shock, and vasopressor requirement, adrenal insufficiency should be considered and treated empirically, preferably within the first hour after vasopressor use is required [33].

Etomidate is a popular drug for the induction of anesthesia, especially in the cardiac surgery population, because it does not depress myocardial activity [34]. Patients requiring vasopressors who were induced using etomidate should be strongly suspected of having adrenal insufficiency and should be treated empirically [34]. Many authors historically have raised concerns with the use of corticosteroids in the postoperative setting, due to the negative effects of corticosteroids on wound healing. However, the doses used in the postoperative setting are usually physiologic (no more than normal secretory levels), compared with large doses used when the negative wound healing effects were first described. Additionally, the effects of corticosteroids are minimal when compared to the effects of persistent hypotension, shock, poor oxygen delivery, and acidosis that proceed from untreated adrenal insufficiency. Considering that adrenal insufficiency is present in nearly 20% of ICU patients, it is important to attune ourselves to the diagnosis and treatment of this comorbidity, because the consequences of untreated adrenal insufficiency are disastrous.

Conclusion

Pharmacologic management of the geriatric patient is fraught with pitfalls and complications. The polypharmacy patient is difficult to balance and difficult to manage in the postoperative setting. Preoperative planning for the most comorbid patients is helpful in the postoperative setting, and attention to the most common postoperative complications can prevent life-threatening complications from affecting our patients and their families. Careful attention to the geriatric patient and to the management of preexisting organ dysfunction can help secure a successful outcome for the geriatric patient, even the most comorbid, most frail, and most difficult to manage of these patients.

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27 Urologic Surgery in the Elderly

John L. Phillips, Nikhil Gopal, Jason Elyaguov, and Muhammad S. Choudhury

Urology consistently ranks among the top three specialties in the United States in terms of the total volume of older adults seen in clinical practice. Only ophthalmology and cardiology outrank urology in terms of the total volume of geriatric care provided in the specialty [1]. In the future, increased population growth among older adults will lead to even higher incidence of urological disorders requiring surgical intervention [2]. Moreover, the incidence and prevalence rates substantially increase with advancing age for some of the most common urologic conditions such as urologic cancers (prostate, bladder, kidney), benign prostatic hyperplasia (BPH), urinary incontinence, and pelvic organ prolapse [3].

Age-related physiological, functional, cognitive, and associated comorbidities present a unique challenge in elderly patients who need urological surgery. A thorough preoperative evaluation is crucial for stratifying risks for a particular surgery, identifying patients' specific intraoperative and postoperative needs based on their comorbidities and for maximally optimizing patients before the procedure [4].

Multiple assessment tools have been created to aid the health care provider in evaluating the elderly patient. Comprehensive geriatric assessment (CGA) is a commonly used tool which is multidimensional and interdisciplinary and assists in determining medical, psychological, and functional capabilities of an elderly person. This evaluation includes comorbid conditions and disease severity, medication review, nutritional status, basic activities of daily living (ADL), instrumental activities of daily living (IADL), psychological assessment with testing (mini-mental status), mood testing using the depression scale, social assessment, and environmental assessment [5].

With this evaluation elderly patients can be categorized into three groups: fit, vulnerable, and frail [6]. Fit elderly patients can be treated like their younger counterpart, vulnerable elderly may be able to undergo standard therapy after appropriate medical care, and frail elderly will be at increased risk. Details about the evaluation of elderly patients requiring surgical intervention can be found in Chaps. 1 and 2.

Urologic Cancer in the Elderly

More than 50% of all cancers and over 70% of all cancer-related deaths in the United States occur in patients who are >65 years [7]. This is especially true in the case of the three most common urologic cancers, prostate, bladder, and kidney, which are much more prevalent in older adults. The median age at diagnosis for

J. L. Phillips · N. Gopal · J. Elyaguov
M. S. Choudhury (✉)
Department of Urology, New York Medical College, Valhalla, NY, USA
e-mail: Muhammad_choudhury@nymc.edu

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prostate cancer is 66 years, and 70% of deaths due to prostate cancer occur in men aged 75 years or older [8]. The median age at diagnosis for bladder cancer is 73 years, and 30% of all bladder cancer are diagnosed in individuals between the age of 75–84 years [9, 10]. Similarly, the median age at diagnosis for kidney cancer, the third most common urologic cancer, is 64 years, and 24.2% is diagnosed in patient over the age of ≥74 years [11].

The challenge of managing older patients with urologic cancer is to accurately assess whether the expected benefits of treatment surpasses the risks in a population with decreased life expectancy, competing comorbidities, and decreased tolerance to stress. In this section, we primarily review the surgical management of common urologic cancers in elderly patient population. We have not reviewed the management of advanced cancer as it is beyond the scope of this chapter.

Localized Prostate Cancer

Prostate cancer, the most frequently diagnosed male cancer in the USA and one of three most common causes of cancer-related deaths, is predominantly a disease of older men, with a median age at diagnosis of 66 years with 70% of death due to prostate cancer occurring in men aged 75 years or older [8].

Treatment decision for localized prostate cancer (c T1–3, No,Mo disease) in older men is challenging because of the wide risk spectrum of prostate cancer and competing causes of death from comorbidities in this patient population. The decision to treat older men with prostate cancer should take into account the risk of dying from the cancer (which depends on its grade and stage/risk category), the risk of dying from another cause (which depends on the severity of comorbidities than on age), potential treatment risks, and risk of developing prostate cancer–associated complications that might interfere with existing comorbidity, and lastly patients' preference [8].

The importance of risk category in prostate cancer was highlighted in a population-based, nationwide Swedish study of a large cohort of 117,328 patients with prostate cancer which showed that mortality risk at 15 years was independent of patients' age at diagnosis but directly linked to the National Comprehensive Cancer Network (NCCN) risk groups, with 10% (Low risk), 20% (Intermediate risk), and 35–40% (High risk) [12].

In this study, death from causes other than prostate cancer was mainly linked to comorbidities, but the aggressiveness of prostate cancer outweighed the comorbid conditions as a risk of death for the intermediate- and high-risk groups. The presence of comorbidities was the strongest predictor of death (from causes other than prostate cancer) in men with localized prostate cancer in this study from the United States [13]. Age was a less significant factor in the study. Therefore, in elderly patients with comorbidities, risk-stratified approach to the management of localized prostate cancer is critical.

Active Surveillance

Active surveillance has been introduced as a treatment option in select men with localized prostate cancer to reduce over-treatment by identifying those who will likely benefit from definitive therapy, while men with true favorable risk prostate cancer are spared curative interventions and its adverse effects [14, 15]. Active surveillance for localized prostate cancer involves actively monitoring the course of the disease with the goal to intervene with curative intent if the cancer progresses.

Large, prospective active surveillance cohorts with predefined follow-up programs and criteria for recommending curative therapy have achieved excellent 98%–99.6% (95% CI 98.6–99) 10-year cause-specific survival [16–19]. Follow-up in these cohorts include regular Prostate Specific Antigen (PSA) testing, digital rectal examinations, and sequential surveillance biopsies.

The Protect study, the first randomized, controlled trial comparing curative interventions (i.e., radical prostatectomy and radiotherapy) to an active monitoring strategy, revealed no survival difference between the three treatment strategies and the 10-year cause-specific survival in men on active monitoring was 98.8% [20].

Active surveillance is preferred for men with very low-risk prostate cancer and life expectancy >20 years and for men with low-risk prostate cancer and life expectancy ≥10 years. Patients with favorable intermediate-risk prostate cancer may also be considered for active surveillance [14, 15].

The advantage of active surveillance is that approximately 2/3 of eligible men will avoid treatment and potential side effects and maintain quality of life/normal activates. The disadvantage of active surveillance is that about 1/3 of men will require treatment, although treatment delays do not seem to impact cure rate. Other disadvantages include chance of missed opportunity for cure despite very low and the need for periodic prostate biopsy [14, 15].

Active surveillance is especially suited for older men with favorable-risk prostate cancer, limited life expectancy, and competing comorbidities.

Observation

Observation strategy in prostate cancer involves monitoring the course of the disease with the expectation to deliver palliative therapy (usually Androgen Deprivation Therapy – ADT) for the development of symptoms or change in exam or PSA levels that suggest symptoms are imminent.

In contrast to active surveillance, in observation strategy no curative treatment is planned. Observation strategy allows elderly frail men to avoid complications of unnecessary treatment.

Radical Prostatectomy

Radical prostatectomy is appropriate for any patient whose tumor is clinically confined to the prostate, who has a life expectancy of 10 years or more, and who has no serious comorbid conditions that would contraindicate an elective operation, and who prefers a surgical option after considering alternatives [14, 15]. Radical prostatectomy is a highly effective treatment for localized prostate cancer.

A low 15-year prostate cancer–specific mortality of 12% was reported in patients who underwent radical prostatectomy (5% for patients with low-risk disease), although it is unclear whether the favorable prognosis is due to the effectiveness of the procedure or the low lethality of cancers detected in the PSA era [21]. Radical prostatectomy improves life expectancy in older patients with few comorbidities in intermediate or high-grade disease [22]. Some patients at high- or very-high-risk prostate cancer may benefit from radical prostatectomy. In an analysis of 842 men with Gleason scores 8–10 at biopsy who underwent radical prostatectomy, predictors of unfavorable outcome included PSA level over 10 ng/mL, clinical stage T2b or higher, Gleason score 9–10, a higher number of biopsy cores with high grade cancer, and over 50% core involvement [23].

Even in a high-risk disease, age has a minor effect on cancer-specific mortality after radical prostatectomy, 9.6% for patients aged 70 years or older vs 9.2% for patients younger than 70 years at 10-year follow-up [24].

The two most important complications after radical prostatectomy, urinary incontinence and erectile dysfunction, are adversely affected by increasing age. A large study of 8295 patients with normal continence and international index of erectile function (IIEF) >18 who underwent radical prostatectomy between January 2009 and July 2013 showed 1-year continence rate of 93.2% in men <65 years of age compared to 86.5% in men >75 years of age. Additionally, 1-year potency rates were 59.3% in men <65 years of age versus 31.3% in men >75 years. In multivariate analysis, older age showed a significant negative effect in both functional outcomes [25]. Other large series have similarly showed the negative effect of age on sexual and urinary function [26, 27].

The 30-day mortality after radical prostatectomy increases with age, although only 1% of men aged 70–79 years die during this time period [28]. The same study showed risks of death and postoperative complications are more dependent on comorbidities than age.

Robotic-assisted radical prostatectomy is now widely used in the United States and many parts of the world. Two randomized trials found a lower rate of blood transfusion with robotic approach [29, 30]. The rate of positive surgical margin is similar between two approaches. Data from a prospective RCT found no difference in margin status between open and robotic approaches. Ten percent of patients in the open and 15% of patients in the robotic group had a positive surgical margin ($P = 0.21$) [29]. Multiple studies have found no statistical difference in the rates of continence or preservation of erectile function after open, robotic, or perineal radical prostatectomy [29–32].

Radiation therapy for localized prostate cancer is an acceptable treatment option [14, 15] and is often used in elderly patients because it is considered less invasive and has acceptable clinical outcome and health-related Quality of Life (QOL) [33].

Cryotherapy has been advocated as a possible treatment for elderly men with localized prostate cancer who may not be candidate for more invasive therapy [34].

Bladder Cancer

Bladder cancer, the second most common urologic cancer, is also more prevalent in the elderly. The incidence increases with age, the median age at diagnosis is 73 years, and individuals aged 75–84 years account for the largest percentage (30%) of new cases [35]. In 2017, there were 79,030 new cases and 16,870 deaths related to bladder cancer in the United States [35]. Approximately 75% of these newly diagnosed patients have non-muscle-invasive bladder cancer and their primary risk is frequent recurrence in the bladder. The remaining 25% have muscle-invasive bladder cancer at presentation and their primary risk is disease progression, metastases, and death.

Non-muscle-Invasive Bladder Cancer (NMIBC)

NMIBC involves the bladder mucosa and may extend to the submucosal layer of the bladder wall. These patients usually present with gross, painless hematuria, and the initial treatment across all age group is trans-urethral resection of bladder tumor (TURBT). It is a safe and effective procedure for endoscopic removal of all visible tumor and can be performed under regional or general anesthesia. Risks related to the procedure (e.g., bladder perforation, hematuria) are similar across all age groups, and any additional risks, in general, is the reflection of associated comorbidities in elderly patients.

Following initial TURBT, 40–70% of these patients will suffer recurrence in the bladder within 5 years, requiring repeated TURBT. Intravesical therapy is the main stay of treatment for NMIBC to reduce the risk of recurrence and disease progression. The use of intravesical therapy following TURBT is determined by tumor grade, stage, multiplicity, size, time, and rate of recurrence [36]. The commonly used intravesical agents are BCG, Mitomycin, Adriamycin, Epirubicin, etc.

Age and Intravesical Therapy

There is concern that patients older than 70 years of age has lower response rate to intravesical BCG therapy. A retrospective Phase II database review from a multicenter trial found that overall response to either BCG or BCG plus interferon was lower in patients aged 80 years or over compared with younger patients [37]. At 24-month follow-up, absolute response was reduced by 22% in patients aged 80 years or over compared with patients aged 61–70 years (39% vs 61%). Age remained a significant variable for decreased response rate after controlling for multiple other relevant variables.

In 2007, Herr from Memorial Sloan Kettering Cancer Center reported his 20-year experience with intravesical BCG therapy in NMIBC [38]. Outcome measures included initial response to BCG and tumor-free recurrence. When the series was stratified by age, >70 vs <70, a small but significant difference was seen in the tumor-free recurrence, favoring patients younger than 70. Increased age seemed to confer a less-durable response to BCG, earlier recurrence, and shorter cancer-free survival time.

A Canadian study of 238 patients, showed 2-year Progression free Survival (PFS) of 87% among patients <75 years vs 65% in patients >75 year ($P < 0.001$). On multivariable analysis, age was an independent risk factor for progression but recurrence free survival was similar among age strata [39].

In general, NMIBC is treated in elderly patients similarly to their younger counterpart with initial transurethral resection of bladder tumor followed by intravesical therapy when appropriate. It appears that response rate to intravesical therapy is lower in elderly patients.

Muscle-Invasive Bladder Cancer

Approximately 25% of bladder cancer patients present de novo with muscle-invasive disease. These patients are at risk of disease spread to regional lymph nodes and systemic metastases. Radical cystectomy and urinary diversion is the most curative treatment option in this group of patients [36].

Radical cystectomy is a complex surgical procedure associated with complications, morbidity, mortality, and extended hospital stays, even in experienced hands [40, 41]. Radical cystectomy poses even more of a challenge in elderly patients with multiple comorbidities.

Concerns have been raised that older bladder cancer patients are not offered curative treatment such as radical cystectomy as often, because clinicians lack quantitative and reliable estimates of competing mortality risks when considering treatments for bladder cancer [42]. Two separate studies which used SEER (Surveillance, Epidemiology and End Results) Medicare database showed that older patients aged >75 are less likely to be treated with radical cystectomy [43, 44], the most curative treatment option for muscle-invasive bladder cancer.

This study evaluated Surveillance, Epidemiology and End Results (SEER) data and found that individuals aged 75 years or over with muscle-invasive bladder cancer had a higher prevalence of cardiac disease, prior cancer diagnosis, chronic anemia, and poor American Society of Anesthesiologist (ASA) physical status classification [44].

Similarly, other studies have shown elderly patients are more likely to have more comorbidities, higher complication rate, and longer hospital stay, which likely influences the clinician's decision to use radical cystectomy in the elderly [45, 46].

Patients over 75 years often have longer hospital stays (5 days vs 4 days, $p = 0.03$) and higher minor complications rate (72% vs 51%, $p = 0.04$) than younger patients [45].

A large study involving 5207 patients with muscle-invasive bladder cancer who were treated with radical cystectomy found 30- and 90-day mortality rate of 5.2 and10.6%, respectively. When broken down by age 90 mortality increased with increasing age at 6.4% for 65–69 years, 10.1% for 70–79 years, and 14.8% for patients >80 years ($p < 0.001$) respectively. The 90-day mortality rates also increased with increasing Charlson comorbidity index (CCI, 0, 1, 2, and 3) 6.3, 10.3, 12.6 and 15.9% $p < 0.001$) [46].

Other studies have shown that performance status rather than age or comorbidities appear to correlate better with outcome after the treatment of muscle-invasive bladder cancer in elderly patients. A study evaluated 152 patients aged 70 years or older, including 33 (22%) patients over 80 years, treated for muscle-invasive disease. In total, 106 patients underwent cystectomy either as primary or secondary treatment. Median survival for the entire cohort was 22 months. Karnofsky performance status (KPS) was assessed before definitive treatment and was then correlated with outcomes. The authors found an overall 4-year survival rate of 14% for those with KPS below 80% compared with 33% for those with KPS above 80%. In a multivariable analysis that included age, KPS, marital status, treatment type, and disease stage, the only independent predictor of overall survival was the KPS score.

Patients with KPS score below 80% had a 1.8 fold increase in the risk of death from any cause compared with those with a better performance status. This finding held true regardless of the definitive treatment chosen, radical cystectomy, radiation therapy, or chemotherapy [47].

That being said, many older patients appear to tolerate cystectomy well. In a series from Memorial Sloan Kettering Cancer Center, studying cystectomy in octogenarian, radical cystectomy in older patients with bladder cancer provided similar disease control and survival outcome with risks of high grade perioperative morbidity comparable to those in younger patients [48].

However, the selection of elderly "fit" patients for radical cystectomy remains a challenge for the clinicians. A publicly available universal surgical risk calculator (http://riskcalculator.facs.org/) was developed using standardized clinical data from the American College of Surgeons National Surgical Quality Improvement Program. Twenty-one preoperative factors are used to estimate postoperative mortality, morbidity, and specific complications with excellent performance [49]. This tool may assist physicians in counselling patients for radical cystectomy.

Comprehensive geriatric assessment (CGA) is another tool which may assist clinicians in counselling patients who need radical cystectomy. The CGA assesses many areas of health of the elderly including function, comorbidities, socioeconomics, cognition, emotion, medication, nutrition, dementia, fall risk, etc. [50]. This tool has been utilized and validated showing its effectiveness in identifying the true health status of these patients [51].

Laparoscopic/Robot-Assisted Radical Cystectomy Versus Open Radical Cystectomy for Elderly Population

As elderly patients potentially experience a higher incidence of complications following radical cystectomy, laparoscopic/robot-assisted radical cystectomy has been proposed as a way of reducing complications, length of stay, etc., in patients with muscle-invasive bladder cancer.

In 2018, an open-level, randomized, phase 3, non-inferiority trial compared robot-assisted radical cystectomy versus open radical cystectomy in patients with bladder cancer (RAZOR) included 302 patients from 15 medical centers in the United States, 150 of whom underwent robotic cystectomy and 152 underwent open cystectomy. The median age for the robotic cystectomy group was 70 years and for the open cystectomy group was 67 years. Two-year progression-free survival in the robotic cystectomy group was 72.3% (95% CI 64.3–78.8) and 71.6% in the open cystectomy group (95% CI 63.6–78.2). Adverse events occurred in 101 (67%) of 150 patients in robotic cystectomy group, and 105 (69%) of 152 patients in the open cystectomy group. The most common adverse event was urinary tract infection, 35% in robotic cystectomy group, and 26% in the open cystectomy group. Postoperative ileus developed in 22% of the robotic cystectomy group and 20% in the open cystectomy group [52].

A study involving a group of elderly patients aged 80–94 years of age who underwent robotic-assisted radical cystectomy reported 2-year recurrence-free survival rate of 73%, disease specific survival of 74%, and overall survival of 61% [53].

However, a study from Memorial Sloan Kettering Cancer Center failed to identify a large advantage for robotic-assisted cystectomy over standard open cystectomy in terms of 90-day complication rate, hospital stay, pathologic outcomes, and 3- and 6-month quality-of-life outcome [54].

Surgical treatment of muscle-invasive bladder cancer in elderly patients is a challenge, but appropriately selected patient tolerate radical cystectomy well with acceptable morbidity and mortality risk. Robot-assisted radical cystectomy may be an option in elderly patients.

Bladder-sparing therapies with endoscopic resection, adjuvant chemotherapy, and/or radiation therapy have been used in older patients with muscle-invasive bladder cancer to avoid the risks of radical cystectomy and in patients who refuse extirpative surgery. Some studies have shown similar survival rate for more conservative therapy compared with radical cystectomy [55].

Renal Cancer

Renal cancer, the third most common urologic cancer, is a disease more common in older adults. In 2017, approximately 63,990 new cases were diagnosed and 14,400 deaths were related to renal cancer in the United States [35]. The median age at diagnosis was 64 years, and about 75% of these cases were diagnosed in patients 55 years or older, of which 26.8% were in patients between the age of 65 and74 years and another 21.9% in patients 75 years or older. Of the newly diagnosed renal cancer patients, 65% were confined to the kidney, 16% presented with regional lymph node involvement, and 16% with distant metastases [56]. An increased use of cross-sectional imaging since the mid-1970s has led to rising incidence of incidentally found, asymptomatic, lower stage, small renal masses and over 50% of the newly diagnosed renal cancer are asymptotic and found incidentally in imaging studies done for unrelated complaints [57–59]. Moreover, in the United States, over 80% of cancer patients aged ≥65 years have at least one comorbidity [60].

A small renal mass (SRM) is defined as an incidentally detected, contrast-enhancing solid or cystic lesion that is ≤4 cm, consistent with clinical stage T1a renal cell cancer, and tumor size appears to be directly related to the risk of malignancy and the presence of high-grade pathology [61, 62]. Small renal masses (SRM) are benign in 15–20%, potentially aggressive in 10% of cases, and the remaining 70%, although malignant, exhibiting indolent biologic behavior [63–65]. Given the substantial proportion of benign lesions and malignant tumors with indolent biologic behavior in this patient population, there is increasing enthusiasm for active surveillance (AS) as a management strategy especially in older patients with comorbidities.

Active Surveillance (AS)

In selecting renal cancer patient for AS, careful consideration should be given to patient factors, tumor factors, and patient preference. Patient factors which should be considered when contemplating AS include age, life expectancy <5 years, high comorbidities, excessive perioperative risk, poor functional status, marginal renal function, and patient preference to avoid treatment risks. In addition, tumor factors which require consideration include tumor size <4 cm, tumor growth <5 mm per year, non-infiltrative in imaging studies, low complexity, and favorable histology, if renal mass biopsy is performed [61].

In the case of AS for SRM, patients are followed with periodic imaging studies such as renal sonogram, CAT Scan, or MRI; and surgical intervention is considered if the growth rate of the tumor is high (>0.5 cm/year), the tumor increases in size to >4 cm, hematuria is present, or the patient prefers it [61, 62].

In a review of 20 separate active surveillance cohort studies, cancer-specific survival (CSS) of 92.3–100% and overall survival (OS) of 42.8–97.6% were reported [62]. Although, the median follow-up in these studies were short ranging between 22 and 47.6 months.

Thermal Ablation (TA)

Minimally invasive surgical techniques such as cryoablation and radiofrequency ablation have been used in older patients with comorbidities as an alternative to active surveillance in renal cancer patients, who are either not candidates or unwilling to have major surgical procedure such as partial or radical nephrectomy.

Guidelines generally recommend considering percutaneous thermal ablation as an option for clinical T1a renal masses <3 cm. Both cryoablation and radiofrequency ablations are options and demonstrate no significant difference in complications, local recurrences, metastatic progression, or cancer-specific survival [61, 66, 67].

A systematic review and meta-analysis comparing thermal ablation (n = 3974) and partial nephrectomy (n = 2519) showed all-cause mortality and cancer-specific mortality were higher among patients undergoing thermal ablation but there was no significant difference in local recurrence rate or risk of metastases [68].

In this study, the review of complications revealed decreased blood loss, transfusion rate, shorter hospital stay, and improved renal function with thermal ablation when compared to partial nephrectomy.

Radical and Partial Nephrectomy

Historically, radical nephrectomy has been the standard of care for localized renal cancer. There has been concern about the effect of radical nephrectomy on renal function especially in older patients with compromised renal function. Elderly patients with decreased glomerular filtration rate are at increased risk of mortality, cardiovascular event, and hospitalization [69].

The reported 3-year probability of GFR <60 ml/min in 65% of patients after radical nephrectomy versus 20% after partial nephrectomy ($p < 0.001$) highlights the importance of preserving renal functional mass when treating patients with renal tumor [70]. Moreover, both radical and partial nephrectomy provide comparable cancer-specific and recurrence-free survival [71]. In terms of complication rate and mortality, both techniques are almost identical, except for perioperative bleeding ($P < 0.001$) and urinary fistula ($p < 0.001$), which are more frequent after partial nephrectomy [72].

The adoption of newer surgical techniques, such as laparoscopic and robotic assisted surgery, has decreased complications, blood loss, transfusion rate, pain, and hospital stays after radical and partial nephrectomy [73–75].

Therefore, when elderly patients who require surgical intervention for renal tumor, especially those with compromised renal function, partial nephrectomy should be considered in appropriately selected patients, preferably using minimally invasive approach. However, radical nephrectomy will continue to be a treatment option in patients with large tumor, complex tumor, intra-renal tumor, and tumor extension into the renal venous system.

Benign Prostatic Hyperplasia

Benign prostatic hyperplasia (BPH) and its potential for bothersome lower urinary tract symptoms (LUTS) is one of the most commonly treated conditions in a urologist's practice. Long established as a disease of age, BPH can be seen in men as early as their 40s and is as prevalent as nearly 90% by the eighth decade of life [76].

A detailed medical history assessing voiding habits can determine the extent of bladder outlet obstruction (BOO); however, distinguishing certain lifestyle habits, such as caffeine intake or sleep behaviors, is important in identifying all possible contributors to LUTS. The International Prostate Symptom Score (IPSS) was developed by the American Urological Association (AUA) as a patient questionnaire that measures seven parameters such as frequency, urgency, nocturia, intermittency, slow stream, feeling of incomplete voiding, and having to push to void in a scale of 0–5 reflecting difficulty with urination [77]. Out of 35, an IPSS score of 20 or higher is considered severely symptomatic. A thorough physical assessment including a digital rectal exam should be performed, and a transrectal ultrasound to more accurately measure the prostate size can be considered. A prostate volume of 30 ml or greater is when BPH and concomitant LUTS can begin to manifest [78].

Uroflowmetry is an objective tool often performed in the office to measure the urinary flow and voided volume. A maximum flow rate (Qmax) of 10–15 ml/sec or less likely indicates some form of urinary obstruction. A post-void residual (PVR) via bladder ultrasound is subsequently measured, in which over 50–100 ml or over of urine retained is considered high [79]. Both of these parameters, however, may reflect inherent bladder pathology and detrusor activity [80]. In such cases, a urodynamic study (UDS) may be done to show potential detrusor over- or under-activity that contributes to LUTS. UDS thus proves especially useful in determining optimal medical and surgical therapy.

First-line therapy for BPH involves medical management initially with alpha-blockers such as tamsulosin, doxazosin, alfuzosin, and terazosin to open the prostatic urethra for easier voiding. Those with selective α1-adrenoceptor blockade are better tolerated, reducing the most common side effects of hypotension, dizziness, and asthenia. Medication targeting the androgen-dependent growth of the prostate has also been developed, notably via 5a-reductase inhibitors such as finasteride and dutasteride. These medications are most effective starting at prostate sizes of 40–50 ml or greater [81]. When combining the two classes of drugs, symptom scores and urinary flow rates improve significantly [82]. Thus, since the 1980s, the advent and success of medical therapy in treating BPH has allowed more men to delay surgical intervention, a major consideration in the older patient.

Though dual medication treatment has been shown to prevent the progression of disease, multiple signs of worsening obstructive uropathy would prompt a urologist to encourage surgery. Signs of bladder decompensation include increasing post-void residual urine, bladder trabeculations, and diverticulae. In addition, stasis of urine and incomplete voiding can lead to the development of bladder calculi as well as recurrent urinary infections. Any changes in the bladder can be seen during an office cystoscopy, which the surgeon may consider prior to the procedure to determine which approach would be most appropriate and what results may be expected postoperatively. Finally, acute urinary retention, with or without kidney injury, is often a hard indication for prostate surgery.

Once surgery is decided, preoperative lab work should include a basic metabolic panel and urine analysis with culture. If microhematuria is detected (>3 RBC/hpf), the urologist should evaluate for other potential sources of blood in the urine beyond the prostate. CT scan imaging, preferably with a delayed contrast study, as well as cystoscopy, would offer a comprehensive work-up in ruling out malignancy, the gravest concern.

Furthermore, serum prostate specific antigen (PSA) should be checked in those whose life expectancy is greater than 10 years, as prostate cancer can rarely manifest as LUTS. Special attention should be brought to those on 5a-reductase inhibitors, which can reduce PSA by 50% on such treatment [83]. Though PSA can elevate with BPH, and consideration of PSA density and PSA velocity would help judge likelihood of benign disease, a TRUS-guided biopsy of the prostate is definitive for formal tissue diagnosis.

Most of the procedures to be described involve an endoscopic approach and are thus considered minimally invasive surgeries (MIS). As a result, they carry lower surgical risk compared to open procedures and have minimal recovery time. These are therefore attractive options in the elderly population who may have multiple comorbidities and other clinical limitations. Since there are various interventions available, surgeon experience and patient characteristics ultimately help determine the optimal approach.

Monopolar Transurethral Resection of the Prostate

In monopolar transurethral resection of the prostate (TURP), a wired loop distributes a current through the prostate gland to an electrode in the grounding pad on the patient. The current best performs in a non-ionic solution, commonly glycine, to maximize cutting potential. Employed through a cysto-resectoscope, the loop resects and cauterizes tissue down to the prostatic capsule. All of the prostatic chips are then collected via an Ellik evacuator and sent as specimen to pathology. Special attention is made to achieve hemostasis throughout the case. A catheter is then placed at the conclusion of the procedure and can be removed in 24 hours provided hemostasis is maintained and continuous bladder irrigation is no longer required. As an endoscopic procedure, monopolar TURP does necessitate dorsal lithotomy position, which may prove difficult in older patients with limited mobility and fragile or contracted extremities. Nevertheless, it is a very effective intervention, improving IPSS scores by 75% and flow rates over 125%, with continued effects lasting over 10 years [84]. As a result, TURP has been dubbed the gold standard for BPH surgical treatment. That said, monopolar TURP has been shown through multiple meta-analyses to have the highest complication rates of transient urinary retention, clot retention, UTI, bladder neck contracture, and blood loss anemia requiring transfusion, compared to other BPH surgeries [85–87].

Bipolar Transurethral Resection of the Prostate

In bipolar transurethral resection, normal saline as an ionic solution can be used since the resecting loop electrode involves both ends of the circuit. The current, in turn, lies directly over the prostatic tissue and has been shown to provide better hemostasis. Thus, bipolar TURP is considered the superior intervention with regard to peri- and postoperative complication rate over the monopolar approach. That said, a number of meta-analyses, however, have shown equal effects on symptom scores, maximum flow rate, and other objective measures when compared to monopolar TURP [87, 88]

HOLEP

Holmium laser enucleation of the prostate (HoLEP) employs a 550-micron fiber through a rigid resectoscope via an 80–100-W power generator to resect adenoma. A morcellator is then introduced, fragmenting very large prostatic chips that would otherwise not be able to pass through the cystoscope. In this sense, HoLEP has been labeled the endoscopic alternative to open prostatectomy because it can technically be used to resect entire lobes. In doing so, however, HoLEP is known to have increased operative time, even when compared to open approach, which may be concerning in the older population. Nonetheless, less catheter time and shorter hospital stays have been observed in HoLEP versus open and TURP surgeries [89, 90]. The use of a morcellator, however, ranks HoLEP at an elevated potential for serious bladder injuries.

Photoselective Vaporization of Prostate (PVP)

In early prostate laser vaporization, a 600-micron fiber was capable of generating 80–120-W power via a rigid cystoscope. With the latest technology, however, a 750-micron fiber is capable of generating up to 180-W power. In vaporization, the laser selectively targets hemoglobin and not water as compared to holmium; thus hemorrhage is reduced, making this option safer for anticoagulated patients. That said, it should be noted that since the tissue is vaporized in this technique, no specimen can be sent for histologic review to rule out potential prostate cancer. The GOLIATH RCT compared PVP to TURP in up to 100 cc prostates across a 2-year follow-up. The study revealed the technique's non-inferiority to TURP in all clinical parameters, with catheter time and length of hospitalization actually being shorter in the PVP group [91].

Rezūm

Rezūm is the latest MIS that applies convective radiofrequency water vapor therapy. As prior conductive heat interventions such as transurethral needle ablation (TUNA) and microwave thermotherapy (TUMT) have fallen out of favor, Rezūm has gained popularity for multiple reasons [92]. Since Rezūm uses convective energy, ablation is possible at a lower maximum temperature of 103 C, which also means time to target heat is shorter. Moreover, the needle device itself is simple to use within a rigid cystoscope and has minimal bleeding risk. The procedure does not require general anesthesia, and patients may be able to go home without a catheter, making Rezūm ideal for an office-based treatment. An RCT with a 3-year follow-up was able to show at least 50% improvement in IPSS and Qmax in men with prostates of up to 80 cc [93].

Additionally, none reported ejaculatory or erectile dysfunction, consistent with prior studies [94]. Because of the minimally invasive nature of this procedure, it may be ideal for older patients with comorbidities. Nevertheless, Rezūm is still a novel technique that requires further long-term review.

Prostatic Urethral Lift, Urolift

Through a rigid cystoscope, the Urolift Delivery Device deploys small permanent implants made of sutures and stainless steel end pieces into the lateral lobes of the prostate. The 4–5 implants are designed to cinch the lobes to create a more patent channel, relieving prior obstruction. This method would not be as effective in prostates with large median lobes, however. Since this technique does not involve resecting the prostate, the Urolift preserves both ejaculatory and erectile function, a feature likely most attractive to the younger population. For similar reasons, blood loss is minimal. Results are promising, employing the Urolift with studies showing increased flow rates by 4 ml/s at 1 year and improved IPSS scores by 42% at 2 years [95, 96].

Simple Prostatectomy

Though there are considerable diversity and austerity in MIS of the prostate, the simple prostatectomy remains an option in BPH management, especially for markedly larger glands (>75 ml). Other considerations for this procedure can include concurrent inguinal hernia, or inability to tolerate dorsal lithotomy position. In an open approach, a lower midline incision is performed, whereby either a retropubic or suprapubic resection can be done. The suprapubic approach may be reserved for prostates with a significant intravesical component, or in cases of bladder stones and diverticuli. Following the capsulotomy, the prostatic adenoma can be freed and resected from the prostatic capsule. Once the adenoma is successfully removed, the bladder neck can be oversewn, the capsule closed, and a drain placed adjacently. Hemorrhage remains a notable perioperative risk in simple prostatectomy [97]. Compared to MIS, a longer hospital stay is also expected, and patients are discharged with the catheter. The simple prostatectomy can also be done robotically with similar results however with lower rates of perioperative hemorrhage [98]. In general, outcomes are very successful for the relief of urinary symptoms as the entire adenoma is removed. That said, postoperative complications of erectile dysfunction and bladder neck contracture can reach 5% and retrograde ejaculation over 80% [99].

As evidenced, the surgical management of BPH is as extensive as it is effective when compared to most pathologies that can be treated operatively. Additionally, considering the majority of the options are MIS, the older patient is at a unique advantage in avoiding more morbid procedures. That said, it is prudent to consider multiple factors beyond surgeon expertise when selecting the ideal procedure: positioning, type of anesthesia, length of procedure, bleeding risk, hospital stay, catheter time, etc. Nevertheless, BPH surgeries carry low morbidity risks and remain important therapeutic interventions for elderly men suffering from LUTS, especially after failed medical therapy.

Surgical Management of Urinary Incontinence in the Elderly

Urinary incontinence (UI) is defined as the involuntary loss of urine. Although the incidence of UI increases with age, it should not be summarily dismissed as just part of the aging process. While UI itself does not result in death, the physical and emotional morbidity can be significant: skin maceration which may lead to ulcer formation [100], withdrawal from outside activities or social gatherings due to embarrassment; personal shame with wearing diapers; and increased reliance on caregivers and loss of independence [101]. UI's maladaptive effect on one's body and mind that may exacerbate or lead to more imminently life-threatening conditions such as sepsis, CVD, malnutrition, or substance abuse mandates adequate management and treatment of this condition in the elderly.

Urinary incontinence can broadly be divided into stress, urgency, overflow, and mixed UI. Stress UI is leakage of urine with increased abdominal process; if mild, leakage will occur only with forceful coughing, sneezing, or running; but if severe, leakage can occur with simply standing. Urgency UI is leakage of urine preceded by a strong sensation of bladder fullness with concomitant need to void (so-called urge). Overflow UI occurs when pressure within a distended bladder overcomes the closure pressure of the urethral sphincter, resulting in leakage, simulating an overflowing receptacle. Finally, mixed UI refers to a combination of any of the three previously described types of incontinence [3].

The etiology of UI in the geriatric population is multifactorial and may be explained through factors both intrinsic and extrinsic to the genitourinary system. With aging, parts of the bladder smooth muscle become replaced with collagen, resulting in decreased bladder capacity and decreased contractility. This can manifest clinically in urinary urgency or frequency that may lead to urge UI and/or diminished emptying of the bladder that may result in overflow UI. The apoptosis of muscle with age can also be seen in the urethral sphincter and pelvic muscles that support the urethra, resulting in decreased sphincter tone and urethral hypermobility that can manifest in stress UI. Elderly patients are more likely to have medical comorbidities with concomitant medications that may contribute to UI. For instance, a patient with osteoarthritis and congestive heart failure may experience increased urine production at night due to translocation of fluid from lower extremities when supine. Due to limitation of mobility with arthritis, the urinary urgency experienced by the patient may evolve into urge UI [102]. Geriatricians often refer to UI as a geriatric syndrome, exemplifying its often systemic etiology [103].

The multifaceted nature of the etiology of UI in the elderly is also reflected in its management, ranging from behavioral to pharmaceutical and finally surgical. While this section is focused primarily on surgical treatments, the discussion of operative indications will involve consideration of nonsurgical options. Unlike other disease states such as benign prostatic enlargement (BPE), treatment for UI does not always need to proceed in a stepwise fashion from conservative to surgical intervention. Rather, the specific nature and severity of UI as well as the overall health of the patient need to be taken into account when deciding on treatment, with the focus being on maximizing quality of life. It is important to remember that chronological age does not always equate to functional age; that is, a 65-year-old independent male only on a baby aspirin who runs half a mile each day will be treated very differently than a 65year-old wheelchair-bound male with DM and CHF who recently suffered a stroke. The distinction between these two individuals is captured within the concept of frailty [104]. It is defined as individuals with impaired cognition, motor function, physical abilities, nutrition, and endurance. In short, they have decreased reserve to recover from an emotional or physical insult. Frailty is correlated with increased postoperative complications and thus should be adequately assessed preoperatively.

The use of catheters in the management of incontinence: Prior to discussing the management of specific types of UI, a brief discussion of the role of urinary catheters in the management of UI is warranted. Particularly in frail individuals not amenable to operative intervention, practitioners, patients, and caregivers may consider them a simple, yet effective way to minimize the morbidity of incontinence-associated dermatitis [100] and the financial and emotional cost of using multiple adult diapers daily. Urinary catheters can be divided into either external or indwelling, with the difference being that external urinary catheters are placed around as opposed to inside the urethral meatus. The benefit of external or condom catheters (Fig. 27.1) are that they divert urine from the patient's body without the risk of catheter-associated urinary tract infections (CAUTI) caused by indwelling urethral catheters [105]. However, condom catheters require patients to adequately empty their urine; therefore, while it may reduce the perceived leakage from overflow UI, it does not

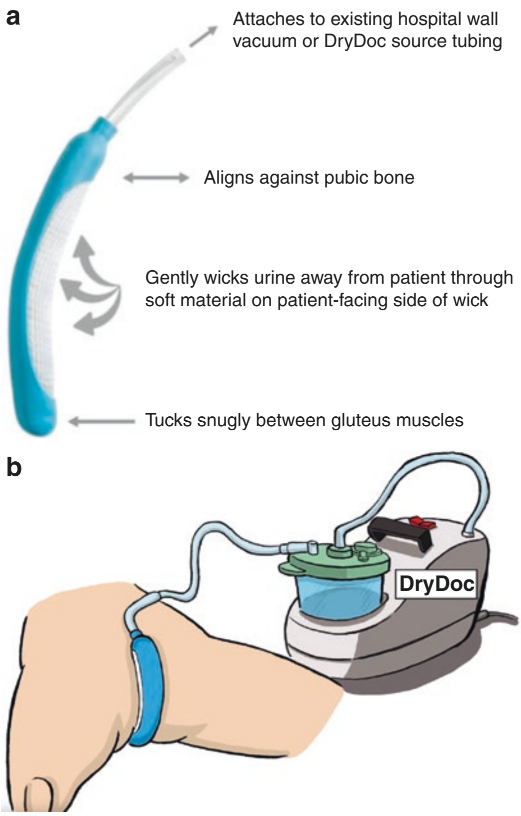

Fig. 27.1 Female external urinary catheter (PureWick™). Top image showing components of catheter taken from incontinencesource.com. Bottom image showing the placement of catheter taken from video entitled "Purewick Demonstration" from PureWick Inc. on youtube.com. Catheter is tucked between gluteus muscle posteriorly and aligns to pubic bones anteriorly. In this way, the catheter is positioned over the urethral meatus. Urine collects at the base of the catheter which is attached to a suction cannister to provide negative pressure for the translocation of urine away from catheter and into tubing. (Courtesy of Bard. © 2019 BD. Used with permission)

alleviate the urine trapped within the distended bladder, which may lead to urinary tract infections and upper tract urinary damage. Thus, patients with overflow UI merit an indwelling urethral catheter. This example illustrates the usefulness of obtaining a bladder scan in elderly patients that present with moderate–to-severe urinary incontinence in order to rule out overflow UI [3].

In summary, external urinary catheters may be an appropriate option for the management of severe urinary incontinence, particularly in a frail elderly patient, with the benefit of reducing reliance on adult diapers and skin breakdown associated with urine. Indwelling catheters should generally be discouraged due to risk of CAUTI which can be associated with significant morbidity and mortality. The one situation where indwelling urinary catheters should be employed is in the case of overflow UI, and for this reason, elderly patients with moderate–to-severe UI should have a bladder scan to rule out elevated PVR.

Male and Female Urge Urinary Incontinence (UUI)

Urge urinary incontinence (UUI) or the involuntary loss of urine preceded by a strong desire to void can be viewed as one endpoint of the spectrum of the overactive bladder (OAB) syndrome complex. Prevalence of OAB increases with age due to both physiological changes within the bladder (i.e., decreased bladder capacity with smooth muscle remodeling into collagen) and the development of medical conditions that can cause urinary frequency and urgency (i.e., diuretics for CHF or autonomic neuropathy associated with diabetes mellitus) [3, 106]. Particularly with the development of UUI, behavioral management such as avoidance of bladder irritants (coffee, alcohol, chocolates, etc.) can often be ineffective as a sole therapy. Pharmacologic therapy for OAB consists of anticholinergics and ß3 agonists. While anticholinergics such as oxybutynin have been shown to be effective in reducing urinary leakage and improving health care–related quality of life, they are not without side effects. In particular, increased risk of dementia has been associated with higher burden of anticholinergic medications, which can be particularly problematic in a frail elderly patient [107]. While ß3 agonists do not carry the cognitive risks of anticholinergics, their pro-hypertensive effects limit their use in patients with hypertension, a common condition in the elderly. Thus, due to inadequate and even harmful effects of nonsurgical options for UUI in the elderly, surgical interventions are particularly appealing as a first-line treatment.

The intravesical detrusor administration of onabotulinum toxin A (Botox) represents one such surgical modality for UUI. Treatment doses range from 100 to 200 units, with the drug inhibiting the release of acetylcholine to motor neurons of the bladder, resulting in decreased smooth muscle spasticity. Acetylcholine inhibition appears to also occur in afferent neurons, producing decreased sensation of fullness. Both afferent and efferent effects of Botox combine to produce reduced urge and urge incontinence [108]. However, Botox can produce adverse effects such as urinary retention requiring temporary catheterization, urinary tract infection, and/or rarely diaphragmatic inhibition affecting respiration.

Studies have shown an association of old age, male sex, multiple comorbidities, and preoperative post-void residual >100 cc with increased adverse outcomes after intradetrusor Botox injections [109]. In regard to the first named variable, when stratifying a geriatric female population into the frail elderly and the non-frail elderly, Liao et al. demonstrated that the non-frail elderly group behaved similar to young patients in terms of postoperative complications. In particular, the frail elderly group had higher rates of elevated PVR (>150 cc) and urinary retention as compared to the two other groups. Furthermore, while frail elderly patients had significantly improved UUI and OAB symptoms post-injection, they had reduced long-term success [110]. Decreased success in this population may be due to multifaceted nature of urinary incontinence as a byproduct of poor functional status and comorbidities. Thus, functional as opposed to chronological age appears to correlate more strongly with worsened outcomes after Botox injection.

Botox injection represents an important therapeutic armamentarium for incontinence due to OAB in the elderly, but particularly in the frail elderly, patients and their caregivers should be counseled about an increased risk of adverse effects such as urinary retention that may require a temporary indwelling catheter or clean intermittent catheterization. Furthermore, realistic expectations need to be made about treatment effect, particularly in an elderly patient with reduced functional status and/or medical comorbidities. Especially as compared to a younger and/or healthier patient, Botox injection may just reduce as opposed to eliminate incontinence.

Sacral neuromodulation represents another surgical modality for the treatment of patients with urge urinary incontinence. This technique consists of percutaneous implantation of a lead electrode at the S3 foramen (Fig. 27.2). The electrode is initially connected to an external stimulator, and if the patient's OAB symptoms improve by 50% during a test period of 1–4 weeks, an implantable stimulator is placed in the patient's gluteal pocket. Resulting electrical stimulation via the lead electrode is thought to inhibit both preganglionic bladder motor nerves and interneurons of afferent nerves, which reduces detrusor contractions and sensa-

Fig. 27.2 Sacral neuromodulation. Note the placement of percutaneously placed lead at S3 foramen. Degree of stimulation controlled externally by the patient. (Courtesy of InterStim by Medtronic, Fridley, MN, USA)

tion of fullness, both of which contribute to urge urinary incontinence [111].

In regard to the geriatric population, sacral neuromodulation has only been investigated in women older than 55 years. Similar to the findings of Botox, although an improved benefit in urinary symptoms was seen post-intervention, older women had a decreased complete dry rate as compared to their younger counterparts. In addition to age, medical comorbidities were negatively associated with response post-sacral neuromodulation [112]. As with Botox injection, elderly females with multiple comorbidities and likely multifactorial etiology of urinary incontinence should be counseled that sacral neuromodulation may only reduce as opposed to eliminate incontinence. Other important preoperative considerations are that patients should have sufficient manual dexterity and cognitive function to titrate settings of the stimulator to optimize urinary symptoms. Sacral neuromodulation was also traditionally contraindicated in patients with significant neurological or orthopedic disease who may require high-resolution MRIs as these imaging modalities are contraindicated in the setting of implanted pulse generator [111]. However, the newer stimulators are compatible with MRI.

UUI is a common cause of urinary incontinence in elderly males and females, and due to first-line behavioral and pharmacological options generally being ineffective and/or harmful, minimally invasive surgery should be a consideration in these individuals. Both intravesical Botox instillation and sacral neuromodulation have shown efficacy in the geriatric population, but particularly with the frail elderly, preoperative expectations of reduction as opposed to elimination of urinary incontinence should be stressed. Patients should be informed that they are at higher risk for urinary retention and urinary tract infection after Botox injection, the former of which may require temporary catheterization. Patients with dementia and poor dexterity should not undergo sacral neuromodulation; furthermore, this surgical modality should be limited to only females, as results of this therapy on older males have not been published. Adequate selection and preoperative counseling of patients will ensure success with these surgical interventions.

Male Stress Urinary Incontinence

According to the Incontinence Society, <10% of male urinary incontinence is attributed to stress incontinence [113]. The majority of stress incontinence seen in older males occurs as a result of radical prostatectomy, with the etiology purported to be damage to the intrinsic urethral sphincter; disruption of nerve endings to the bladder; loss of urethral support; and/or reduction in length of membranous urethra [114]. Although stress incontinence is commonly seen after radical prostatectomy, between 84% and 97% of patients fully regain continence by 12 months postoperatively. However, about 30% of patients undergoing a prostatectomy will require either adjuvant or salvage radiation for disease recurrence, with incontinence rates of 33–42% after radiation [115]. Given that approximately 70,000 patients underwent a radical prostatectomy in 2010 [116], a not-insignificant proportion of the geriatric population will experience prolonged postoperative urinary leaking that can be a severe impediment to their quality of life, especially since many of these patients had no symptoms prior to their surgery and/or radiation.

As mentioned above, one theory for post-prostatectomy stress incontinence involves loss of urethral support; if this theory is correct, then increasing periurethral muscle support should reduce urinary incontinence. This is the rationale for many urologists recommending pelvic floor muscle therapy (PFMT) (Kegel exercises) for patients with urinary leakage after radical prostatectomy. However, evidence has been mixed on the therapy's efficacy. One study demonstrated a significant improvement in continence after 3 months in patients undergoing PFMT as compared to a control group, but the relative benefit decreased at 12-month follow-up [117]. Thus, PFMT may simply reduce time to urinary continence only in those patients that may have otherwise regained urinary continence by

12 months. The subset of patients that are not continent at 12 months will likely require surgical therapy as opposed to additional physical therapy to improve their urinary symptoms.

Surgical modalities to treat male stress incontinence include artificial urinary sphincter (AUS), male urethral sling, and transurethral urethral bulking agent. Most of these modalities, including transurethral bulking agent, address the potential intrinsic sphincter deficiency present after prostatectomy. In patients that have severe medical comorbidities precluding them from general anesthesia or desired less invasive treatment, injecting bulking agents such as *Durasphere* or *Macroplastique* into the urethra could improve urinary symptoms. Patients need to be counseled that repeat injections may be warranted as benefit decreases over time and that the overall efficacy is less than the more-invasive surgical options [118].

AUS is considered the gold standard for post-prostatectomy stress urinary incontinence as it is the treatment with the highest rate of success across a broad range of populations, including post-radiation and post-sling patients. AUS consists of a narrow band cuff placed around the urethra that is inflated and deflated through manipulation of a scrotal pump which moves fluid to and from an abdominal reservoir and cuff (Fig. 27.3) [119].

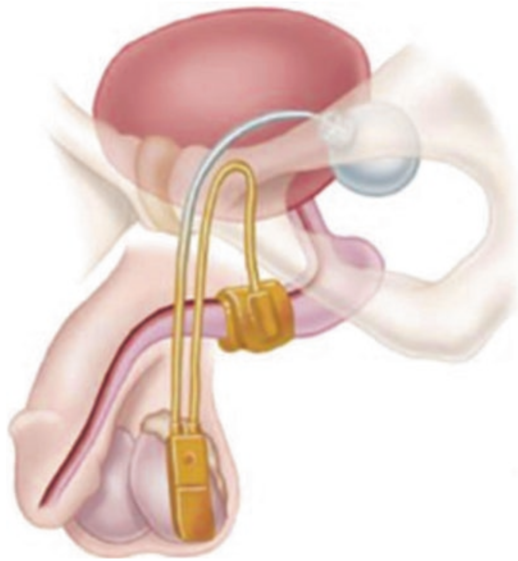

Fig. 27.3 AMS 800 AUS showing anatomic relationship between pump, cuff, and pressure regulating balloon (reservoir). (Courtesy of Boston Scientific, Marlborough, MA, USA)

Success rates have been cited between 60% and 90% depending on the length of follow-up and definition of success (complete dry vs. reduction in pad usage). Sphincter infection, erosion into the urethra, and atrophy of the urethra are feared complications of AUS placement, all requiring the revision or replacement of the AUS, and occur at rates of 19–26%, with most reoperations occurring within the first 48 months of placement. Furthermore, the device tubing, pump, and other components are susceptible to malfunction over time, with 7.5 years being the median duration of AUS [120]. A penoscrotal approach to implanting the AUS as opposed to a two incision abdominal and perineal approach has been shown to have decreased overall device survival [121]. Other adverse factors for the longevity of AUS include the presence of any intraoperative complications, postoperative bleeding, and impaired wound healing. Conflicting data exists for functional and postoperative complications after AUS placement in patients with previous pelvic radiation. It is generally thought that functional outcomes are similar to patients with no prior radiation but there is an increased risk of erosion or urethral atrophy due to the periurethral fibrosis and hypovascularity characteristic of post-radiation changes [114].

A variety of male urethral slings exist, with the most common ones in use in the United States being AdVance and Virtue. Unlike the previously described treatments, the AdVance transobturator urethral sling that is placed retrourethrally does not function by compressing the urethra to achieve continence. Rather, the sling acts to displace the urethra more posteriorly into a pre-prostatectomy position which also increases the functional urethral length [122]. Complete continence is achieved in 60–70% of patients that underwent the placement of an AdVance sling over a mean follow-up time of 2–3 years [123]. These rates should be considered in the context of a select patient population. Namely, these studies do not include patients with severe stress urinary incontinence or with history of radiation, as these groups of patients have poor outcomes with urethral slings [124]. The periurethral fibrotic changes occurring with radiation makes the urethra more resistant to displacement and thus less likely to respond favorably to the AdVance sling. Patients with severe stress urinary incontinence may have multifactorial etiology to their pathology with both loss of urethral support and intrinsic sphincter deficiency. Since the AdVance urethral sling addresses only the former alteration post-prostatectomy, incontinence would be expected to continue post-sling placement.

Unlike the AdVance male urethral sling with two transobturator sling arms, the Virtue male urethral sling has four sling arms (two transobturator and two prepubic) [125]. Thus, the Virtue sling acts to both compress and displace the urethra. Therefore, one may expect this sling to be more effective than the AdVance male urethral sling. Studies have been mixed, however, on its utility. While one study showed a success rate of 79% 12 months post-sling placement, that rate decreased to 32% within 5 years with a 22% rate of sling explantation [126]. Another study cited a sustained improvement in urinary symptoms in patients with Virtue male urethral sling over 36 months, with the caveat that the majority of these patients had only mild stress urinary incontinence [127]. Virtue male urethral sling is the newest addition to the sling market, and additional comparison studies to existing slings as well as technical refinements are needed in order to more accurately define Virtue sling's role in the stress incontinence domain.

In conclusion, persistent stress incontinence 12 months post-prostatectomy will likely only improve with surgical management. Transurethral bulking agents represent the least invasive but also the least effective form of therapy, with repeat injections required even in the case of improved symptoms post-initial injection. For more definitive treatment of mild-to-moderate stress urinary incontinence, either male urethral sling or AUS may be done, depending on patient and/or practitioner preference. For AUS placement, patients must have sufficient manual dexterity to manipulate the pump to allow for volitional voiding.

In the case of severe stress incontinence or stress incontinence in the setting of pelvic radiation, AUS should be offered as first-line treatment due to both improved efficacy and higher level of evidence in these settings as compared to slings. A urethral sling may still be offered, for instance, in a quadriplegic male post-prostatectomy with severe stress incontinence. However, the patient should be adequately counseled preoperatively that he may experience only minor improvements in symptoms as opposed to dryness. Again, urinary incontinence should be explained as a spectrum, as opposed to a dichotomous condition, in order to best manage patients' expectations both pre- and postoperatively.

Female Stress Urinary Incontinence

Unlike males, stress incontinence in females is far more common, affecting up to a third of individuals who present with urinary incontinence [114]. The incidence of stress incontinence increases with age and can be attributed to loss of tone in the urethral sphincter or pelvic floor muscles [128]. Unfortunately, except for cases of mild stress incontinence, conservative management such as pelvic floor exercises is not effective. For the elderly patient with multiple comorbidities requiring anticoagulation or precluding general anesthesia, transurethral injection of synthetic agents to bulk the proximal urethra and thereby stem the efflux of urine from the bladder may be employed. Patients should be counseled that, while these operations may be safely performed in the office, their efficacy is limited (reduce as opposed to eliminate leakage) and decreases over time, often requiring multiple injections (32% at 47 months) [129].

For patients desiring and capable of undergoing more definitive intervention, mid-urethral sling placement may be offered (Fig. 27.4). These are synthetic polypropylene mesh placed transvaginally using tactile feel from either the retropubic space or the obturator foramina to the mid-urethra to increase ure-

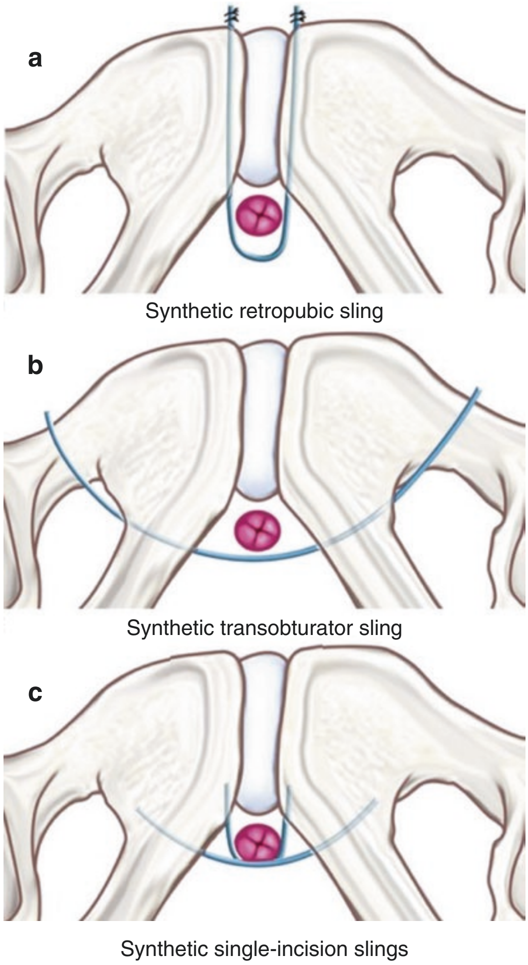

Fig. 27.4 Schematic showing the placement of the three different urethral slings in females. All the slings are placed in the mid-urethra but differ in the mechanism of anchoring. The retropubic sling is anchored by the endopelvic fascia. The transobturator sling is anchored by the obturator internus and externus as well as surrounding fascia. The single-incision (or mini-sling) is anchored only by the obturator internus [134]. Note that, unlike the transobturator sling, the mini-sling does not pierce through the obturator membrane, which should result in reduced likelihood of injury to the obturator nerve which translates into theoretical reduced thigh/groin pain postoperatively. (From Baggish and Karram [135], with permission)

thral coaptation [128]. Unlike the more traditional pubovaginal sling or Burch colposuspension procedures, mid-urethral sling placement does not require an abdominal incision and is thus less invasive with reduced postoperative recovery; it is able to be performed as an outpatient procedure. The TOMUS randomized trial comparing retropubic vs. transobturator slings demonstrated that both had equivalent efficacy in relief of urinary leakage through both subjective and objective measures. However, both had different rare serious side effects, with the retropubic route having a higher rate of bladder perforation, while the transobturator route resulting in more chronic leg pain [130]. Both prospective and retrospective cohorts comparing older women (>70 years) to younger counterparts with pure stress urinary incontinence demonstrate that, while older females enjoy similar improvement in stress incontinence, they have a higher incidence of postoperative urinary tract infections and de novo urge urinary incontinence [131]. The recent introduction of the "mini-sling" may diminish the thigh pain associated with traditional transobturator devices; indeed, recent trials have shown a favorable efficacy to side effect profile [132, 133]. However, further trials are needed, particularly in the elderly, to precisely define the role of the mini-sling in the management of stress incontinence (Fig. 27.4) [134]. As discussed earlier, urinary incontinence in the geriatric population should be thought of as a syndrome with multifactorial etiologies. With decreased bladder compliance as collagen replaces smooth muscle with aging, as the bladder fills with urine postoperatively after mid-urethral sling repair, its decreased capacity with concomitant urges become apparent. As always, adequate preoperative counseling to both the patient and family is important to accurately illustrate expected postoperative outcomes. Surgery for stress incontinence is a choice, rather than a necessity, but should be an informed choice for the patient.

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Gynecologic Surgery in the Elderly

28

Tana Pradhan, Cara Grimes, Gizelka David-West, Alessandra Marino, and Stephanie Twomey

Aging is an extraordinary process where you become the person you always should have been —David Bowie

According to the National Institutes of Health, approximately 8.5% of the world's population is aged 65 and older, and this percentage is expected to double by 2050 [1]. It is important to note that the ratio of males to females decreases in the aging population due to the longer life expectancy of women. This is expected to result in a phenomenon referred to as "the excess of women," making the care of problems in the geriatric female patient paramount.

Gynecologic surgeries in the geriatric patient are performed for either benign or malignant disease process which includes pelvic organ dysfunction with the preoperative evaluation being tailored to the reason for surgery. The risk assessment of a patient undergoing a debulking surgery for ovarian cancer will be different than that of a patient requiring a simple vulvectomy. Our goal in this chapter is to cover the most common gynecologic conditions requiring surgery in elderly women and review points to consider when making the decision to take a geriatric woman for gynecologic surgery. We will also present the top considerations for providing perioperative care and uncover barriers that may be encountered in this unique population.

Gynecologic Conditions in Older Adult Women

Overall the most common gynecologic complaints specific to the aging female are atrophic vaginitis, post-menopausal bleeding, pelvic floor disorders, and vulvar dermatitis. A pelvic mass in the post-menopausal women is less common, however, when encountered often warrants exploratory surgery and therefore will be covered in this chapter. Certainly, each clinical presentation has a host of differential diagnoses, and only a subset of these conditions warrant surgical evaluation.

Older women with atrophic vaginitis may complain of dryness, dyspareunia, soreness, pain,

T. Pradhan (✉) · G. David-West · A. Marino
S. Twomey
Department of Obstetrics and Gynecology, Division of Gynecologic Oncology, New York Medical College/ Westchester Medical Center, Valhalla, NY, USA
e-mail: tanashah.pradhan@wmchealth.org

C. Grimes
Department of Obstetrics and Gynecology, Advanced Urogynecology and Female Pelvic Medicine and Reconstructive Surgery, New York Medical College/ Westchester Medical Center, Valhalla, NY, USA

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Table 28.1 Gynecologic conditions and treatments in older women

Condition	Presenting symptoms	Treatment approach
Vulvar/vaginal atrophy	Dryness, itching, postcoital bleeding	Moisturizers, lubricants, vaginal estrogen therapy
Vulvar/vaginal dysplasia	Itching, visible lesion, bleeding or discharge	*Conservative management:* Topical immunomodulator *Surgical management:* Wide local excision of vulva Laser ablation of vagina Upper vaginectomy
Vulvar cancer	Visible lesion with or without pain, bleeding, discharge Inguinal lymphadenopathy	*Depends on stage of cancer:* Vulvectomy with or without groin node dissection Radiation therapy Chemotherapy
Endometrial hyperplasia	Vaginal bleeding	*Depends on type of hyperplasia:* Ranges from hormonal therapy to surgical intervention with simple hysterectomy
Endometrial cancer	Most common: painless post-menopausal bleeding	*Conservative management:* For patient who are not surgical candidates, hormonal therapy is an option *Surgical management:* Surgery with hysterectomy, BSO, and pelvic lymph node dissection is mainstay of treatment
Ovarian cancer	Bloating, loss of appetite, weight loss, pelvic pain, nausea, and vomiting	*Depends on stage of cancer:* Surgical debulking and staging Chemotherapy
Pelvic floor disorders	Vaginal bulge or pressure, urinary or fecal incontinence, defecatory dysfunction (splinting, straining, incomplete evacuation), incomplete bladder emptying	*Conservative management:* Behavioral therapy, pelvic floor physical therapy, medication therapy, pessaries *Surgical management:* Midurethral sling, reconstructive procedure (retains vaginal function), obliterative procedure (lose vaginal function)

or urinary symptoms which prompt a gynecologic evaluation (Table 28.1). On exam there may be evidence of petechiae, cervix flush to the vagina or loss of rugae especially if there is severe atrophy. There may even be post-menopausal bleeding as a result. With advancing age (or premature estrogen deprivation, e.g., oophorectomy or cancer-related treatment), the loss of estrogen causes the dryness of the genitourinary tissues which predominantly have estrogen receptors. Typically, a trial of vaginal lubricants and/or topical estrogen, if not contraindicated, is prescribed as long as no bleeding or genital lesions are noted.

Menopause is the cessation of menses for 12 months as a result of loss of depletion of ovarian follicles. Any bleeding after this time period warrants a gynecologic evaluation. Most older women have painless bleeding, and only approximately 10–20% of these cases result in the diagnosis of an endometrial cancer. However, the incidence of cancer is on the rise due to increasing rates of obesity in the United States which results in increased peripheral estrogens with resultant stimulation of the endometrial lining and development of preinvasive or invasive disease. Other causes of post-menopausal bleeding include endometrial or cervical polyps, atrophic vaginitis, exogenous hormone use, trauma, atrophic endometritis, or other genitourinary cancers.

Although pelvic masses are a less common gynecologic condition in the elderly woman, the incidence of ovarian cancer is highest in women age 65 and over and may require radical surgery. Due to the low overall incidence of ovarian cancer in the general population and the lack of a cost-effective screening tool, screening of the general population is not recommended. Women may present with vague symptoms such as weight loss, abdominal bloating, early satiety, or nausea. Additionally, women may have mild abdominal pain, urinary frequency, or urgency. There has been some effort to create a symptom index to predict ovarian cancer (e.g., symptoms present for less than 1 year and greater than 12 days per month) [2]. However, healthcare providers must pay attention to the constellation of nonspecific symptoms as mentioned above with their frequency and initiated prompt referral to a gynecologist or a gynecologic oncologist for a comprehensive assessment. Unfortunately 75% of women diagnosed with epithelial ovarian cancer have advanced stage disease due to lack of effective screening, vague symptomatology causing diagnostic delays, and the anatomic location of the ovaries making significant symptoms apparent only with evidence of large tumors and metastatic disease.

Vulvar dermatitis or vulvar lesions can also present with post-menopausal bleeding and vulvar pain. Up to 1 in 30 elderly women may develop vulvar lichen sclerosis, a benign chronic inflammatory skin condition which can be associated with squamous cell cancer at a frequency of approximately 4.5%. This condition is diagnosed based on clinical history and exam, along with vulvar biopsy for pathologic diagnosis. Lichen sclerosis is primarily treated with topical steroid creams and ointments as well as interlesion steroid injections. Patients often present with vulvar irritation and pruritis, which can progress to erosions and fissures due to chronic scratching. Surgical intervention for this condition is considered if cancer is found associated with lichen sclerosis, or often a last resort once the patient has failed all medical management options.

Pelvic floor disorders include urinary incontinence, fecal incontinence, defecatory dysfunction, and pelvic organ prolapse. Pelvic floor disorders are more common with advancing age and result in a decreased quality of life leading women to seek medical attention. Specifically, urinary incontinence is considered a geriatric syndrome which is a highly prevalent multifactorial health condition that can have substantial morbidity and is associated with adverse outcomes of aging in older adults including disability, nursing home admission, and mortality [3]. Approximately 6% of nursing home admissions of older women can be attributed directly to urinary incontinence resulting in an estimated cost of $3 billion per year [4]. Further, meta-analyses found that a median of 58% of nursing home residents suffer from urinary incontinence [5].

Initial treatment for many pelvic floor disorders is conservative and includes behavioral therapy and pelvic floor muscle training. Second line treatments include anticholinergic medications for urgency incontinence and pessaries for pelvic organ prolapse or stress incontinence. There is concern about significant associations identified between anticholinergic medication use and increased risk of cognitive impairment and dementia [6]. Finally, surgical procedures exist to treat pelvic organ prolapse, and the options vary depending on a patient's comorbidities and goals of treatment.

Perioperative Considerations in the Older Woman

After a directed assessment, the gynecologic surgeon may consider operative intervention for further diagnosis or definitive treatment. The decision to proceed with surgery in the elderly woman involves careful consideration of disease outcomes, surgical approach and frailty assessment. Even though advanced age is a risk factor for significant surgical morbidity and mortality, age itself should not preclude a woman from having indicated gynecologic surgery. The preoperative assessment should be comprehensive and useful to detect potential sequelae in the postoperative period.

Common indications for surgery in the elderly women are (1) post-menopausal bleeding, (2) endometrial cancer, (3) pelvic masses suspicious for ovarian cancer, (4) vulvar precancer or cancer, and (5) pelvic organ prolapse or incontinence.

For post-menopausal bleeding, the procedure is commonly hysteroscopy with dilation and curettage to evaluate and sample the endometrium for polyps, hyperplasia or to diagnose malignancy. This procedure is typically an ambulatory procedure and can be performed under sedation if needed. If hyperplasia or malignancy is discovered, hysterectomy may be warranted.

For endometrial cancer, standard of care is a hysterectomy with removal of tubes and ovaries and possible retroperitoneal lymph node evaluation including pelvic and para-aortic lymph nodes. Laparoscopic or robotic approaches for hysterectomy require positioning in steep Trendelenburg position and insufflation with the need of maintaining pneumoperitoneum which may be difficult for extreme obesity or significant cardiopulmonary standpoint. Recently sentinel lymph node algorithms with minimally invasive surgery commonly robotic surgery have been adopted as standard of care for endometrioid endometrial lesions. Sentinel lymph node algorithms reduce the rates of lymphedema and reduce time under anesthesia required for complete lymphadenectomy in those tumors believed to have little risk for nodal disease. Finally, for women who are suboptimal surgical candidates for laparoscopic/robotic or laparotomy approaches, a vaginal hysterectomy with bilateral salpingo-oophorectomy can suffice to remove the primary site of disease. Since endometrial cancer is typically found at clinical stage 1 (85% of cases), hysterectomy with removal of tubes and ovaries can provide excellent disease control.

Conversely, for ovarian cancer, initial surgical cytoreduction via a midline incision laparotomy is the standard of care for suspected advanced disease (Stages III and IV). Ovarian cancer surgeries can be minimally invasive if the disease is confined to the ovary isolated to 1 or 2 quadrants of disease or recurrent disease. Palliative surgery for bowel obstruction is another common indication for operative management either in the initial or recurrent setting. Surgical procedures include radical oophorectomy and hysterectomy, pelvic and para-aortic lymph node dissection, total omentectomy, bowel resection commonly recto-sigmoid resection, diaphragm and peritoneal stripping, partial hepatectomy, distal pancreatectomy, and splenectomy. The goal of cytoreduction is debulking to no gross residual disease to afford the longest overall survival.

Most of the gynecologic data on frailty assessment has recently been in the setting of a suspected advanced epithelial ovarian cancer diagnosis. Surgery is the cornerstone of treatment of ovarian cancer, however, there is data showing equivalent survival between neoadjuvant chemotherapy and upfront debulking surgery. There is a strong bias toward upfront surgical management in the United States due to tumor resistance and higher rates of survival in the United States than reported in international studies. Frailty in the older woman would influence the decision to pursue neoadjuvant therapy if there are potentially modifiable factors that reduce the risk of morbidity and mortality.

A frailty index has been explored as a means of predicting outcomes in advanced ovarian cancer. To date more than 50% of studies on frailty are in the male population, and little data exists on the preoperative assessment of older women with a suspected cancer diagnosis. In retrospective analysis of older advanced ovarian cancer patients, frail patients were more likely to be older, higher BMI, higher ASA score, have less surgical complexity, and higher rates of having residual disease [7]. They were also three times more likely to have an Intensive Care Unit Admission within 30 days of surgery and a non-home discharge (two times more likely than non-frail patients). Even though age was a risk factor, it was frailty that was predictive of adverse outcomes for patient undergoing laparotomy [8].

In endometrial cancer, minimally invasive surgery is the cornerstone of treatment, however, few studies look at age and frailty in this population. In the landmark Phase III trial LAP2 which established minimally invasive surgery as standard of care, a recent secondary analysis was performed looking at advanced age and complications each of the trial groups, open versus laparoscopic (including robotic) surgery. In the study population 31% were 70 and older but only 6.6% were 80 and older [9]. Overall complications such as prolonged hospitalization, readmission, and death were still lower in the minimally invasive group regardless of age [10].

Surgery for vulvar disorders includes wide local excision of the vulva, simple vulvectomy, and radical vulvectomy with inguinal lymphadenectomy. The postoperative morbidity of these surgeries increases as they become more radical, with the risk of complex wound failure being as high as 85% and the risk of lower extremity lymphedema up to 70% [11]. With such high risk for morbidity, the preoperative evaluation of the geriatric patient must be multifaceted to ensure the right candidate proceeds with the right surgical intervention. Over the years, the more radical vulvectomy surgeries with full inguinal lymphadenectomy have been modified to reduce morbidity by decreasing the size of the vulvar incision and by employing sentinel lymph node dissection for early stage vulvar cancers. Such modifications in technique have lowered wound complication rates to 30% and lymphedema rates to approximately 20% [12]. Additionally, for patients who are poor surgical candidates or with unresectable vulvar tumors, external beam pelvic radiation therapy with concurrent radiosensitizing chemotherapy is utilized as either definitive therapy or as neoadjuvant therapy to then decrease the morbidity of surgical resection.

The two main pelvic floor disorders that are often corrected surgically are stress incontinence and pelvic organ prolapse.

Advances in anti-incontinence surgery over the last 25 years have resulted in a minimally invasive same day midurethral sling surgery that is appropriate for the majority of women with simple stress incontinence. This allows a safe and effective procedure in an outpatient setting that reduces risk exposure. Age-related risks of incontinence surgery are not well delineated in the medical literature, but overall, sling outcome studies that stratify women by age sometimes find increased risks of postoperative complications (urgency, recurrent UTIs) with equal or slightly less effective success outcomes [13].

Pelvic organ prolapse can be surgically treated via the abdominal route (usually through a minimally invasive approach) or a vaginal approach. A common consideration when approaching surgery for pelvic organ prolapse is to balance risk and benefits associated with reconstructive versus obliterative procedures to correct pelvic organ prolapse. Reconstructive procedures in which a woman retains functional use of her vagina can be native tissue repairs which involve suturing tissues to ligaments to provide support and plicating the fibromuscular tissue of the vagina to strengthen and support her tissues or involve the use of grafts/mesh to augment native tissue support. For elderly patients with multiple comorbidities who do not desire future penetrative vaginal intercourse, obliterative procedures can be considered. In these procedures a woman is left with a foreshortened and narrowed vagina. Obliterative procedures offer the lowest morbidity and highest success rates but at a cost of no more penetrative sexual activity.

Sung et al. analyzed data from the Nationwide Inpatient Sample (NIS). The overall risk of death following urogynecologic procedures was low at 0.04%, but elderly patients undergoing urogynecologic procedures were at higher risk for inhospital death and perioperative complications, even after adjusting for comorbidities. Elderly women 80 years and over who underwent obliterative procedures vs reconstructive procedures had a lower risk of complications compared with those who underwent reconstructive procedures for prolapse (17.0% vs 24.7%, $P < 0.01$) [14].

Future Considerations

In the surgical literature, enhanced recovery pathways (ERAS) have become increasingly adopted for both open and minimally invasive gynecologic surgery. These pathways offer a series of perioperative considerations which emphasize returning the patient back to its physiologic homeostasis. For example, certain strategies used in ERAS protocols are: addressing pain by limiting narcotics and treating pain preoperatively; early to immediate refeeding; and avoiding excessive intravenous fluids. While older women may be excellent candidates to include in these pathways, they have been excluded in initial studies. There are some feasibility studies looking at older women in ERAS protocols, but increased efforts to include this population are necessary. [15]

Apart from specific considerations in gynecologic surgical procedures, it is important to note that facilitating a home discharge when possible is paramount. Women are often the primary caregivers for the family regardless of sociodemographic, racial, or ethnic background. Even the prompt surgical recovery of the older female patient is crucial, therefore when possible minimally invasive surgery including vaginal surgery is employed. When the older woman has been diagnosed with a gynecologic cancer, it can be devastating for the family structure. Not only would there be physical considerations if the patient had undergone radical surgery requiring diversion of the bowel or bladder or radical vulvectomy where post-op mobility is limited but also effects of treatment.

If adjuvant treatment is required, women would need support during chemotherapy and radiotherapy including socioemotional support. If the woman has always been the caregiver, who would be there in her time of need? There is a paucity of data showing how social support of the female patient can affect time to treatment and hospital length of stay. There have been studies which show that the role of family dynamics can play a part in a patient's decision to undergo treatment [16]. Providers must understand the elderly female patient's family responsibilities as they may care for young children, grandchildren, and even elderly parents. These factors must be discussed and taken into consideration to assist a patient with her decision when and if to undergo any treatment, including surgery, chemotherapy, radiation therapy, or a combination thereof. For benign and malignant disease processes, supportive care services need to be targeted to this vulnerable older female population with the understanding of the entire family structure that she supports.

Conclusions

Gynecologic surgery in the older female patient should improve quality of life, extend survival if possible, and also avoid any preventable healthcare burden to society (e.g., nursing home admissions, falls, delirium, and vaginal hemorrhage from gynecologic tumors). Balancing extensive surgical efforts such as major pelvic reconstructive surgery and radical ovarian cancer debulking need to be tailored to the geriatric patient rather than simply outright denied. However, in many instances, no surgical intervention is an acceptable treatment plan. Table 28.2 outlines several treatment strategies employed for gynecology when the woman may be too frail for any surgical intervention.

The decision to operate on the older woman is multifaceted. Women are living longer and should not be discriminated upon simply due to age alone. For the non-frail older woman, they can undergo minimally invasive and radical surgical procedures which could reduce the long-term morbidity of a nonsurgically treated disease process. For frail women who are poor surgical candidates, the goal is to achieve a good quality of life as well as minimizing burden to the patient's family. Secondarily, the goal would be to reduce healthcare system burden for avoidable disease sequelae. Since women are living longer and makeup a substantial portion of our geriatric population, astute surgical decision-making for gynecologic surgery in the elderly woman is critical to optimize healthcare outcomes for society.

Table 28.2 Treatment strategies employed for gynecology when the woman may be too frail for surgical intervention

Gynecologic condition in the older woman	Nonsurgical option(s) for frail women
Vaginal hemorrhage from gynecologic cancer	Pelvic radiation (therapeutic or palliative dosing)
Malignant ascites/malignant pleural effusions	Permanent indwelling catheters
Bowel obstruction	Gastrostomy tube placement, octreotide, large bowel stent
Ovarian cancer diagnosis (can give neoadjuvant if preoperative optimization is possible)	Palliative care, chemotherapy (directed at symptoms such as ascites)
Endometrial cancer diagnosis	Hormone therapy, radiation therapy
Pelvic organ prolapse	Pelvic floor physical therapy, pessary

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29 Postoperative Quality of Life in the Elderly

Shekhar Gogna and Rifat Latifi

Surgical problems in the face of age-related physiologic changes and comorbidity burden place elderly at high risk of morbidity, mortality, and functional decline after surgery. The fear of poor postoperative outcomes in elderly themselves, their families, and their physicians, often merely because of age, and it precludes many patients in need of surgery to undergo surgical interventions. The clear definition acceptable of postoperative outcomes measures is important in order to measure and improve them. Moreover, how does the patient and their healthcare providers decide what the real expectations are, what to look for, and how to advise the elderly in this topic. In other ways, what should I expect after surgery in elderly, both as patient and family member, but in fact as a surgeon? And, can I precisely predict how will the operation improve the life of my patient? The answer is, it depends on the operation and the goal of operation.

The number of elderly (aged 65 and older) who undergoes noncardiac surgery is expected to double from 7 million to 14 million by year 2030 [1]. Nonetheless, it is predicted that the number of elderly patients undergoing surgical procedure will continue to rise significantly. Hence, anticipating the postoperative functional outcomes in elderly surgical patients is of outmost importance. The studies and common sense dictate outcomes that depend on the type and extent of treatment, and this notion the influence and the treatment preferences of older patients [2]. Shared decision-making between the patient, family, and their surgeon should define the objectives and goals of surgical intervention and outlines the expected quality of life postoperatively.

Postoperative quality of life depends in part on the preoperative quality of life which is further determined by overall health and conditions leading to surgery. We have seen again and again that preoperatively frail patients do worse than those who are not frail and are physically and emotionally fit. Certain procedures itself are performed to improve quality of life in elderly such as the cochlear implants, which improve hearing; cognition and depression [3]; hip and knee arthroplasty, which improves ambulation [4]; pelvic floor repair for stress incontinence [5], transurethral resection of the prostate, which improves urological dysfunction [6], and so forth. Needless to say, perioperative complications do have a remarkable role to play in the outcomes overall [7].

This chapter aims to highlight the concept of quality of life and measures to improve it in the elderly undergoing surgery. We begin by describing

S. Gogna
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: Rifat.Latifi@wmchealth.org

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the pathophysiology of poor postoperative health-related quality of life in the elderly. The second part is an attempt to define and measure postoperative health-related quality of life in elderly (HRQoL). We will then highlight the utility and components of comprehensive geriatric assessment (CGA) because preoperative CGA is an evidence-based utility tool that helps in improving postoperative HRQoL. The last section deals with the methods to improve the HRQoL.

Pathophysiology of Poor Postoperative Health-Related Quality of Life (HRQoL)

Major surgery elicits a metabolic stress response and inflammation that is more pronounced in older patients. Tissue injury during major surgery is aggravated by repeated ischemia-reperfusion events [8]. Furthermore, tissue injury and ischemia-reperfusion together may lead to systemic effects on the brain and peripheral nervous system. This leads to a biochemical cascade and increased transcription of proinflammatory cytokines such as interleukins (IL-1, 2 & 6, TNF-alpha) consequences of which are secondary loss of appetite, sleepiness, fever, aching joints, and fatigue, and thus withdrawal from normal social activities. This sickness behavior may impair health-related quality of life (HRQoL) shortly after surgery [9, 10]. This intricate process is depicted in Fig. 29.1. The interaction between anatomical, physiological and biochemical balance changes in the postoperative protoplasm of the elderly impacts the quality of life. The relative importance of individual biochemical, social, and cognitive factors is different in every patient and is difficult to measure or quantify. The entire web of these interactions and the effectiveness of surgical procedures dictate the outcomes.

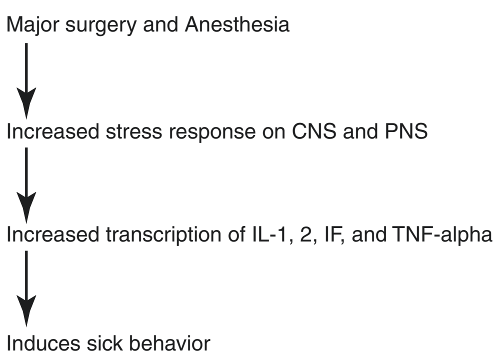

Fig. 29.1 Pathophysiology of poor quality of life in elderly postoperatively. CNS central nervous system, PNS peripheral nervous system, IL interleukin, TNF tumor necrosis factor

Definition and Determination of Postoperative HRQoL in Elderly

Both patients and we, the healthcare providers, know that “QOL is important.” However, what exactly is QOL, how do we define it? Quality of life (QOL) is a broad multidimensional concept that usually includes subjective evaluations of both positive and negative aspects of life [11]. Aspects of health status that a patient appreciates, when integrated with the components of QOL has been defined as health-related quality of life (HRQoL) [12]. The concept and determinants of health-related quality of life (HRQoL) have evolved since the 1980s to encompass physical or mental aspects of overall quality of life that are shown to affect health [13]. The term QOL and HRQoL are often used interchangeably, with little distinction between the two, giving rise to confusion.

Determination of HRQoL

There are numerous validated questionnaires to measure HRQoL. The questionnaires can be generalized into two categories: generic instruments and disease-specific instruments (Table 29.1) [14–22].

The list of scales has a common underlying message that an ideal health assessment would include a measure of physical health, a measure of physical, social, and psychological functioning, and quality of life. The ultimate goal of these scales is to determine well-being in all aspects of life during the existence of the disease process or while undergoing subsequent treatment for it.

Table 29.1 Validated tools to measure health-related quality of life

Type of questionnaire	Developed by	Description
Generic instruments		
1. CDC HRQoL–14 "Healthy Days Measure" [14]	Center for Disease Control	Based on integrated set of broad questions about recent perceived health status and activity limitation
2. Short Form Health Survey (SF-36, SF-12, SF-8) [15]	RAND Corporation: an American nonprofit global policy think tank created in 1948 by Douglas Aircraft Company.	Widely used questionnaire assessing physical and mental HRQoL. Used in clinical trials and population health assessments
3. EQ-5D [16]	EuroQol group: formed in 1987 with the researchers from five countries: Netherlands, the United Kingdom, Sweden, Finland, and Norway	Designed for self-completion and patient-reported outcome (PRO) measures
4. AQoL-8D [17]	Global panel company, CINT Australia Pty Ltd after online survey in Australia, Canada, Germany, Norway, the United Kingdom, and the United States	Measures HRQoL over 8 domains – independent living, happiness, mental health, coping, relationships, self-worth, pain, senses
Disease-specific instruments[a]		
1. International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) [18]	European Organisation for Research and Treatment of Cancer	Used in urinary incontinence
2. New York Heart Association (NYHA) scale [19]	New York Heart Association	Most commonly used to evaluate the impact of heart disease on individuals
3. EORTC measurement system [20]	European Organisation for Research and Treatment of Cancer	For use in clinical trials in oncology
4. European Cooperative Oncology Group (ECOG) scale [21]	European Cooperative Oncology Group	Most commonly used to evaluate the impact of cancer on sufferer
5. Hospital Anxiety and Depression Scale (HADS) [22]	Developed by Zigmond and Snaith (1983)	Commonly used by physicians to determine the levels of anxiety and depression, it is a 14 item scale

[a]Some important scales, does not represent the exhaustive list available in literature

Importance of Measuring the Postoperative Quality of Life in Elderly

As previously discussed elderly are the fastest-growing population, subsequently they will be the largest shareholders of healthcare resources. Hence, as clinicians we need to use HRQoL as a proxy measure to understand the impact of disease and its treatment. There are numerous advantages of measuring postoperative HRQol: (1) assessment of the difference between morbidity and treatment response between groups of patients; (2) ability describing health status and decision-making in the management of individual patients; (3) assessment of the standard of healthcare in the community, and (4) resource allocation decisions.

Measuring the postoperative HRQoL and subsequent actions taken on the basis of these measurements should be recorded, studied, and reported in medical health records. Well-defined expectations of health-related quality of life research questions will eventually affect the decision-making process of agencies such as the Food and Drug Administration, European Medicines Agency [23], or National Institute for Clinical Excellence [24] on how to further advance the process of caring for the elderly and HRQoL.

The Utility of Comprehensive Geriatric Assessment: First Step Toward Better Postoperative HRQoL

Comprehensive geriatric assessment (CGA) is defined as a multidisciplinary diagnostic and therapeutic process that identifies medical, psychosocial, and functional limitations of a frail elderly, aimed to improve the outcome [25]. The components of the CGA are shown in Table 29.2. A recent Cochrane review on the impact of CGA on elderly admitted to surgical services found that older people who received CGA had a lower risk of dying and was more likely to return to the same location they lived in before hospital admission [26]. The application of CGA even in medical inpatients and community-dwelling older people has been shown to improve mortality at 36-month follow-up and increases the chance of living independently at home [27]. CGA has been shown to decrease the length of stay, rates of institutionalization, and readmission, and improves functional status in oncology [28], vascular [29], orthopedic [30], and elective general surgery [31].

Table 29.2 Components of comprehensive geriatric assessment (CGA)

Domain	Variables
Medical	Comorbid conditions and disease severity Medication review Nutritional status
Mental health	Cognition Mood and anxiety Fear
Functional capacity	Basic activities of daily living Gait and balance Activity/exercise status Instrumental activities of daily living
Social circumstances I	Support from family or friends Social network such as visitors or daytime activities Eligibility for being offered care resources
Environment	Home comfort, facilities, and safety Potential use of telehealth Transport facilities Accessibility to local resources

With the demographic shift, higher proportion of elderly will undergo emergency general surgery (EGS) procedures. EGS comprises illnesses that require surgical intervention urgently. A third of EGS patients undergo surgical intervention, and 28.8% of those were elderly undergoing major emergency general surgery in the United States [32]. Importantly, while elective surgery rates decrease drastically in patients over the age of 75 years, rates of emergency interventions increase. There is a rising demand for establishing the CGA by geriatrician lead team in emergency departments. There are some heterogeneous studies in the literature, but well-designed RCTs are lacking [33].

Outcomes Measures of Postoperative Health-Related Quality of Life (HRQoL) in Elderly

While there is an overall agreement of HRQoL, less clear are a number of questions such as what is it that we are measuring, or even more obvious, how do we define a good quality of life after surgery vs another patient who is not doing that well? Surprisingly, the universal outcome measure (or a generally agreed-upon measure) does not exist [34]. Hence, this is an area of ongoing intensive research. So far the general functional outcomes such as activities of daily living (ADLs) and independent activities of daily living (IADLs) are used to assess the QOL in elderly patients [35]. Both ADLs and IADLs provide a measure of independence, which matters to the elderly when it comes to postoperative QOL. Functional capacity takes into account both these basic activities of daily living (ADLs), eating, bathing, dressing, toileting, and walking; and IADLs, shopping, banking, and housekeeping [36]. Evaluation of ADLs and IADLs are considered outcomes of long-term recovery, and the data about the impact of surgery on them is available but scant. Surgical stress, frailty, sarcopenia, hormonal dysregulation, and prolonged bed rest all act in concert and dramatically reduce muscle mass and functional capacity, which leads to impaired ADLs and IADLs.

The short-term outcome measure of HRQoL is the "recovery from surgery," and this aspect of geriatric care has an immediate impact on the clinicians and is an important indicator of the quality of healthcare. The new quality payment program (QPP), 2017, has been implemented by Centers for Medicare & Medicaid Services (CMS) with the goal of disposing payment with high-quality care in the hospitals [37]. The short-term (early) recovery is divided into three phases: early, intermediate, or late postoperative recovery.

Early postoperative recovery phase has been defined as first seven postoperative days which are influenced by pain, nausea, perioperative medications, and delirium [38, 39]. The intermediate phase has been defined as the first 28 or 60 days which are influenced by pain, anxiety and depression, physical impairment, and cognitive dysfunction [40, 41]. The late postoperative recovery phase has been defined as the first 6 weeks to 3 months [42].

This postoperative functional decline has been labeled as "hospitalization associated disability" [43]. Prolonged bed rest, polypharmacy, overuse of urinary catheterization, physical restraints, and restricted diets contribute to the feeling of loss of independence in elderly [44]. Table 29.3 shows the validated tools to measure long- and short-term recovery [45–47]. The limitation here is that there are plenty of scales available, but none of them is specific for the elderly.

Table 29.3 Validated tools to assess short-term and long-term recovery

Tools to assess long-term recovery	Description
1. Katz Index of Activities of Daily Living (measure ADL) [45]	Eating, bathing, dressing, toileting, walking
2. Lawton's instrumental activities of daily living scale (IADL) [46]	Shopping, banking, housekeeping
Tools to assess short-term recovery [47]	
1. Post-anesthesia recovery score	Composite score in PACU on inpatients
2. Post-discharge surgical recovery scale (PSR)	Composite score on day 4 after ambulatory surgery
3. 24-Hour Functional Ability Questionnaire (24hFAQ)	Composite score after 24 hours of ambulatory surgery
4. Post-anesthesia short-term quality of life tool (PASQOL)	Composite score on day 7 after ambulatory surgery
5. Surgical recovery index (SRI)	Composite score in inpatients on day 7, 14, 21 and 28
6. Functional recovery index (FRI)	Composite score after day 1, 3, 5 and 7 of ambulatory surgery
7. Postoperative quality of recovery score (PQRS)	Dichotomous score noted baseline at 15 and 45 min then day 1 and 3 and 3 months on inpatients
8. Surgical recovery scale (SRS	Composite score in inpatients on day 3, 7, 30, and 60

Interventions to Improve the Postoperative Health-Related Quality of Life (HRQoL)

Lawrence et al. prospectively examined the functional independence after major abdominal surgery in the elderly. They observed that cognitive status improves by 3 weeks (after a mild decline), ADLs improve by 6 weeks to 3months, and IADLs take 3–6 months to improve to baseline [48]. Many times in our day to day surgical practice, we have seen that eventful short-term recovery affects long-term recovery, and the negative outcomes may even logarithmically potentiate [49]. So logically, improving short-term recovery will enhance long-term recovery. However, the independent interventions targeting long-term outcome measure are also important.

The interventions can be divided into three phases: (1) prehospital intervention; (2) inhospital intervention; and (3) posthospital intervention. Importantly, prehospital, inhospital, and posthospital interventions represent the entire continuum of care.

Prehospital Intervention

In 2012, American College of Surgeons, National Surgical Quality Improvement

Program (ACS NSQIP), and the American Geriatrics Society (AGS) created the best practices guidelines to optimize perioperative care of the geriatric surgical patient [50]. They emphasize that in addition to obtaining complete history and performing detailed physical examination, elderly should be screened for depression, postoperative risk of delirium, alcohol or substance abuse, nutritional status, risk factors for postoperative pulmonary complications, baseline frailty score, patient's social support system, and capacity to understand the anticipated surgery. The intervention should be done in the form of preoperative cardiac evaluation according to the American College of Cardiology/American Heart Association for patients undergoing noncardiac surgery along with appropriate preoperative diagnostic tests. The complete documentation of medication history, polypharmacy, functional status, and history of falls is of paramount importance. Addressing the concern in any of the abovementioned domain will translate into an intervention/s to improve geriatric surgical care.

Prehabilitation is a very effective intervention performed during the preoperative period and has been shown to improve functional status before and after surgery. This program which ranges from 6 to 8 weeks employs (1) exercise techniques targeting specific muscles or joints by walking, cycling, or swimming to increase VO2max and anaerobic threshold (AT); (2) patient education about surgery and the recovery process; (3) dietary counseling to improve preoperative nutritional status: and (4) stress reduction under direct supervision of psychologist by relaxation with breathing exercises at home [51, 52].

The evidence of postoperative improvement after prehabilitation is encouraging from the initial studies, but there is heterogeneity of the data, wide inclusion and exclusion criteria. Some patients benefit more from the other techniques, which are based on their physiological reserve and type of disease process. So more dedicated studies with well-defined outcome measures are needed [53, 54].

Inhospital Interventions

The literature and guidelines are replete with the inhospital intervention, and all of them emphasize evidence-based geriatric care. The guidelines on optimal perioperative management by ACS NSQIP and AGS provide a sound platform [55]. They emphasize on employing regional anesthetic techniques with multimodal or opioid-sparing analgesia to prevent cognitive and functional decline. The judicious use of intravenous fluids along with appropriate hemodynamic management is one of the important interventions in immediate perioperative care. Correct medical reconciliation of all indicated and current medications is very important. Preventing delirium [56], postoperative nausea vomiting [57], pulmonary complications [58], falls [59], UTI [60], pressure ulcers [61], and functional decline [62] in elderly should be addressed on admission and should be part of all quality improvement projects in the hospitals.

Post-discharge Interventions

Discharge planning involves formulating a comprehensive aftercare plan for patients in whom they are briefed about their disposition, dosage, side effects, and major drug interactions of new medication started in the hospital. It also involves arranging for special care needs such as diet, intravenous medication, wound care, or physiotherapy. The patients are given follow-up appointments with contact numbers for clinic visits [63]. The aim is to reduce hospital length of stay and unplanned readmission to hospital [64]. A Cochrane database review on the effects of individualized discharge plans showed that it leads to reductions in hospital length of stay and readmission rates for elderly admitted to hospitals. However, the authors did emphasize that its impact on mortality, health outcomes, and cost still remains uncertain [65].

Enhanced recovery after surgery (ERAS) programs are a series of evidence-based perioperative interventions that support recovery by reducing the physical stress reactions after sur-

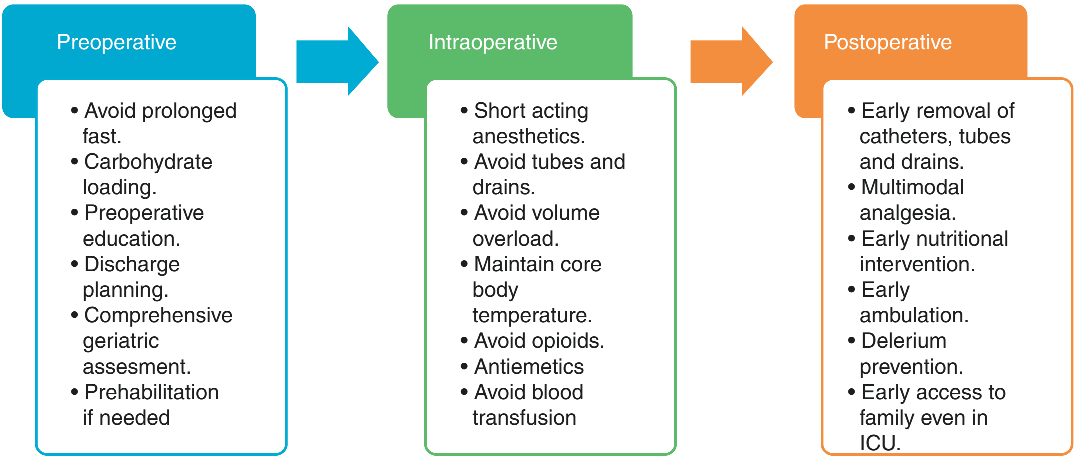

Fig. 29.2 An illustration of a typical ERAS protocol. ICU intensive care unit

gery [66]. This series of the perioperative protocol to enhance recovery was first applied in 1995 by a Danish surgeon, Henrik Kehlet for colectomy [67]. This has now been applied to other major operations and even medium-size surgeries. The series of perioperative, intraoperative, and postoperative interventions described above constitute ERAS protocol, depicted in Fig. 29.2 [68]. The studies have shown comparable efficacy of implementing ERAS protocol on postoperative outcomes in younger and elderly patients. Kisialeuski et al., compared outcomes after implementing ERAS protocol in elderly with non-elderly population after laparoscopic colorectal surgery. The older group had higher ASA scores, but there was no difference in time to first bowel movement, hospital length of stay, or the number of perioperative complications [69]. In a Danish study on fast track hip and knee replacement of patients above 85 years, most patients were able to leave the hospital in 3 days [70]. The same group also emphasized the need for anemia management both pre- and postoperatively in this patient group. The underlying message being that individualizing the ERAS protocol will further enhance the outcomes.

The improved longevity has led to the demographic shift in trauma and acute care surgical services. Many preoperative and intraoperative ERAS interventions outlined in Fig. 29.2 are not entirely feasible for trauma patients. Some examples being the reduced duration of fasting, discharge planning, CGA, avoiding blood transfusion, etc.

In a systematic review, Paduraru et al. concluded that implementing ERAS protocol was beneficial in elderly who underwent emergency surgery with a reduction in postoperative complications, hospitalization, and readmission rates [71].

This systematic review of heterogeneous studies, four cohort studies, and one randomized controlled trial evaluated the impact of ERAS after emergency surgery calls for more in order to evaluate this concept and to make more tangible recommendations.

ACS NSQIP Geriatric Surgery Pilot Project: Spreading the Message

The role of and the importance of teamwork and communication in surgery have been established. Evidence demonstrates the positive effects on both technical skills and patient outcomes [72]. In order to improve geriatric patient outcomes, the ACS has partnered with John A. Hartford Foundation to develop a geriatric surgery quality initiative program and created Coalition for Quality in Geriatric Surgery (CQGS) Project [73]. This is a 4-year initiative to define the processes, resources, and infrastructures necessary to provide optimal care of the older adult surgical patient. The CQGS has engaged the groups representing the various surgical services, anesthesia, geriatrics, nursing, social work, pharmacy, patient advocacy, emergency medicine, physical therapy, community resources, advocacy and regulatory organizations, and, perhaps most importantly, patients and families themselves. This project will provide evidence-based standards of care, uniform system for data collection, and measurement of outcomes in the elderly surgical population.

Conclusion

For the elderly, living independently and with dignity, postoperatively is one of the most important aspects in deciding to undergo surgery. Postoperative quality of life should be the most important patient-centered outcome measure in this fastest-growing segment of the world population. Aging, frailty, and high burden of comorbidity are the risk factors for poor functional recovery. It is important to be able to identify elderly who are at greater risk for poor postoperative functional outcomes. The comprehensive geriatric assessment offers a great advantage and has shown to improve outcomes. Measuring and documenting ADLs and IADLs is very important to understand asses and improve QOL. A validated HRQoL tool specific to the elderly population is needed. The postoperative QOL is affected by preoperative, intraoperative, and postoperative course in the hospital. American College of Surgeon developed the optimal perioperative management of the geriatric patient. These applications of these guidelines along with ERAS protocol has shown to improve the outcomes and hence the quality of life. The importance of good clinical judgment and experience is of paramount importance.

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Part III

Palliative Care, Spirituality, and Mental Health

30 Surgical Decision-Making in the Elderly with Serious Surgical Illness: The Role of Palliative Care

Vincent Finbarr Blood, Matthew K. McIntyre, and Christian A. Bowers

Our reluctance to honestly examine the experience of aging and dying has increased the harm we inflict on people and denies the basic comforts they most need.
Lacking a coherent view of how people might live successfully all the way to the very end, we have allowed ourselves to be controlled by the imperatives of medicine, technology and strangers.
Atul Gawande (Surgeon and Author), Being Mortal: Medicine and What Matters in the End

Surgeons constantly face new challenges as knowledge and research along with technology are continuously evolving to surgically achieve optimal patient outcomes. Historically, surgeons have led by example through translational science, implementing new technological innovations, or advancing surgical techniques. Surgeons have followed the same time-honored leadership blueprint in the application of palliative care to the geriatric surgical patient (GSP). Palliative care is unique with its humanistic battlefield that not only seeks to holistically understand our patients and their families but also our colleagues and perhaps, most importantly, ourselves. This challenge is to the very essence of our souls, values, and culture, and not to surgical technique or technology.

We must behave and think differently to change this dogma lest we lose our purpose as surgeons: to treat our older surgical patients with compassion and dignity within a comprehensive patient-based approach. We must have dynamic vision and foresight of what is important to the GSP as defined not just by their pathology but by their personal, psychosocial, clinical situation, and overall quality of life (QoL). This perspective permits Surgical Palliative Care (SPC) to demonstrate integrity to the GSP's entire situation to determine which course honors and follows the patient's values best. This unique and vulnerable patient population needs us to be a different type of hero than the traditional paintings of the famous general surgeons that line our country's oldest and most prestigious surgery departments. In this chapter, we attempt to understand the intersection of Geriatric Medicine (GM), surgery, and SPC. Barriers to SPC will be

V. F. Blood (✉)
Department of Surgery, Westchester Medical Center, Valhalla, NY, USA
e-mail: Vincent.Blood@wmchealth.org

M. K. McIntyre
School of Medicine, New York Medical College, Valhalla, NY, USA

C. A. Bowers
Department of Neurosurgery, Westchester Medical Center, New York Medical College, Valhalla, NY, USA

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acknowledged and discussed. Solutions and tools to assist the surgeon in this difficult transformation and decision-making will be postulated.

Understanding Each Other: Geriatric Medicine, Palliative Care, and Surgery – A Prerequisite for SPC Decision-Making

A crucial first step in integrating SPC into an effective interdisciplinary team caring for the older age patient with serious surgical illness is an accurate understanding of the other disciplines involved, primarily GM and palliative care (PC). Why does each entity act and think in the way that they do? Mutual understanding and exchange of ideas through effective communication is a key component to working as a team to reach the moral and ethical common goal of optimizing patient-focused care.

Cultural differences across disciplines and an unwillingness to engage in meaningful conversations contribute to isolation and limitations in interdisciplinary care. Ideally, the objective is a patient-focused, comprehensive interdisciplinary care team utilized for establishing palliative care decisions based on open discussions. A multidisciplinary team differs from an interdisciplinary team because in an interdisciplinary team different disciplines assume differing levels of control depending on the clinical and personal situation, whereas in a multidisciplinary team one discipline is in charge of all decision-making and overall care. Surgeons may interpret this as loss of control and ownership of their patient.

The number of older adults undergoing procedures for serious surgical illness is growing, as half of all US surgical procedures are in patients over 65, but their mortality rate continues to decrease [1, 2]. It is thought that over half of all procedures performed in the USA are in those over 65, and each individual in this group is likely to require at least one surgery [3]. Therefore, surgeons frequently manage older patients, but PC is under-recognized despite having demonstrated its efficacy, and the demand for SPC is constantly increasing [4].

SPC implementation has been problematic due to the various heterogenous clinical scenarios inherent to the GSP. The advanced patient care options available permits various surgical subspecialists to push the envelope for what GSP can tolerate. However, these treatment advances may come at an inconspicuous cost as GSPs are less likely to receive palliative or hospice care in their final year of life when compared to medical patients [5]. This is unfortunate since SPC patients have better pain management, higher satisfaction with care, increased QoL, and reduced healthcare costs [6, 7].

Given the remarkable advanced surgical care now available, the pertinent question is shifting to “not can we operate but, rather should we?” What will the patient’s functional status be and how does that coincide with their wishes or advanced directive? Surgeons must shift to a comprehensive patient-focused, interdisciplinary care model that considers patient and family goals, values, and potential outcomes instead of what the technical surgical possibilities are. The nuances of the technical mastery of a Whipple, for example, are lost on the patient and his family if the patient becomes impaired and struggles with a protracted hospital course full of suffering that ultimately ends in their death anyways.

What Makes the Geriatric Patient Unique?

The GSP is unique from a personal, psychosocial standpoint and a clinical perspective. Many of these patients have chronic illness, comorbidities, and decreased physiologic reserve that portend worse postoperative outcomes. Polypharmacy complicates medical care in the elderly and is frequent as 39% of patients over 65 years take more than five medications daily [8]. Furthermore, older patients frequently have baseline impaired activities of daily living (ADLs), decreased activity and independence, varying degrees of frailty, and impaired cognition [9]. The already complicated informed decision-making process is further complicated by the frequent psychological and emotional impairments prevalent in older patients. Appropriately, family and caregivers are asked to assist, care for, and make important healthcare decisions, but then indirect decision-making and surrogacy issues can further cloud the surgical decision-making process. The surgeon must accordingly recognize that they are treating a "care unit" consisting of patient, family members, and caregivers [10]. This "care unit" must be communicated with, educated, and involved in decision-making at all phases of the patient's course. The GSP's wishes, goals of care (GOC), and social situation are key elements to the decision-making process, and families should be involved early, and frequently, to establish a relationship with the physician in the event the patient becomes incapacitated or their wishes are unknown.

Additionally, given that over 1.7 million American geriatric patients are living in nursing homes or hospice, the social aspect of the patient's life must be considered in any surgical decision [11]. For example, if the patient's baseline functional status is poor, as evidenced by hospice dwelling, then shared decision-making must be utilized *before* an intervention is planned. This can be especially challenging in new or acute surgical scenarios such as traumatic injury where the care is very protocolized and time is precious. This highlights the need for established GOC and realistic conversations months or years before an acute scenario arises, something that is not possible for a trauma or acute care surgeon to do. We must therefore rely on our primary care colleagues to routinely have and document these conversations in an easily accessible database. Patients should also be encouraged to share their goals with family members who will be entrusted to make surrogate decisions on their behalf should the situation arise.

Geriatric Patients and Barriers to Palliative Care

Firstly, PC is frequently viewed as a terminal event with end of life care, but it offers so much more to patient, family, and the surgeon. This narrow perspective deprives patients of potential benefits and impedes optimal care. Secondly, a potentially dangerous and harmful false dichotomy exists: (1) palliative and symptom-based care aimed at increasing QoL from a physical, psychological, and spiritual perspective and (2) curative- and disease-focused care. These two areas are often seen as mutually exclusive. However, these two goals can and should be carried out in parallel with a high level of coordination because a single clinician operating in a vacuum will struggle and typically fail to achieve this goal. The lead clinician should be determined by whether palliative or curative treatment is the goal.

Alarmingly, focus of care decisions are often heavily influenced by providers while excluding patient wishes, GOC, and without discussing pertinent end-of-life issues. A frequent misconception is that SPC is a primary care process rather than an adjunctive, parallel system of care. In GSPs, the SPC process can be longer, more dynamic, and subject to change depending on numerous dynamic variables such as chronic illness, worsening comorbidities, and psychosocial personal change. Over time, the weight of each factor can change also as priorities shift and different decisions become appropriate. SPC and PC focusing on shared common ground (QoL, control over one's life, care for patient and family, collaborative care etc.) will help to integrate these disciplines and deliver the best care.

What Is Palliative Care?: Definitions, Principles, and Proper Use

PC is an essential part of total care offering a wide range of treatment and support for these patients and their families and is not just a place to send patients who we believe can no longer benefit from surgery for cure or where surgery is no longer a realistic, viable treatment option (Table 30.1). Nor is it equivalent to giving up or withholding care. It is not an "on" or "off' switch, but rather a spectrum that assumes a larger and larger role of the care as a patient's demise becomes more and more certain.

Table 30.1 Principles of palliative care

Basis is a relief of pain and suffering (physical, emotional, and spiritual)	End of life care is one important part of palliative care not it's "only" role
Improving quality of life	Treatment of the "whole" patient (patient-focused model)
Multidisciplinary and integration into an interdisciplinary team	Continuous reassessment and change of objectives if necessary
Curative treatment and symptom-based palliation are not mutually exclusive	Symptom management
Early education, effective communication, and mutual understanding	Caring for the caretaker is essential
Early establishment of patient's wishes, feelings, and goals of care	Palliative care extends beyond death and includes the bereavement process

Jerant et al. acknowledged that PC must be individualized to unique patient populations, especially in assisted living situations [12]. They examined barriers to PC in the older age patient and proposed a model to overcome them. This "TLC" model consisting of timing, teamwork, longitudinal care, collaborative, and comprehensive care was shown to improve palliative care interventions. PC is caring for the critically ill patient with advanced/terminal disease and their care unit with an "interdisciplinary" team whose primary objective is to increase QoL and decrease pain and suffering.

The graphs in Fig. 30.1 represent PC implementation models to help understand the PC team's interrelationship with other disciplines. The first model is a dated and ineffective way to use PC, albeit the most common interpretation by the public and non-PC providers. The key to effective PC is early involvement with patient and family as well as early integration and formation of the interdisciplinary care team.

The above points give credence to the effective, proper use of PC models as are summarized in Fig. 30.1b, c. As discussed, early coordinated involvement is critical to effective PC and decision-making. Curative treatment and palliative treatment (both medical and surgical) should be carried out simultaneously and in parallel. The situation is dynamic. Constant reassessment, education, communication, and changing care goals to meet the situation are required within the patient's clinical course and personal choices. The balance of treatment aimed at disease (curative) versus symptoms (palliative) as well as supportive care will vary according to time, place, and individualization of the patient's situation. Services offered can be surgical, medical, and nonmedical. They are aimed at curative treatment when appropriate and always strive to decrease pain and suffering and increase QoL. With the integration of palliative care, transition to different phases of care will be smoother with early and effective implementation as shown when these models are used.

Shared decision-making is a vitally important PC principle as it centers on the patient, promotes interaction, and offers a degree of control over life to the patient and family. The PC team assists in decision-making and should be involved in end of life or de-escalation of care scenarios, fitting with the second PC implementation model. These situations are dynamic and patients and families frequently do change their minds, and early PC involvement will help everyone get a better end result of increasing the patient's QoL and decreasing pain and suffering and to clarify goals of care and expectations for treatment and prognosis. SPC necessitates the formation of an interdisciplinary care team in order to provide the highest level of care. Formation, acceptance, and integration of an interdisciplinary team will require major changes in work flow from the current practice for many.

Surgical Palliative Care (SPC): The Concept of SPC as a Paradox Is a Potentially Harmful Misconception

> Before undertaking surgery, the surgeon should consider the whole man, his life, history, habits, constitutional idiosyncrasies, previous ailments, interactions of his mind, embed and body.
> John Hunter (Father of Modern Surgery)

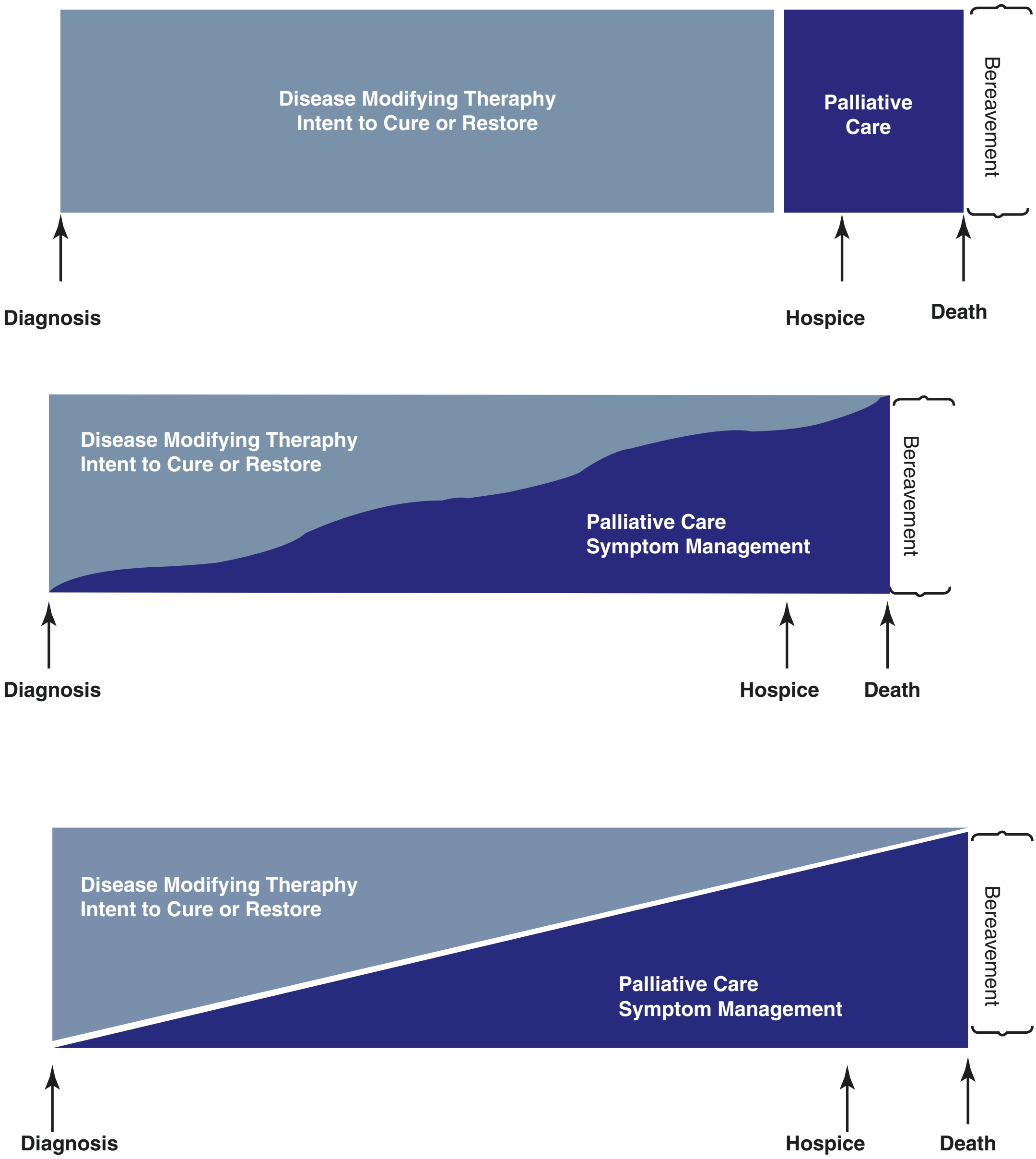

Fig. 30.1 (**a**–**c**) Diagrams of models of palliative care – demonstrating correct and improper use

Surgical Palliative Care

SPC is PC applied to the advanced, seriously ill, or terminal surgical patient, while palliative surgery is surgery performed to ameliorate symptoms without hope for curing pathology and is part of SPC. SPC has not been adopted widely or easily due to many current barriers impeding a surgeon's acceptance and implementation of SPC into their arsenal of overall patient care.

Barriers to SPC

SPC is not paradoxical, but is a valuable treatment option and potential supportive tool for

Table 30.2 Barriers to surgical palliative care

Surgical culture
Surgical personality and training
Definitions of success and failure
Working with an interdisciplinary care team
Understanding of surgical ethics
Psychology of the surgeon – patient relationship
Miscommunication
Misunderstanding of palliative care
Paucity of research and corresponding high-level evidence
Uncertainty of prognosis, clinical and personal situation
Disease-based approach often given bigger role than patient-based factors and model

the surgeon (Table 30.2). The second PC implementation model demands that surgeons play a major role on the interdisciplinary team and permit the potential benefits of PC into their practice. These GSP clinical situations are complicated and fluid, so attempting to manage everything alone as a solo surgeon can lead to the consequences of acting as a "misguided hero". This may be grave and harmful to patient and surgeon.

The Historical Perspective of SPC: Return to a Surgical Tradition

Historically, palliative surgery was ubiquitous across surgical disciplines since surgery's modern foundation and their early teachings reveal incredible PC foresight and compassion for the patient's overall well-being as they recognized the importance of a patient's QoL [13]. PS examples include Billroth performing a gastrectomy to relieve a patient of a horrible QoL with intractable vomiting, decreased nutrition, and an inability to eat [14]. Cardiothoracic surgery's simple incision through stenotic heart valves to relieve severe congestive heart failure symptoms is another [15]. Neurosurgical PS interventions include cordotomy for providing pain relief in a terminal patient [16].

It is important to reflect that Balfour Mount, a urologist, is credited with establishing the term palliative care in the early 1970s. His early writings described the principles of PC as we know them today [17]. Mount was extremely concerned and disheartened with surgery's narrow-minded focus on surgical procedures and disease. He rejected this purely patho-centric model of care and stressed the need for one that combined disease-based factors with patient factors especially QoL and patient well-being. He believed that surgical and disease-based variables alone disregarded the most important element of total surgical care, the patient. He challenged the notion of outcome measures of survival and short-term morbidity as the only goals of surgical care. The reassessment of more important outcomes such as QoL and leading a good life devoid of, or with minimal, pain and suffering are prescient and on the mark. Mount's challenge to his colleagues and higher level of thinking is where we must take surgical decision-making.

We must be compelled to stress the wonders of surgery in the larger context of patient well-being, function, comfort, and QoL. The surgeon must be engaged in all phases of care and administer effective communication to all involved in the surgical decision-making process. The surgeon's role is to guide treatment recommendations and support the patient and family. This is "true" courage and a surgeon's purest, most noble destiny. Why SPC has not been more fully accepted into our culture as surgeons and in practice is concerning. The time is long overdue. We must be honest, accept the need for improvement, and take measures to do so.

Surgical Palliative Care "Areas for Improvement"

Surgical Culture: The Surgical Personality

What is a surgical personality and does it affect one's ability to incorporate PC into surgery and a surgical decision-making framework? The "surgical personality" is a hardworking, self-critical, strong minded, independent, decisive, action oriented, hands on individual with an absolute obsession on achieving positive results. This personality is stereotypical because these traits that attract people to become surgeons are the required characteristics in order to successfully endure the rigorous training and become competent surgeons [18]. However, these same necessary "survival" traits are not conducive to fitting in and working in a PC setting. Uncertainty runs rampant in surgical decision-making in relation to SPC in older adults with serious surgical illness. Uncertainty of prognosis, intricate personal and family dynamics, highly charged emotional situations, decreased function, frailty, dependence on others, and complex psychological issues are just some of the many challenges in SPC. For surgeons, perceived loss of control of "our patient," unwillingness or reluctance to accept other colleagues' opinions, and intense feelings also make it difficult to reconcile, but surgeons must undergo introspection and change if they want the best outcome for their patients.

Surgical Training and Defining Success and Failure

Surgical training reinforces and even selects for the surgical personality. There is very little praise in training, but plenty of criticism and failure is defined by death, and complications are questioned and taken personally. What went wrong? What did you do? These frequent questions after failure may illicit many strong emotions including guilt, self-blame, self-loathing, shame, and sadness. Surgeons are deeply affected by what surgical culture defines as success and failure, so it is critical to make a reassessment of outcomes and what our perception of success and failure are. In SPC, success can be a death, as long as the patient's goals and wishes were achieved and followed, respectively. Palliation can be a success by supporting your patient, so they may live the best life they can as defined by them until the end. A patient centric model of living life with quality until the end is as much of a success as curative treatment. The reality of incurable disease, unrealistic expectations, and death often bring to light our limitations and are seen as failure.

The Psychology of the Surgeon: Patient Relationship

The geriatric patient confronting serious surgical illness often views the surgeon as a hero and savior, and a rescue is expected, even when impossible. We can give our all to care for our patients even when there is no cure or surgical treatment but must not permit the hero/savior physician expectation to cause the surgeon to feel a sense of failure or frustration at not being able to cure or fix the patient because providing PC is frequently the best possible outcome [19]. When the surgeon feels like they have nothing to offer, this may be the time they actually have the most to offer their patient at his or her most difficult phase of life. Be there, show interest, listen, talk, support, be compassionate, and show presence. This may be the most valuable gift we have. We have ourselves. To offer ourselves is the ultimate gift to our patient even if there are no associated RVUs or CPT codes. We must learn to laugh and cry with our patients. Each patient and family will react differently. There is no right answer other than patient individualization.

The psychological phenomenon of transference may be experienced by the patient after clinical deterioration or bad news. A recent systematic review by Srinivasa et al. showed that patient complications effect surgeon personal and professional well-being and identified four main themes to these occupational hazards. (1) surgeons have feelings of anxiety, guilt, shame, and others that interfere with their personal and professional lives, (2) surgeons lack coping strategies and can turn to substance abuse, (3) talking with trusted colleges is seen as weakness, and (4) these complications affect future practice [20].

A Distinct Surgical Ethics

Ethics are foundational and play a daily major role in every SPC interaction. Patient autonomy and capacity are particularly emphasized given the prevalence and significance of control and dependence issues. Issues of surrogacy including advance directives add additional complexity, but indirect surrogate decision-making should reflect what the patient would want given the totality of the circumstances. Strained patient family dynamics may also be a confounder due to complex relationships and differing opinions. Finally, human bias, including the surgeon's, may factor into the situation, but surgeons must educate and communicate effectively with surrogates so as to do what the patient would likely want. The interdisciplinary team must support and help navigate this complex dynamic.

Dr. Miles Little proposed a distinctly surgical ethics that overlaps with the goals of SPC and combines within the broader medical ethics [21]. He describes five distinct ethical principles of surgery within the surgeon patient relationship: First, rescue, the surgeon attempts to cure and save the patient and, if successful, is comfortable. Second, proximity requires self-awareness and is critical to understand how intimate and sacred the patient-surgeon bond is, and SPC must account for this. The ethical principles of ordeal and aftermath are the third and fourth principles where the surgeon must be present and guide the patient after the realization of the enormous physical and mental toll surgery has taken on them. Finally, presence is the fifth and final ethical principle. It is the only principle experienced solely by the surgeon and consists of being there for the patient in mind, body, and soul regardless of the clinical or personal course. Surgeons must never abandon their patient, and distancing behavior must be avoided [22]. Surgeons must always be present to support and demonstrate compassion, and the effect on family members, caregivers, and caretakers alike cannot be overstated. The serious consequences this experience may have on caregivers need further inquiry [23].

Surgical Palliative Care Summary

Traditional surgical culture focuses on disease-specific or surgical outcomes, and their communication to patients is easy. Although challenging, we must explore our own personalities, training, psychology, ethics, and overall surgical culture. Our self-awareness will guide us through the SPC decision process which is complex, dynamic, and high-stakes emotionally and physically. We must help the patient care unit make the best decision possible within the context of the individual patient situation and using all the information we have available.

Surgical Palliative Care Decision-Making: A Paradigm and Framework to Improve Care

Introduction: SPC Decision-Making

Figure 30.2 depicts the framework of SPC surgical decision-making that can be used as an adjunct to assist the entire interdisciplinary team, not to solve the complicated clinical scenarios by following an algorithm, but should be included in the assessment of all patients to foster a cognizance of the possibility of SPC for all geriatric surgical patients. Methods to foster and improve integration of PC into surgical and trauma ICUs must be thought of at each decision point with the individual well-being as the shared objective of all and the center [24]. Within this context for decision-making, the timing and physical location of the patient are critical factors. The patient's physical location (nursing home, skilled nursing facility, etc.) and the acuity of the surgical decision-making are critical as well with regard to an emergent situation or an outpatient elective procedure being considered.

The Surgical Palliative Care Decision Points

The first and most important decision point is (Decision 1 – Fig. 30.2) whether or not to initially involve a SPC team with older ill patients. Uncertainty of prognosis, complex family dynamics, lack of understanding, complex decision-making, decreased capacity, and many other factors often make SPC involvement a necessity to best care, even when many surgeons may feel initially that formal SPC interdisciplinary care teams may be unwarranted because they

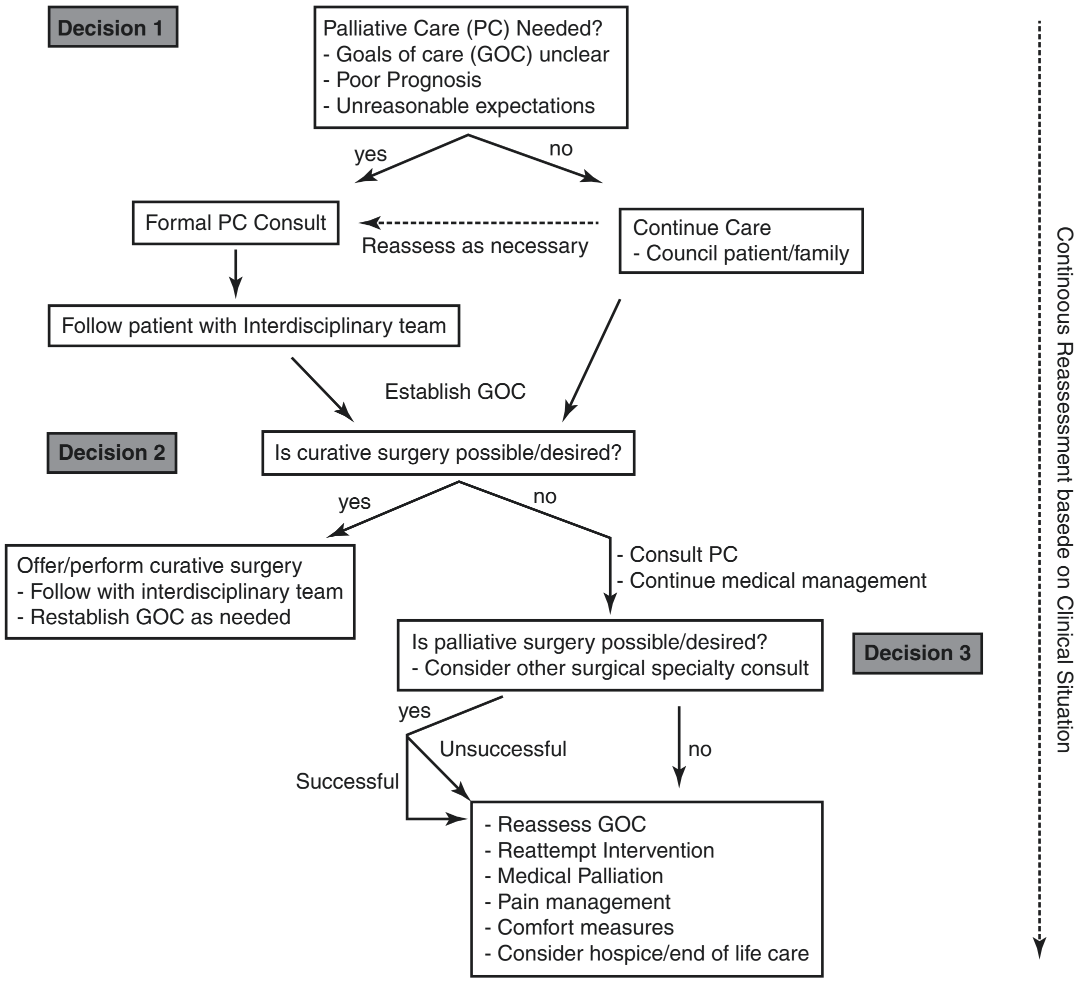

Fig. 30.2 SPC decision-making

can handle it themselves. SPC initiation does not have any requisite criteria for initiation although SPC guidelines for triggers to SPC involvement, as a means of increasing utilization and improving care, have been proposed [25]. Others have proposed protocols to accomplish essential SPC goals at reasonable time intervals [26, 27]. However, earlier is better so as to avoid the older implementation model of only engaging SPC after a decision has been made to not pursue further aggressive measures.

Decision 2 of Fig. 30.2 is whether curative surgery is the correct option for the individual patient. Traditionally, SPC is initiated when the decision "no" has been selected, but this is too late for optimal SPC utilization. Even if curative surgery is pursued, palliative treatments and support can also continue in parallel. Palliative surgery (decision 3) must account for not only the risk benefit discussion but also must factor preoperative optimization for what are typically very sick patients. The interdisciplinary care team is critical at all of the points in Fig. 30.2, and establishing the GOC is crucial, and GOC are readjusted to focus on QoL and relief of pain and suffering. Decisions concerning disposition and social factors are critical and must be discussed thoroughly as a change in settings can be disruptive and patients must feel in control and not abandoned.

Following Decision 3 of the SPC model is the critical decision to transition to end of life (EOL) care. The physician must effectively communicate the reasons for the transition and the process of EOL care while respecting the patient and family wishes. It should be a shared decision giving the care unit a role and sense of control of the situation. EOL goals of care must be established, support provided, and symptom management made a priority [28]. After death, the bereavement phase must be acknowledged and all affected cared for.

In summary, palliation has historically been part of a surgeon's job description and has been a major American College of Surgeons (ACS) educational goal for residency programs. Many educational initiatives have addressed this area from, "The Workforce on Palliative Care in Surgery," the creation of a Resident's Handbook in Surgical Palliative Care to ongoing educational and research conferences and workshops. The ACS has established PC guidelines [25]. Surgeons must lead by building on this strong foundation to restore the surgical tradition of palliation and SPC [19]. The educational component for SPC must be a priority, and it must focus on teaching that which can prove elusive to many brilliant technical physicians but is vital in SPC: the art of communication. There are models and aids to assist in cultivating this skill. "Breaking of Bad News" and EOL discussions are true tests of the ability of a surgeon to communicate an understanding of SPC and decision-making. Aids like the SPIKES Model give us guidance and structure to such difficult conversations [29], but it must be formally studied for trainees to learn it [30].

Models and Quantitative Tools to Aid in Decision-Making

As outlined elsewhere in this book, there is an emerging area of research across surgery into the effect of frailty, i.e., a reduced physiologic reserve, on surgical outcomes. Intuitively, we all know that the more comorbidities a patient has, the worse they are likely to do the more invasive and longer a procedure is. However, measures of frailty actually quantify this effect, and, as one might expect, frailty has the potential to better predict outcomes and augment more traditional scoring systems for the prediction of morbidity and mortality.

Based on large datasets, over 150 different measures of frailty have been developed; however the most commonly used is the modified frailty index (mFI) [31]. The mFI is a set of 11 comorbidities that are each assigned 1 point if present and include history of functional dependence, impaired sensorium, diabetes, hypertension on medication, chronic or acute lung disease, myocardial infarction, congestive heart failure, angina/prior cardiac surgery/percutaneous cardiac intervention, transient ischemic attacks, cardiovascular accidents or stroke with neurologic deficits, and peripheral vascular disease/rest pain. Across several surgical disciplines, a high mFI has been associated with increased risk for death, complications, and other morbidities [32, 33]. However, given that this is a relatively new field of study, it is still unclear which index best applies to a given situation. For example, Ondeck et al. showed that age and American society of anesthesiologists (ASA) scale better predicted adverse outcomes following hip arthroplasty compared to the mFI and Charlson comorbidity index (CCI) [34], while conversely this same group found that the CCI best predicted outcomes following spinal tumor surgery [35]. Conversely, Bateni et al. showed that the ASA, mFI, and CCI have limited predictive value for stage 4 cancer patients with bowel obstruction [36]. Therefore, while measures of frailty have promise to be used in predictive models of outcomes, several obstacles remain: (1) each disease state (with its given intrinsic mortality) may be best predicted by a different frailty index; (2) there are a dearth of prospective studies in this field; (3) for a given disease, outcomes may be best predicted by some other non-frailty variable; however, more disease-specific study is needed; and (4) frailty indices have been validated for standardized endpoints such as mortality and postoperative complications; however, it is unclear whether they predict other endpoints such as long-term outcomes, discharge home, or other QoL measures.

As alluded to above, the study of surgical outcomes frequently focuses on in-hospital complications and mortality; however it fails to identify other areas that matter to patient well-being. Traditional scoring systems such as the SOFA, APACHE, and intracranial hemorrhage score have all been developed to predict in-hospital outcomes especially mortality. The ethical issue with improving in-hospital survival at whatever cost is that it leaves the possibility that we will be discharging patients to a fate that is worse than death. One example of this is the decompressive craniectomy (DC) trials for malignant MCA infarction in elderly patients which showed that DC saved lives, but at the cost of creating significantly more extremely disabled elderly patients [37]. As a result, patients deserve the information to provide informed consent to our interventions including the quantitative risk of never being able to function in society again or the inability to participate in the activities they care about most, particularly relevant in the geriatric population, who have fewer years of life left and tend to be less interested in permanent significant disability than younger patients. Additionally, clinicians have a poor ability to predict short-term mortality and are frequently overly optimistic about prognosis [38]. The scoring systems discussed above are an attempt to account for a patient's physiologic reserve to better estimate outcomes. Future studies must include long-term outcomes below in order for our patients to truly provide informed consent.

These somewhat overlooked areas of surgical research include patient pain, depression, discharge location (home, nursing home, rehab), and long-term measures of QoL. For example, a recent systematic review found no randomized trials investigating QoL following cardiac surgery among the elderly but did show, in lower-quality studies, that QoL decreases among 8–19% of patients following cardiac surgery [39]. While this is only one example, it highlights the need for more study on endpoints that matter to patients such as the ability to return to work, pain, reintegration with society, and feeling like a burden on their families. One of the reasons these endpoints are underresearched is that it is logistically difficult to objectively measure them. Pain, for example, is fluid and changes by the day, thus making it difficult to reliably quantify. Another reason these endpoints are understudied is that we are not evaluated on them. Hospitals and physicians are heavily scrutinized for their mortality and complication rate; however long-term QoL measures are often overlooked as a quality measure.

While a somewhat abstract concept, measuring QoL is an important endpoint that should be used more frequently in surgical research. Common measures of health-related QoL is the Short Form 12 (SF-12) and Short Form 36 (SF-36) which ask questions regarding pain and whether health (including emotional health) interfered with working, socializing, accomplishments, etc. The major drawback to this type of scoring system is that the patient must be cognitively present and able to complete the survey in order for it to be useful, and thus it may be less accurate among nursing home residents [40]. Another common approximation of patient QoL is the mini-mental status exam (MMSE), which can be useful to predict postoperative complications. For example, the MMSE have been shown to predict postoperative delirium and long-term cognition following cardiac surgery [41]. Other scoring systems designed for the PC practitioner have also been developed to predict short-term mortality among terminal patients. One of the most common, the Palliative Prognostic Index (PPI) includes variables such as oral intake, edema, dyspnea at rest, delirium, and the palliative performance scale. A PPI >4 is associated with a predicted lifespan shorter than 6 weeks [42, 43]. While these tools help to predict short-term survival, they are limited in their long-term predictive value, thus making their use as predictors of long-term patient-centric outcomes limited.

In summary, while several systems for approximating frailty and predicting outcomes exist, their widespread implementation into preoperative decision algorithms is dependent on validation for each disease state and determination of their predictive value for non-traditional endpoints such as QoL, return to work, and pain. These endpoints are what patients care most about and should be included in future studies examining long-term outcomes of our interventions. However, as noted, prospective collection of these endpoints is difficult to obtain and difficult to use in research. Consequently, they have been largely ignored in favor of measuring mortality. As a result, mortality is the most frequently studied endpoint in SPC [7, 44]. The goal of future research should be to determine an objective measure of long-term outcomes that could be used to establish goals of care including the decision to operate. Therefore, as a means of providing information for informed consent, we have an ethical obligation to study these endpoints and develop objective tools to predict them.

Surgical Palliative Care Research and Ways to Improve the Evidence: Where Things Stand Today

The American College of Surgeons in 2003 identified seven key areas for the research and implementation of palliative care in surgery (Table 30.3). An excellent systematic review by Lilley et al. examined the state of the research in achieving these goals in surgical palliative care. They found only 25 suitable articles in the field of surgical palliative care have been published and only 9 of which are randomized clinical trials [7]. For purposes of brevity, we will only focus on surgical decision-making; however we encourage the reader to examine the Lilley article for more information.

Of the three studies that have investigated SPC and surgical decision-making, two by Miner et al. examined the role for palliative surgery among advanced cancer patients. First, in 2004, they showed that palliative procedures (including for obstruction, neurologic symptoms, pain, dyspnea, and jaundice) provided symptom improvement or resolution in 80% in 30 days. The median survival was 194 days from surgery; however the procedures were associated with 29% morbidity and 11% mortality within 30 days [45]. In 2011, they went on to describe how the palliative triangle of patient symptoms, values, and GOC can be used to carefully select patients for palliative surgery. Using this triangle they showed a 91% symptom improvement or resolution, lower postoperative morbidity (20%) and mortality (4%), and prolonged survival to 212 days, on average [46]. Similarly, Tan et al. showed that among patients undergoing colorectal surgery, those managed by a dedicated geriatric surgical team focusing on preoperative evaluation/rehabilitation and functional recovery had a high rate of return to functional status postoperatively [47].

Table 30.3 7 Domains of surgical palliative care

Surgical decision-making (disease/procedure focused)
Patient decision-making (patient focused)
End-of-life decision-making (recognition and the process)
Symptom management
Communication
Process of care
Surgical education

Research on surgical decision-making among elderly patients is lacking. This is true for both palliative and curative surgery. At a minimum, surgeons should incorporate GOC discussions into all conversations with patients and their families pre- and postoperatively. The research outlined above is a start; however there is a tremendous paucity of work in this field. Specifically, there is a need for surgical decision algorithms that incorporate palliative care concepts and predict mortality, QoL, and patient factors.

Gaps in knowledge must focus on patient function and QoL measures as well as effects on caregivers. Recent studies have emphasized that caregivers are subject to long-term effects of a loved one being hospitalized including post-traumatic stress disorder and lower QoL that can extend for over a year after hospitalization [48, 49]. Physicians have a role in preventing some of these adverse effects through counseling and providing family-centered counseling, which may even reduce ICU length of stay [50]. In summary, we must ask the right questions that will help us and our patients arrive at the best decision for the patient in the broad context of the entirety of their situation. Of major relevance, the effects on the caregiver's well-being are often overlooked, and future research is needed to establish ways of better caring for the caregiver and incorporating their opinions into the decision-making process.

Our approach to methodology along with studying the pertinent outcome measures and questions is key. The longitudinal nature of older patient's care can cross many care settings and physicians and can include the opinions and biases of multiple caretakers. Collecting data is difficult due to the patient's inability to participate in feedback secondary to decreased cognitive or overall function, frailty, loss to follow-up, distorted, missing data, and even death. Alternate means of gaining data may be needed including behavioral observation or data obtained by proxies given that randomized control trials are difficult in this setting [51, 52].

SPC decisions are of great complexity. Decision science examines all techniques and issues of such a decision-making process. Collaboration with PC as evidence grows may help ensure the decisions are made in the context of patient and family desires [53]. Best evidence and a structured decision process which requires study is needed to ensure that all relevant, critical SPC issues are addressed and help enable patients and families to be informed so as to make the best decision in accordance with the patient's wishes and values.

Conclusion

> Cure some, Treat often, Comfort all.
> Hippocrates

Through the lens of the surgical geriatric patient with serious illness, we examined barriers, proposed aids, and solutions, demonstrated a basis for these tools and where future inquiry can optimize SPC. SPC deserves its place in the field of surgery. In the end, it is about us and our patients. It is both that simple and complex. Peace for our seriously ill geriatric surgical patients can be achieved with dignity and humanity. A focus on the patient, their QoL, wishes, and "entirety" as people is necessary and of great importance to this "success." Achieving acceptable QoL, patient well-being, and dying devoid of pain and suffering is the means to this peace for patient, family, and surgeon. We must acknowledge we are human with all that entails: weakness, strength, fear, courage, and hope. It is our job to do the best we can with the objective data available and, most importantly, incorporate it into a patient-centric, interdisciplinary, and comprehensive model of care. We must give our geriatric surgical patients with serious and advanced disease the best life possible and an acceptable QoL as defined by the patient to the very end. A prolonged death filled with angst, pain, and suffering of the physical, emotional, and spiritual type must be accepted as wrong, harmful, and, ultimately, eradicated. While daunting, this will truly make us the heroes our patients often see us as. This chapter is meant to inspire and support surgeons in the pursuit of this most humanistic and pure form of care. The time for this paradigm shift in surgical culture is now. Good luck to all.

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31 Family Involvement: What Does a Loved One Want at the End of Life?

Patrice L. Anderson

EVERYONE dies. Death is not an inherent failure………… The vital goal almost all people want from medicine is not having a good death but having as good a life as possible all the way to the very end.

Atul Gawande [1].

Everyone dies, and one of the hardest things anyone may ever have to do is to make end-of-life decisions for someone they care about. If a patient is incapacitated and no longer able to decide for themselves, others must decide for them. Sometimes patients specify future healthcare desires in legal documents. However, without documentation physicians must often rely on surrogates. As our population gets older, end-of-life care has become one of the most prevalent and important issues in healthcare. This chapter will explore how end-of-life decisions are made, who should be making them, and how the healthcare team can support patients and family members through the end-of-life process?

P. L. Anderson (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center, Valhalla, NY, USA
e-mail: PatriceLynn.Anderson@wmchealth.org

How End-of-Life Care Decisions Are Made and Who Should Make Them

When a patient is no longer able to speak for themselves, others must decide for them. This daunting task is much easier if there is written documentation as to the patient's wishes. The Patient Self-Determination Act encourages all patients to make and document choices about the types and extent of medical care they would like to accept or refuse should they become unable to make these decisions in the future due to illness [1]. This federal law went into effect December 1991, and it requires hospitals, nursing homes, and hospices to advise patients about their right to accept or refuse medical/surgical care and to execute an advanced directive [1].

Written Guidance

Advanced directives enable both physicians and patient's loved ones to make educated, informed decisions about a patient's healthcare when a patient does not have decision-making capacity, and they make provisions for

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healthcare decisions in the future. These are fluid documents that can be changed and adjusted by the patient, as his/her medical circumstances and goals of care change [2]. As an extension of patient autonomy and self-determination, these legal documents allow a patient to detail their medical wishes, values, and preferences about end-of-life care. The two main types of advanced directives are the living will and the durable power of attorney for healthcare.

A *living will* is a document wherein a patient provides goals of care and treatment preferences to guide future healthcare decision-making [3]. Here a patient may clearly specify which procedures they would want if they were unable to voice an opinion. *A durable power of attorney for healthcare* is a document that assigns a healthcare proxy who is someone to make medical decisions for a patient when they are incapacitated. A durable power of attorney can also be referred to as a representative, an agent, or a proxy. This is usually someone the patient trusts will act in accordance with their values and wishes.

Many states have their own advanced directive forms.

Though not an advanced directive, the National Physician's Orders For Life-Sustaining Treatment (POLST) Paradigm is another way for patients to establish their end-of-life wishes. A POLST form has a set of specific medical orders that a seriously ill patient can fill in and have their physician sign. This form addresses wishes in an emergency such as cardiopulmonary resuscitation and intubation. This form is most appropriately used by patients who are likely to have a predictable medical crisis based on a terminal diagnosis. Per the POLST.org website: "The POLST decision–making process and resulting medical orders are intended for patients who are considered to be at risk of a life–threatening clinical event because they have a serious, life–limiting medical condition, which may include advanced frailty" [4]. Emergency personnel, like EMTs and paramedics, are unable to use advanced directives to guide their care. They are required to provide every possible treatment to keep a patient alive and transport them to the emergency room. However, emergency personnel can follow a POLST form because once this form is signed by a physician, it is a medical order.

Table 31.1 The POLST Paradigm varies by state

POLST (Physician Orders for Life-Sustaining Treatment)
POST (Physician Orders for Scope of Treatment)
MOLST (Medical Orders for Life-Sustaining Treatment)
MOST (Medical Orders for Scope of Treatment)
TPOPP (Transportable Physician Orders for Patient Preference)
COLST (Clinician Order for Life Sustaining Treatment)
DMOST (Delaware Medical Orders for Scope of Treatment)
IPOST (Iowa Physician Orders for Scope of Treatment)
TOPP (Transportable Orders for Patient Preferences)
AzPOLST (Arizona Provider Orders for Life-Sustaining Treatment
LaPOST (Louisiana Physician Orders for Scope of Treatment)
OkPOLST (Oklahoma Physician Orders for Life-Sustaining Treatment)
PAPOLST (Pennsylvania Orders for Life-Sustaining Treatment)
WyoPOLST (Wyoming Providers Orders for Life-Sustaining Treatment)
SAPO (State Authorized Portable Orders)
SMOST (Summary of Physician Orders for Scope of Treatment)

The POLST program, or similar programs which go by different names, can be found at the POLST.org website. This paradigm exists at some level in 50 states. The POLST Paradigm is known by different names in different states (Table 31.1).

When There Is No Written or Direct Verbal Guidance: Surrogacy

Default surrogate consent statues, available in the majority of states, allow physicians to consult either a designated individual or a group of individuals who will be tasked with making medical decisions for patients who are unable to do so for themselves [5, 6]. Surrogate laws were developed to help protect the wishes of incapacitated patients that have no advanced directives. Most states have developed a hierarchy model, or priority list, indicating which immediate family members may serve as a surrogate, for example, (1) a spouse (unless legally separated), (2) an adult child, (3) a parent, and (4) an adult sibling.

Many states have broadened the definition of a surrogate to include nonfamily members incorporating friends and domestic partners [5–7]. Additionally, some states have developed a mechanism for "unbefriended" patients. These are patients whose identity is unknown or patients who have no one to speak for them. In this situation, physicians, often in conjunction with ethics committees or other physicians, make end-of-life decisions, incorporating their medical knowledge and the best interests standard [6, 7]. If making life-ending decisions is too difficult and overwhelming for a loved one, they have the option of completely deferring decision-making to the treating physician or team. Most families, however, decide to use a consensus model. This style of decision-making is a collaborative process among family surrogates and multiple members of the patient's treatment team, each of whom has a different insight on how to best honor a patient's goals of life [6].

Several different approaches to surrogacy decision-making at the end of life have been proposed. One is called *substituted judgment* [6, 8, 9]. In this method, a surrogate is asked to put him- or herself in the place of the patient and to decide as if they are that person, to extrapolate from the patient's known personal values, and to think like the patient would think. The surrogate is often encouraged to pull from previous discussions with the patient and to act as an informant as to the patient's wishes without relying on their own personal preferences. This can be difficult as there is often discordance between what a patient would want and what their surrogate would do. A systematic review by Shalowitz and colleagues evaluated 40 years of research on surrogate decision-making. They identified 16 studies that examined 151 hypothetical scenarios. Their goal was to assess how accurately surrogates were able to predict a patient's treatment choice. They concluded that both the patient designated and default surrogates predicted the patient's treatment preferences with only 68% accuracy [9]. This discrepancy may stem from the fact that surrogates are unable to remove themselves completely from the situation and the decisions surrogates make are not substantially different than those they would have made for themselves. Another reason surrogates may not adequately represent a patient's treatment preference is because these preferences are fluid and change. As a patient's health status changes, so too do their priorities and wishes with regard to life-sustaining treatment over time [10, 11].

Questions we can ask that may help surrogates make the best decision possible are depicted in Table 31.2 [8]. Substituted judgment supports a patient's autonomy, but it may also help the surrogate psychologically. Families feel a significant burden when making life and death decisions for a loved one. Emphasizing substituted judgment may alleviate some of this by framing the decision based on what the patient would want rather than what the surrogate would want to do.

A second approach to surrogacy decision-making is the *best interests standard*. In this case healthcare management decisions are made in accordance with societal norms and beliefs about what is best for a dying patient [6, 8, 12]. This approach is designed to incorporate a patient's quality of life based on what most people would want.

Table 31.2 Questions that may help surrogates make end-of-life decisions

Has the patient ever spoken about what they want at the end of their life?
Has the patient expressed an opinion about how someone else has been treated that could be used to extrapolate in the situation?
What have been the patient's values in life?
What has given their life meaning?
Would the patient want the most days of life, or would the patient want fewer days with a better quality of life?

Framing the End-of-Life Discussion

Often, family members or surrogates are overwhelmed with choices when a loved one nears the end of their life and the patient can no longer speak for themselves. The concepts and terminology with which they must grapple are often new, confusing, and frightening. This can be a time of incomparable sadness and unparalleled stress that has the potential to affect family members long after the patient dies. The decision-making burden can be profound. The hope to improve the experience of a dying patient and their family has become a widespread, international resolve. The number of publications over the last 50 years on "end-of-life care" has gone up exponentially (Fig. 31.1) as have the available resources for patients, families, and medical personnel (Table 31.3).

The framing of end-of-life discussions, the terminology used, the compassion shown, and the explanations provided can have an enormous effect on improving the experience of death for the surrogates, the family, the friends, and ultimately the patient. Family members often struggle with the subtle differences between aggressive treatment, stopping curative therapy, do not resuscitate (DNR), withholding life sustaining treatment, no escalation of care, withdraw of care, and comfort measures. This is an area where the medical community can substantially decrease the burden felt by families after someone dies if they allow families to voice their concerns and work through the stumbling blocks with them.

What Does "Do Everything" Really Mean?

When faced with a loved one actively dying, family members often request that physicians to "do

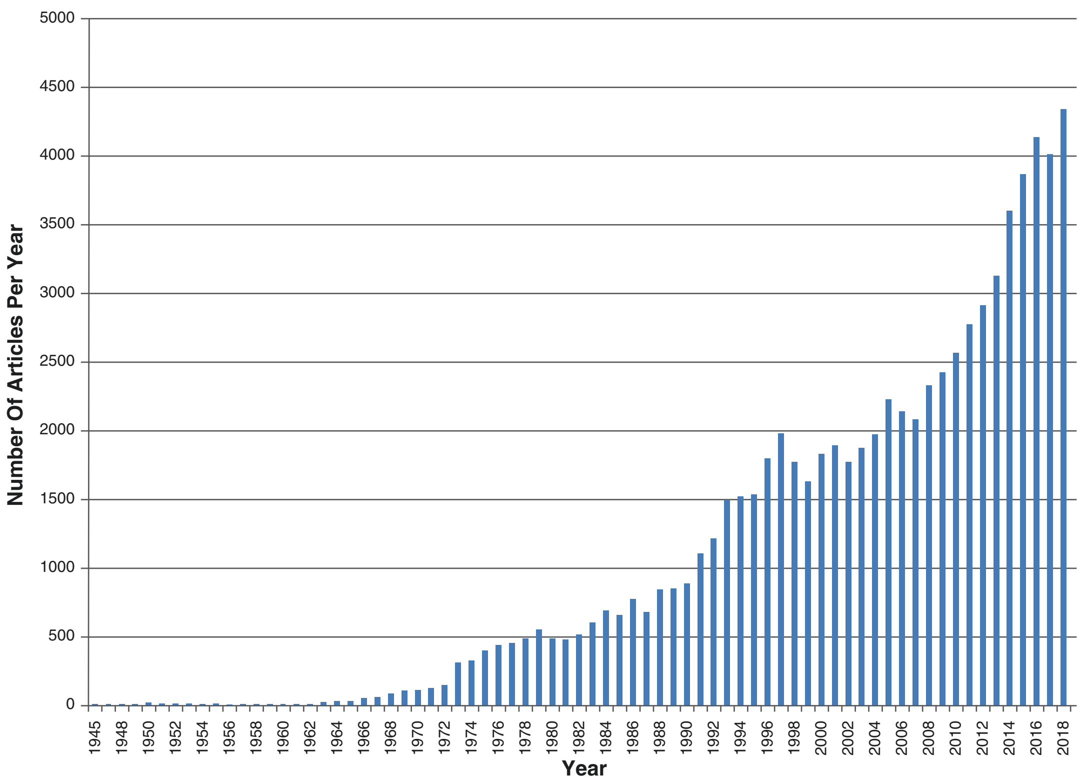

Fig. 31.1 Number of articles on "end-of-life care" published per year on PubMed since 1945

Table 31.3 Some of the end-of-life care resources available for patients, families, and physicians

American Society of Clinical Oncology
National Palliative Care Research Center
Promoting Excellence and End-of-Life Care
End-of-Life Nursing Education Consortium
AMDA Foundation
Association for Death Education and Counseling
Center to Advance Palliative Care
The Education on Palliative and End-of-Life Care Project
Aging, Health And Healing
National POLST Paradigm
The Coalition to Transform Advanced Care
Supportive Care Matters
What Matters Now
CancerSource
Aging With Dignity
Cancer Resources
Journey of Hearts: A Healing Placed in Cyberspace
US Living Will Registry
Veterans Guide to Long-Term Care
National Association of Social Workers
Hospice And Palliative Nurse Association
Hospice Foundation of America
American Academy of Hospice And Palliative Medicine
National Coalition for Cancer Survivorship
National Family Caregivers Association
MyDirectives
Gift From Within – PTSD Resources for Survivors And Caregivers
American Medical Association – Education for Physicians on End-of-Life Care Project
Open Society Institute – Project on Death in America
Robert Wood Johnson Foundation – Last Rites Campaign

everything." This stems from a deep-seated need to feel like they have done everything possible to help their loved ones. As healthcare professionals, it is our responsibility to reframe this request and focus end-of-life discussions on advocating for what is ultimately in accordance with what the patient would want instead of just doing everything. The medical equivalent of doing everything is a full code. These extraordinary measures are meant for critically ill patients as a temporizing measure for the body to have time to regain normal function. Full codes are not intended to be used for someone who is dying and will never regain a good quality of life. Coding these patients may only delay the inevitable and the patient will still die. In fact, this has the potential of increasing the patient's and the family's suffering without changing the outcome. It is imperative that we help the families understand the balance between the burden of treatment and the benefits to the patient's quality of life, not their quantity of life [13].

Stopping Aggressive Treatment Is Not the Same as "Doing Nothing"

If there is a "do everything," that implies that there must be a "do nothing." An integral part of end-of-life discussions should include dispelling the misconceived notion that stopping aggressive treatment means to "do nothing". We do not stop caring for the patient. It is the exact opposite. We listen to what the patients want. In 1927, when speaking at the Harvard Medical School, Dr. Peabody summarized this well when he said that "one of the essential qualities of the clinician is interest in humanity, for the secret of the care of the patient is caring for the patient" [14]. Often families need to be reassured that appropriate symptom management will continue in accordance with the patient's wishes even after curative treatment has stopped. Too often, the end of a patient's life can be negatively impacted by interventions meant to cure them.

Withdrawal of Care Is Not the Same as "Killing Someone"

The decision to withhold or withdraw life-saving treatment can be emotionally challenging, and many families equate this to abandonment, "giving up," or "killing someone." If aggressive care is incapable of extending a patient's life in a meaningful way in accordance with the patient's desired quality of life, stopping this type of treatment is appropriate, ethical, and humane. In fact, withdrawing some treatments and shifting the goals of care from cure to comfort allows physicians to concentrate solely on relief of symptoms, and patients often feel better. It is important for physicians to recognize that families go through a process in which they must transition from hoping for a cure to the acceptance that death is imminent. This process can be devastating and hard. Various family members often make this transition at different times and usually after the patient themselves have accepted their death. It is important that as physicians we approach this time with empathy and compassion.

"Allow a Natural Death" (AND) May Seem More Acceptable Than Do Not Resuscitate (DNR)

For a medical professional, a do not resuscitate order is equivalent to allowing a natural death. It means that if a patient's heart stops or they stop breathing, we will not employ extraordinary measures to prolong their life. For some families "do not resuscitate" has a negative connotation because it implies that we are electively not doing something we are capable of doing. Many have postulated that allowing a natural death may seem more compassionate to families, and this could ultimately make this decision easier [15, 16]. In the end, the result for the patient is the same – there will be no extraordinary measures taken to prolong life. For the family, however, allowing death to occur naturally may be easier to accept.

What Is Quality End-of-Life Care, and Is There Such a Thing as a "Good Death"?

When a patient's illness defies treatment and their goals of life can no longer be met, focus must move from cure to comfort. This is when the medical community needs to make every effort to facilitate a "good death" or a dignified death. What does this mean? In 1997 the Institute of Medicine defined a good death as "one that is free from avoidable distress and suffering, for patients, family and caregivers; in general accord with the patient's and family's wishes; and reasonably consistent with clinical, cultural and ethical standards" [17]. "Dying with dignity" has been defined as physical comfort, autonomy, meaningfulness, usefulness, preparedness, and interpersonal connection [18]. For each person their definition of a "good" death is shaped by individual hopes, fears, and beliefs. There is no standard "dignified death" just as there is no standard "good death." It is our role to help families figure out this very personalized definition and honor it.

A recent systematic review identified and critically appraised tools measuring the quality of death and dying [19]. The review highlighted that though there are an abundance of tools available to assess the quality of death and dying, because this is such a personal matter, we may never develop a single measurement tool [19]. Instead of trying to find a tool, concentrating on topics revealed in several studies could help ensure a quality end of life or good death. Themes that are important to patients at the end of life are summarized in Table 31.4 [19–23].

Table 31.4 Themes important to patients at the end of life

The dying process: dying during sleep, quickly, where, when, how
Adequate pain and symptom management: not suffering, dying with no pain, no thirst, no anxiety, calm sleep, no dyspnea
Emotional well-being: emotional support, peace, psychological comfort, whole person well-being
Family: family support, surrounded by loved ones, family acceptance of death, desire not to be a burden on the family, connectedness with loved ones
Dignity: respect as an individual, maintaining independence, autonomy
Life completion: saying goodbye, acceptance of death, preparedness
Religion and spirituality: comfort, faith, clergy support
Treatment preferences: not prolonging life unnecessarily, reassurance that all available life-saving treatments have been exhausted, a sense of control over treatment choices
Quality of life: maintaining pleasure
Relationship with the help care team: trust, support, and comfort from the entire treatment team

Expanding the Overall Treatment Plan to Include Support for Surrogate Decision-Makers

Often surrogates struggle with trying to make an informed decision which adequately reflects their loved one's values, preferences, and end-of-life goals. Making life-sustaining treatment decisions for a loved one can be very traumatic. As our population ages, many of these decisions are now being made in our ICUs. Whether it is a patient-designated healthcare proxy or a default surrogate, a designee may experience psychological and physical stress including anxiety, fear, depression, fatigue, posttraumatic stress symptoms, and "post-intensive care unit syndrome" [24–29]. Patient age, lack of information, and patient illness severity are some of the predictors for psychological and physical distress in family members [24, 30].

Like patient-centered care at the end of life, there is also evidence that family-centered care is of great importance as well [24, 31]. This type of care incorporates the emotional needs of family members into the overall treatment plan of the patient. End-of-life family conferences should be specifically designed to help families work through difficult decisions that need to be made with effective communication, respect, collaboration, and support [32, 33]. These discussions need to start early, and they should include patient's priorities, goals of care, appropriateness of treatment, disease trajectory, and possibility for quality survival. These conversations often include difficult truths and prognostic estimates that may facilitate family decision-making that has the potential to maximize quality of life over quantity. Patient's families need to have the opportunity to discuss what they think the patient may want, to express their grief and sadness, to alleviate their feelings of any guilt, and to understand the ultimate goals of care. To avoid rushed, last-minute, middle of the night decisions, aspects of care that should be addressed during these goal-oriented family meetings should include many aspects of care (Table 31.5) [2].

Table 31.5 Aspects of care that should be addressed during goal-oriented family meetings

Respiratory distress and requirement of a ventilator
Cardiopulmonary resuscitation
What to do with pacemakers/defibrillators
Hemodialysis
Enteral feeding access or parenteral nutrition
Use of antibiotics
Utilization of IV hydration
Life-sustaining medications
Sedation and pain management
DNR/AND orders
Organ tissue donation
POLST and MOLST forms

What Happens If the Medical Staff and the Family Members Disagree on a Treatment Plan

On occasion family members request interventions that a physician may find "futile" or "medically inappropriate." This can be a challenging ethical situation. In 2015 the American Thoracic Society (ATS), the American Association for Critical Care Nurses (AACN), the American College of Chest Physicians (ACCP), the European Society for Intensive Care Medicine (ESICM), and the Society of Critical Care Medicine (SCCM) jointly published a policy on how to respond to requests for potentially inappropriate treatments in intensive care units [34]. This multi-society statement was designed to provide clinicians with tools for managing surrogates of critically ill patients. They emphasized early proactive communication and collaborative decision-making, utilizing "potentially inappropriate" care instead of "futile" care when speaking with family members, and they provided steps for resolution of conflict regarding potentially inappropriate treatments [34].

More recently, in 2019, the American Medical Association Principles of Medical Ethics [3] suggested that the physician:

1. Review the patient's goals of care and desired quality of life with the family.
2. Reassure the family that medically appropriate interventions, specifically symptom management, will be provided.

3. Negotiate a mutually agreed upon plan of care that includes both the physicians clinical judgment and the family's understanding of the patient's wishes.
4. Seek guidance from an ethics committee if the family continues to request treatment that the physician feels is not medically warranted.

It Takes a Village

Providing exceptional care for dying patients takes an extensive treatment team including: physicians, palliative care providers, nursing staff, social work, clergy, and the patient's family. This end-of-life shared decision model strives to find a cohesive consensus between patient autonomy, family needs, and medical opinion.

Conclusion

The reality is that every one of us will die one day. As healthcare providers sometimes all we can do is ensure patient autonomy and fulfill their wishes and those of their loved ones. There are countless technical and scholarly articles about end-of-life care, but perhaps in the end – it is about honoring a dying patient and their family by treating them with openness, respect, compassion, dignity, advocacy, and commitment to the highest quality of care. Even with all we know, and all we can do as medical professionals, this may be where we make the greatest impact on our patients and their loved ones. In the end everyone should get to die how they lived, on their own terms.

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32 Spiritual and Religious Considerations in the Care of the Elderly

Husham Abdelrahman, Mohammad Asim, and Ayman El-Menyar

Religiosity and spirituality are important elements of well-being among the elder population worldwide. Although both are often approached as similar concepts, in reality, they are not identical but have common characteristics. According to the 2000/2001 Gallup polls, nearly two-thirds of elderly US citizens (above 50 years) noted religion as "very important" and attended regularly church or synagogue. This could explain the increasing interest to understand this important and complex aspect of care. Notably elderly people are being reported more religious and spiritual than the younger population. For instance, in the USA >90% of elderly are considered as religious or spiritual, while only 6–10% are atheists. It has been suggested that the well-being, inner peace, personal meaning, belonging and connectedness, and belief in life hereafter would help to guide the actions and are considered important coping factors among the elderly. Moreover, terminal illness would prompt and provoke the religiosity and/or spirituality needs especially upon approaching the end of life [1]. An earlier study interviewed 205 advanced cancer patients about religiousness and spiritual support. Although spiritual support is associated with improved quality of life, such needs were not fulfilled by the religious communities or health-care system [2]. Overall, the majority of elderly patients relied on religion, at least to a moderate degree, in enduring health issues and adverse societal circumstances.

H. Abdelrahman · M. Asim
Department of Surgery, Trauma Surgery, Hamad General Hospital, Doha, Qatar

A. El-Menyar (✉)
Department of Surgery, Trauma Surgery, Hamad General Hospital, Doha, Qatar

Clinical Medicine, Weill Cornell Medical College, Doha, Qatar

What Does Religiosity and/or Spirituality Mean?

Although both terms are often used interchangeably, the difference between religiosity and spirituality is beyond this text. However, for the sake of simplicity and understanding, "Spirituality involves humans' search for the purpose of life, while religion is associated with an organized entity with specific fundamental beliefs, rituals, and practices about a higher power or *God* [3]." For instance, in different faiths like Christianity, Islam, Jewish, Buddhism, Hindu, and the sub-affiliations (Protestant, Catholics, Eastern Orthodox, Mormon, and others), it defines relationships and responsibilities with certain ritualistic practices and attendance in a worship place.

There are three main dimensions of religiousness which include the organizational (social worship practices), non-organizational (praying/meditation/reciting and watching holy books), and subjective (or intrinsic) religiosity

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(motivating/drives behavior and influence decision-making).

Both religiosity and spirituality are important consideration for the care of the elderly; however with respect to subjective health status, spirituality might be a crucial explanatory factor for good health [4]. It is important to note that spirituality could be associated with religiosity for those who have faith in God but for atheists it will be unrelated [3]. Notably, spiritual commitment, belief, attitude, and practice of people may influence their perception of health status, interaction with their ailments, decision-making, wishes, and preferences [5].

How to Measure Religiosity and Spirituality?

There are various measures to assess religious involvement such as organizational religiousness, non-organizational religiousness, intrinsic religiosity, self-rated religiousness, and observer-rated religiousness. On the other hand, the measures of spirituality includes self-rated spirituality, observer-rated spirituality, and daily spiritual experiences [6–12].

Spirituality can be described in several ways, and its perception could vary for different individuals and thus difficult to measure or capture in activities (practices) or personal inquiry (attitudes and experiences) [7]. Often the religiosity is measured within the spirituality scope as if the latter being considered broader and that is also confusing.

A valid measure for assessment of spirituality is the Spirituality Index of Well-Being (SIWB) [9]. This instrument contains 20 items with 2 subscales involving religious and existential well-being which demonstrated associations between health and well-being in the outpatient settings for geriatric primary care. The Spiritual Needs Questionnaire (SpNQ) is a common measure for the assessment of spiritual needs of patients with chronic pain conditions and cancer [10]. Moreover, the Spiritual Needs Assessment for Patients (SNAP) is another instrument consisting of 23 items intended to measure the psychosocial, spiritual, and religious needs [11].

The Problem of Being Hospitalized Among the Elderly

To further define the problem of the sick elderly patients, it is very important to consider the stressors of being hospitalized in the elder population. In simple words, it is the the fear for loss. These stressors include fear of disease seriousness and nearness to dying, abandoning social roles, dependence, confronting the unknown, and threatened sense of control and adequacy along with unpleasant physical symptoms, effects of hospitalization which restrict mobility, and limited stimulation which assaults patient's sense of competence [13]. Based on the current literature, religious and spiritual beliefs could help in explaining the meaning of existential questions that arise with respect to a sickness and the possibility of death [14]. However, there exists a great challenge for health professionals to help provide spiritual nursing care to patients experiencing sickness [15]. This is attributed to the fact that health-care professionals are often inexperienced and unaware to deal with the religious and spiritual beliefs of the patients and relatives.

The Importance of Religious and Spiritual Beliefs in Clinical Practice

Religious and spiritual beliefs are considered as essential factors both socially and psychologically in health determination, perception, and response to treatment. In accordance to the World Health Organization (WHO), the definition of health refers to the "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [16]. That is why spiritual well-being is integral to the evaluation of health-related quality of life [17]. Religion and spirituality are assumed to provide hope and courage in difficult situations as well. Even among socially isolated elderly residing in institutions, the personal meaning, individual value of religion, and access to spiritual resources are important components of well-being [18].

The effects of religious and spiritual beliefs can be summarized in three psychological benefits. First is a *positive attitude* about life, stress, and disease that may improve resilience and outcomes both in short- and long-term basis. Second, they provide *a sense of meaning or purpose* that delineate behaviors, support, and relationships. Third, they develop an *optimized tolerance and coping* to illness, hospitalization, and disability.

Religious commitment is beneficial for well-being and prevention of both mental and physical illnesses, enhance recovery, and empower coping abilities [19]. Health-promoting practices such as avoidance of smoking (tobacco), heavy alcohol use, or other substance abuse resulted in healthier and longer life, e.g., Mormons and Seventh-Day Adventist have higher life expectancy (2–4 years) than in the Federal Republic of Germany [20]. Elderly people who have such community networks are less likely to neglect themselves. There appears to be a strong link between religiosity and successful adaptation to the challenges of aging [21]. An earlier study suggested that there is a need to enhance the skills and capacity of self-care among elder population which strongly correlates with decline in self-neglect and increases their well-being [22]. Studies also showed that spiritual support by medical team in critically sick patients influences medical decision and improves quality of life especially at the end of life with greater hospice utilization and less aggressive medical interventions [23].

Is Religiosity and/or Spirituality an Alternative or Complementary to Medical/Surgical Treatment?

Historically religiosity and spirituality were somewhat considered the same (synonymous), before the era of modern and scientific-based practice, where for a while it was separated nearly completely. However, recently the interest was renewed, and currently they are considered as important adjuncts to complement and supplement the different medical management approaches.

That's particularly true considering the reality of conventional treatment, where fears, side effects, previous unpleasant encounters, and the need for supportive personal approaches are by large the most common explanation for their choice. The overall belief is that religiosity is associated with better physical, mental, psychological, social, and functional health as well as less chronic pain experience [24].

Why People Seek Alternative or Adjunct Therapies?

There are many causes that limit the conventional treatment, such as side effects, previous negative experiences, looking for more personal support, and a holistic sense of health. One should not think of religious or spiritual healing as a substitute for standard medical care; but active religious commitment is beneficial for prevention, coping, and even recovering from both mental and physical illnesses as previously stated [25]. Furthermore, they are very helpful in rehabilitation and disability acceptance [25]. An earlier study showed that spirituality and religiousness are associated with the utilization of complementary and alternative medicine (CAM) among adult population [26]. Another concept is the integral medicine which emphasizes that human beings have various emotional, mental, and spiritual dimensions to treat which are necessary for the diagnosis and management of disease and improvement of well-being [27]. Therefore, the medical team should be aware of the implications and consider the sociocultural, spiritual, and psychological parameters in the patients. Therefore, integral medicine is the next step of integrative medicine with multidimensional approach involving curing from physical to psychological and cultural to spiritual in addition to conventional and alternative medicine.

Patient's Perspective on Clinical Management and Decision

The potentially harmful impact of the health exterminators could be expressed in attitude issues with respect to inflexibility, anxiety, reluctance, and looking for religious rituals like praying and chanting as a substitution to lifesaving interventions and therapies. The religious devotion might enhance excessive guilt, inflexibility, and anxiety. Patients with mental illness are more vulnerable of developing religious preoccupations and delusions. Certain religious groups discourage mental and physical health care, including potentially lifesaving therapies (e.g., blood transfusions, treatment of life-threatening infections, insulin therapy) [28], and may substitute religious rituals (e.g., praying, chanting, lighting candles). Some religious communities are more rigid and may isolate elder population from nonparticipating family members and the broader social community [29]. The elderly people often have distinct spiritual needs that may overlap with but are not the same as psychologic needs. Therefore, identification of patients' spiritual needs might help to understand and provide the desired support in terms of spiritual counseling, involvement in religious activities, and socialization with the specific religious community members [30].

Caregiver's Perspective on Religiosity and Spirituality

In a study among caregivers of patients with terminal cancer, the investigators found that caregivers with a strong personal religious faith and many social contacts were better able to cope with the stresses of caregiving during a 2-year period [31]. However, there has been less focus on the role that religion/spirituality might play in coping with stress of informal caregiving of older persons who need assistance with activities of daily living. Caregiving for elder population may be influenced by religion/spirituality beliefs as those caregivers with firm religious beliefs are more involved and motivated to provide care among eldely and mentally ill relatives [32]. Moreover the relationship quality might influence caregiving as poor quality of relationship between caregiver and care recipient may be considered as a risk factor for subjective burden or higher levels of overload [31, 33].

Interestingly, the religious beliefs of individuals lead to different health-care practices which may vary depending upon a specific religion. There are four major pathways which could explain the influence of spirituality/religion on health which included *health behaviors* (specific diet or prohibition of alcohol and smoking), *social support*, *psychological states* (religious people have more optimism and faith which help in coping with stress), and *"psi" influences* (belief in supernatural laws), and they might have indirect effect on health [34].

Notably, in light of perennial discussions about the relationship between science and faith, most physicians apply medical science while maintaining a belief that God intervenes in patients' health [35]. This also indicates a way that religious characteristics may influence the care of patients in clinical contexts like end-of-life care in which some patients and families articulate hopes for miracles [36]. This is what the secular physician may not notice or may ignore, but the religious physician may emphasize or exaggerate. In particular, those patients who have stronger religious beliefs seek out religious physicians, and those patients who are less inclined toward religion are more comfortable with secular physicians. Therefore, clinicians and patients who shared strong religious concordance showed preference for religion and spirituality [35]. Some studies suggested that there is less empirical basis for prediction about the association of religious beliefs or activity with favorable health outcomes [37].

Religiosity and/or Spirituality Consideration for Treatment of Elderly Patients

Taking a history of spiritual/religious belief is a sensitive issue and should be performed with great attention and care. Although there are several validated screening tools for assessing the two concepts, it might be more appropriate to use a generic approach without forcing or intruding way before introducing the concepts into the inquiry process unless as previously mentioned to be self-reported or clear and obvious. One of the approaches to do that is to ask a personal question about the "most important coping mechanism" and from there to carry further clarifications about why is it valid or not to consider religion and spirituality. Also to quantify these effects, the proposed questions would be of great help: "whether their spiritual beliefs are an important part of their life?" and "How these beliefs influence the way they take care of themselves and choices?" and "whether they participate in a religious community or activity and would like their needs to be fulfilled."

Furthermore, the religiosity and/or spirituality of the treating physicians and caregiver can potentially impact the process of care. The important considerations should bring in the discussion the concerns and wishes, understanding the requirements of the elderly as well as coping with the stresses in dealing with terminal, complex, and end-of-life issues. The inquiry about these issues (or spiritual beliefs) is relevant when the patient self-report to be religious. Among patients with palliative care for frailty, severe distress, or critical or near end of life, their religious needs are obvious, and justify the call for support of spiritual services in order to provide compassionate holistic care [38]. It is more likely that patients may encounter different opinions with regard to their beliefs and medical treatment in relation to the religious beliefs of their physicians.

The Evidence of Religiosity and/or Spirituality in Health Care

The current scientific methodology primarily based on physical measures to determine the evidence behind spirituality and religion in disease or health influence; thus it is instrumentally incorrect to rely on it completely. Religiosity and spirituality are more likely to be associated with higher social support especially in terms of religious organizational activities, alleviation of depressive symptoms, enhanced cognitive function, and greater cooperativeness [6, 39]. Intrinsic religiosity is associated with better physical functioning and lower depression scores among elderly survivors of cancer [40, 41]. Although there exists a link between religiosity and physical and/or mental functioning, still a strong scientific evidence is lacking.

As long as the absence of evidence is not evidence of absence, it needs to be interpreted carefully. Therefore, the health-care professional should not ignore the conceptualization of spirituality and religiosity even if it has not been well defined and understood. As part of the commitment to patient-centered care, the physician should respect the patient's beliefs, request for pastoral care, and religious service for terminally ill patients. As a matter of fact, in such patients the physician rather should embrace the spiritual approach and utilize efficiently, to the maximum, all related health benefit through social and psychosocial support that enhances recovery and helps patients to cope with their disease, health-related decisions, and acceptance of therapies [42]. The long-term effects expected are satisfaction, trust on the care system, monetary savings related to reduced length of stay, and return to the premorbid status [2]. Nevertheless the spiritual support is underutilized both by the religious communities and by the medical team which can potentially improve the patient's quality of life [2]. Therefore, the spiritual support should be considered at the level of training for the clergy services, particularly at the community level and to the medical team.

Religious Reasons Informing End-of-Life Controversies

Do Not Resuscitate (DNR) and Withdrawal Treatment

The End of Life (EoL) remains a challenging issue to be addressed among patients and their relatives in different geographic locations around the world with diverse beliefs and religious doctrine and commitment [43]. While it might be clear from the technical point of the view by the physician that the futility of care and lack of evidence about provision of care would result in a clinically acceptable outcome, sometimes this might not be clear to the other parties involved such as the patient and relatives or guidance clergy, religious or advisory bodies. The patient or more often the relatives would have different point of views, and in the absence of a guidance like a living will or predictive or evidence of patient's previously expressed preferences, DNR becomes an ethical dilemma. In some occasions the call for legal considerations and decision might be further modified by different state laws and definition of these important concepts as well as patient beliefs and religion [44]. Withdrawing treatment is referred to as an active, life-shortening treatment which is considered unacceptable. However, withholding treatment is a passive intervention and so deemed permissible under certain circumstances [45].

Although there exists an important link between religiosity and/or spirituality with health, however, the strong evidence pertaining to the influence of the different dimensions is lacking due to methodological weakness, incompatibility, and several confounding issues. Considering this, the renewing interest on the linkage did not address how physicians should develop adequate cultural and religious conceptions, overcome cultural stereotyping, and practice spirit of culturally sensitive medical care [44]. Beyond doubt there is a need to respect patient wish for religious services and rather embrace that as complementary to support health in the holistic view. At the end, religion commonly informs ethical judgment and underlies the public discourse and that's particularly true in communities that are considered religious [46]. Overall, the religious and cultural beliefs for predicting personal willingness toward withdrawal treatment or DNR or mercy killing are far more complicated and need better understanding of the aspects possibly influencing cultural or religious convictions.

Advanced Directives and Living Will

Advance directives refer to the communication or conversation and/or documentation between the physician and the patient focusing on clarifying the patient's wishes and values and projecting the type of medical treatment the patient would want to opt under certain circumstances in which the patient becomes incapacitated to make a decision [47]. It also relates to a surrogate decision-making either specified by the advance directives or the law which typically designates in order the spouse, adult child, parent, adult sibling, grandparent, or friend to assume this role [48]. The expression can be either one of the three as follows: the living will (LW), the durable power of attorney for health care (DPA), or the conversation with a physician or others. In many institutions, assessments of physicians are required to determine the patient incapacity of decision-making [49] and open the door for considering alternative consent like emergency, surrogate, and therapeutic privilege among others according to local laws and regulations.

Role of Hospital Clergy/Chaplain

There is certain public opinion which considers the community clergy as a symbolic moral voice, and their attitude and opinions are a key influence in the formulation of the beliefs and acceptance of ethical dilemmas such as DNR and withdrawal treatment. Interestingly, when comparing the community clergy with the hospital chaplain, the former would typically be expected to be traditional in their views of religion and its influence on health, while the latter mostly has extensive training in the mental, social, and spiritual needs of hospitalized patients particularly among the elderly and supporting the end-of-life care [50]. A recent study showed that the majority (80%) of clergy believe under certain circumstances the terminally ill patients should be allowed to die; on the other hand, they outrightly disregarded the idea of physician-aid in dying or physician-assisted suicide [51]

Moreover, it is highly recommended to include hospice clergy in health-care teams, if the patient was receptive to spiritual support-linked care by religious community and clergy at patient community with all the positive support of the community which can be called upon to help for patient convalescence like meals, transportation, escort, and housekeeping. It also helps to reduce alienation and isolation and increase sense of belonging and coping with illness and its related limitations for a fast recovery. Therefore, the interplay between religious beliefs, medical knowledge, and trust needs to be established within the general population and among patients facing a life-threatening illness.

Balancing Faith and Health Care

Religion is far more beyond a set of beliefs and practices which cannot be ascertained instrumentally; rather it encompasses a spiritual way of being existed in the world [46]. Over the past decades, clinicians were trying to understand and balance the health care by restoring spiritual basis of medicine, which is supposed to have a strong link with health-care practice [52]. It has been suggested that the spiritual support provided by a clinical team results in improved hospice utilization and quality of life in patients approaching end of life [53]. However, surrounding issues of trust, the role of miracles, and caution of prognostication are some of the factors hindering the partnership between religion and medicine [51]. Hospital clergy services; include the importance of listening, understanding grief, being a supportive presence for the family, and displaying appropriate bedside manners which provide spiritual support at the end of life. Clergy training focusing on the health-care education and end-of-life care could help in overcoming issues of medical disbelief in terminally ill patients [54]. Therefore, there is a strong need to strengthen the relationships between clergy and clinicians for establishing a holistic approach of patient care.

In conclusion, religiosity and spirituality are important elements of well-being among elder population worldwide. The level of religious participation among elder population is greater than that in any other age group. There are various measures to assess religious involvement such as organizational religiousness, non-organizational religiousness, intrinsic religiosity, self-rated religiousness, and observer-rated religiousness. In patients with palliative care for frailty, cancer, or critical or near end of life, the religious needs are obvious and justify the call for the support of spiritual services in order to provide compassionate and holistic care. On the other hand, the religious devotion might enhance excessive guilt, inflexibility, and anxiety. Therefore, it is important to take into consideration the potential benefits and the possible drawbacks of involving religiosity and spirituality in elderly patients seeking care for health issues and surgery.

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33 Surgery in the Elderly with Mental Health Issues

Faisal Jehan and Rifat Latifi

The demographics of the US population are undergoing a dramatic shift as the population is not only growing but aging as well. Since 1980, the geriatric population has increased by 21% [1]. Over the past three decades, the US population has been growing at a rate of 39%; however, those over the age bracket of 65 and 85 have almost doubled and tripled during this time [2]. This rightward shift of the population histogram has been attributed to the increased life expectancy due to the effective screening measures/diagnostic tools and advancements in the management of diseases. The second factor contributing to such a shift is the aging "baby boomers" [3]. With continued advancements in the healthcare and standard of living, life expectancy is further estimated to increase. It is predicted that by the next 20 years, those over the age of 65 will comprise 1/5th of the total population [4]. This rapidly growing new subset of population has peculiar needs and poses a great impact on our health. For instance, 9.6 million emergency department (ED) visits were attributed to age 65 and above from 2009 to 2010, accounting for a rate of 511 per1000 persons, and it increased with age [5, 6]. Similarly, in the year 2010, adults aged 85 and over accounted for only 2% of the US population but disproportionately accounted for 9% of hospital discharges [6]. In order to provide quality care, the healthcare system must adjust promptly to be able to take optimal care of this new predominant subset of the population.

F. Jehan
Department of Surgery, Westchester Medical Center and New York, Medical College, Valhalla, NY, USA

R. Latifi (✉)
Department of Surgery, New York Medical College, School of Medicine and Westchester Medical Center Health Network, Valhalla, NY, USA
e-mail: rifat.latifi@wmchealth.org

Surgery in the Elderly

As the US population continues to age, along with the increase of E.D. visits and hospitalization, elderly patients will also require increased surgical procedures and resources [7]. Elderly patients have proportionately higher rates per population, compared to their younger counterparts, of inpatient as well as outpatient surgical and nonsurgical procedures [3, 7, 8]. In 2006, about 35% of the total inpatient procedures while 32% of outpatient procedures were performed in elderly patients [8, 9]. Data from the National Health Statistics Reports has demonstrated that out of the 45,963 procedures, 16,238 were performed in patients aged 65 years and over [9]. With such growing proportion, to achieve optimal surgical outcomes, focused research on this subgroup is warranted to allow better understanding of the specific needs of these patients. Surgical management of elderly patients is far more challenging compared to young patients for numerous important reasons. First and foremost, increasing age-related comorbidities, hyper-

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tension, dementia, heart diseases, degenerative joint diseases, may require preoperative optimization and complicate the postoperative care. Second, the acute surgical stress in elderly patients with baseline limited physiologic reserves to withstand stressors severely impedes healing and the recovery from surgery. Third, the unreliable clinical signs and symptoms and the attenuated inflammatory and immune response in the elderly further complicates the course, leading to a delay in recognition and appropriate management of postoperative complications. The unpredictable response of sedatives, anesthetics, and narcotics and the drug–drug interaction with patient home medications are also critical challenges in elderly patients.

Mental Health Issues and Epidemiology

Mental health has been defined by the World Health Organization (WHO) as "a state of well-being in which every individual realizes his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to her or his community" [10, 11]. Unfortunately, however, every one in three individuals faces a disruption in their mental health at some point of their life [11]. Mental illness refers to a group of conditions involving changes in emotion, thinking, behavior, or difficulty/distress functioning in social, work, or family activities. Mental health issues and neuropsychiatric disorders comprise about 14% of the global burden of disease [12]. In 2013, five different mental illnesses made into the top 20 causes of global burden of disease, leading to the most years lived with disability [13]. Major depression was second, anxiety disorders was seventh, schizophrenia was eleventh, dysthymia was sixteenth, and bipolar disorder was seventeenth on the list. According to the 2016 data from the National Survey on Drug Use and Health (NSDUH) by the Substance Abuse and Mental Health Services Administration (SAMHSA), approximately 44.7 million adults had some kind of mental illness while 4.2% (10.4 million) of all US adults had severe mental illness [14].

The demographic shift as the population is living longer and improved survival comes at a cost of greater proportion living with morbidities and disabilities increasing the prevalence of mental illness [15]. Mental illness has evolved as a major contributor to the overall morbidity and disability globally [12].

Classification of Mental Health Diseases

Mental health illness encompasses a wide array of disorders. For the sake of simplicity, we have categorized broadly some of the major mental illnesses in Table 33.1.

Table 33.1 Major mental illnesses

S. No	Category	Disorders
1.	Mood disorders	Depression Bipolar disorder Mania Dysthymia Cyclothymia
2.	Psychotic disorders	Acute psychotic disorder Schizophrenia Schizoaffective
3.	Anxiety disorders	Generalized anxiety disorder Obsessive-compulsive disorder (OCD) Panic disorder Post-traumatic stress disorder (PTSD) Social phobia (social anxiety disorder) Specific phobia
4.	Personality disorders	Paranoid personality disorder Schizoid personality disorder Schizotypal personality disorder Antisocial personality disorder Borderline personality disorder Histrionic personality disorder Narcissistic personality disorder Avoidant personality disorder Dependent personality disorder Obsessive-compulsive personality disorder

Table 33.1 (continued)

S. No	Category	Disorders
5.	Eating disorders	Anorexia nervosa Bulimia nervosa Binge eating disorder
6.	Developmental disorders	Intellectual disability disorder Autism spectrum disorder Attention deficit hyperkinetic disorder (ADHD)
7.	Cognitive disorders	Dementia Delirium
8.	Drug abuse	Alcohol and drug abuse and withdrawals

Mental Illness in the Elderly

As the proportion of elderly population continues to increase as a result of improved survival from previously lethal conditions and the aging baby boomers, a larger subset of the elderly have to live with morbidities, disabilities, and some form of mental illness [16]. As stated previously, between 2015 and 2050, it is estimated that the number of people over the age 60 will increase from 900 million to 2 billion [17]. Elderly patients by virtue of their diminished physiologic reserves and decreased stress coping capacity are not only at a higher risk for mental illness but also have worse outcomes [18]. Elderly individuals have unique physical and mental health challenges that need to be timely identified and addressed. Major depression, dementia (Alzheimer's and vascular), anxiety disorders, late-life schizophrenia, and drug abuse disorders especially alcohol are common mental health problems that affect the elderly. These can be severely debilitating in terms of quality of life if they remain unrecognized or untreated in the elderly.

Elderly patients who live alone, have no family support (friends/relatives), are socioeconomically and geographically disadvantaged have experienced a traumatic brain injury or those who are suffering from a progressive or chronic illness or pain syndrome are at high risk for mental illness and depression. Screening of at-risk elderly individuals and early diagnosis and appropriate pharmacological and psychosocial treatment is pivotal in the management of these patients.

Every one in five individuals over the age of 60 suffer from some form a mental or neurological illness [17, 19, 20]. Mental and neurological disorders contribute 6.6% of all disability-adjusted life years (DALYs) among people aged 60 and over. Furthermore, these mental and neurological disorders account for 17.4% of years lived with disability (YLDs) in the elderly group. The two most common mental and neurological disorders in individuals aged 60 and over are depression and dementia. Depression affects about 7% while dementia affects 5% of the world's elderly population. Similarly, anxiety disorders affect 3.8% while substance abuse affects about 1% of the world elderly population. Substance abuse in the elderly predisposes them to self-harm. Substance abuse problems are particularly difficult to diagnose in the elderly people and often remain undiagnosed and untreated. Mental health issues in the elderly often culminate in the cases of self-harm or suicide. About 25% of deaths from self-inflicting injuries worldwide are in the elderly sub-group of the population. The elderly individuals have the highest suicide rate of any age group [21]. Compared to an overall rate of 11 per 100,000 for all ages, men aged 85 years or older have a suicide rate of 45.23 per 100,000 [21].

Risk Factors for Mental Health Issues Among the Elderly

Elderly patients by virtue of their age-dependent decline in physiological reserves, additional comorbidities, and decreased stress coping mechanisms are at an increased risk for developing mental health problems. Older adults come across different life stressors at different points in their lives. However, life stressors are not only more common in the later part of left, but elderly individuals have a significantly less ability to deal with those stressors due to the decline in intellectual, cognitive, and functional abilities. For example, elderly individuals are more likely to experience grief or bereavement events due to loss of a significant other, retirement from job, or a change in their social and economic status. In addition, progressive chronic medical conditions, pain syndromes, reduced agility, and increasing frailty and delayed return to baseline health from illness predispose them to require placement in a long-term facility care (subacute rehabilitation or skilled nursing facility centers). This results in the separation of the elderly from the family; the increased loneliness and isolation predispose them to develop mental health issues like depression and anxiety. Mental health and physical health are interconnected and dependent on each other. For example, depression is thought to be associated with the increased risk of coronary heart disease, osteoporosis, diabetes complications, cancer incidence and progression, and cancer mortality [22–25]. Similarly, a meta-analysis has shown the association between positive emotional well-being and favorable prognosis of physical illness [26]. On the other hand, patients with chorionic debilitating illnesses like cancer have an increased risk of developing mental illness [27].

Abuse is also common in the elderly. Abuse can be in any form including physical, verbal, psycho-emotional, financial, and sexual abuse. Abuse can also be in the form of abandonment, neglect, and nutritional deprivation. Data from the World Health Organization suggest that 1 in 6 older individual experience some form of elder abuse [17]. Elder abuse is a major stressor in the elderly and not only leads to physical injuries but is also associated with serious life-long mental health consequences, including depression, anxiety, post-traumatic stress disorder, and suicide.

Dementia and Depression Among the Elderly as Public Health Issues

Dementia

Although normal aging is associated with some slowing of mental ability, usually it is not severe enough to interfere with the function of everyday life. On the other hand, dementia is a decline in mental ability severe enough to interfere with the performance of daily life activities. Dementia, although more common in the elderly, is not a normal part of aging. Dementia is defined as a chronic and progressive decline in memory, cognition, thinking, behavior, and emotional response that significantly impairs the ability of an individual to perform the activities of daily living. An estimated 50 million people worldwide have dementia, and the total number is projected to increase to 82 million in 2030 and 152 million in 2050 [17]. Dementia is not only a physical and social burden on the patient, family, and the society, but also has an enormous economic effect on the healthcare system. The direct costs of medical treatment and requirement of long-term care and the indirect costs due to loss of productivity and dependence associated with dementia are staggering. In addition, the emotional, physical, and socioeconomic stress to the family and caregivers is unimaginable.

Depression

Depression is one of the most prevalent mental health problems in the elderly. It is estimated that about 7% of the elderly population suffer from depression [17]. Depression is associated with a decline in physical, emotional, mental, and social functioning and accounts for 5.7% of years lost to disability (YLDs) in the elderly over the age of 60. Depressive symptoms and their effects on functioning also complicate the treatment of other chronic diseases and further worsen the outcomes [28]. Due to overlapping symptoms among normal aging, age-related chronic diseases, and depression, it often remains underdiagnosed and the treatment is often overlooked. Depression in the elderly is associated with increased functional decline compared to those with chronic medical conditions such as lung disease, hypertension, or diabetes. Depression in the elderly is also associated with increased health resource utilization by increased emergency department visits and hospitalization and longer hospital length of stays.

Challenges in the Assessment and Diagnosis in the Elderly

Elderly patients most commonly present with atypical signs and symptoms of altered mental state, anorexia, hypothermia instead of fever, lack of localized pain, and decline in functional status after any organic illness [29]. These symptoms are similar to the presentation of mental illness in the elderly. In addition, the classical features of the mental diseases are seldom seen in elderly patients. For instance, elderly patients usually do not meet the full criteria for depression or anxiety and often present with vague somatic symptoms. This makes prompt diagnosis and detection of treatable mental illness a challenge in the elderly. Increasing frailty in the elderly, decreased mobility, and other age-related medical comorbidities further complicate the detection of mental disorders in these patients. Frailty, immobility, impaired cognition, and incontinence which are often referred to as geriatric syndromes may mimic or mask the psychopathology, making diagnosis in this subset further challenging.

Patient-related factors is another important barrier in the diagnosis of mental health problems in the elderly. Elderly patients have multiple comorbidities and are more likely to report somatic symptoms of pain, fatigue, and sensorium and psychological symptoms are usually underreported and are masked by these somatic symptoms. This leads to missed diagnosis and a wrong perception of lower prevalence of mental diseases in the elderly. Sometimes mental illness is considered as a part of normal aging in the society, and this stereotype further lowers the actual prevalence of mental illness in the elderly. Patients taking multiple medications can have drug-related side effects which can make the differentiation of psychiatric illness in elderly patients. Because of the lack of geriatric specialists, primary care physicians carry much of the burden for diagnosis of mental disorders in the elderly population. However, their familiarity with geriatric-specific syndromes and mental health illness in the elderly is only minimal. Reported data from the literature has consistently shown that the ability of primary care physicians to recognize mental illness and referrals for proper treatment is below the standard of care. For instance, a study that interviewed primary care providers demonstrated that only 55% of internists felt confident in diagnosing depression, while only 35% of the total felt confident in prescribing antidepressants to elderly patients. Due to the lack of geriatric mental health specialists and the complex referral system if one is available, it is estimated that up to 63% of the elderly population above 65 years with a mental disorder do not have an adequate access for the diagnosis and treatment of mental health illness. Barriers to timely and correct diagnosis and treatment of mental illness can be broadly classified in three groups as shown in Table 33.2.

Table 33.2 Barriers to identification and treatment of mental illness in the elderly

S. No	Category	Barriers
1.	Patient barriers	Preference for primary care Tendency to emphasize somatic problems Reluctance to disclose psychological symptoms
2.	Provider barriers	Lack of awareness of manifestation of mental disorders Complexity of treatment Reluctance to inform patients of a diagnosis
3.	System barriers	Time pressures Reimbursement policies Complex referral process Lack of geriatric specialists

Preparing the Elderly Patient with Mental Health Issues for Surgery

In order to achieve optimal outcomes in elderly patients with mental illness undergoing surgery, a robust preoperative optimization program, vigilant intraoperative care, and close postoperative follow-up are required. A multidisciplinary patient-centered team approach is indispensable for the preparation of elderly patients with mental health issues. It starts with the patient's primary care provider and will require the involvement of psychiatrist, geriatrician, anesthesiologist, cardiologist, and surgeon to plan the optimal approach and time and delineate the postoperative care of patient.

Preoperative Screening and Optimization

The preoperative phase is by far one of the most critical phases to determine the outcomes of elderly patients with mental illness after surgery. A structured preoperative screening and optimization is required to adequately prepare this complex subset of patients for the stress of surgery.

Screening and Specialist Referral

Preoperative assessment by a multidisciplinary team and geriatric experts can improve outcomes after surgery for the elderly, who are more likely than the younger patients to develop preventable postoperative adverse events [30]. Data across different surgical specialties has consistently shown that patients who received preoperative interdisciplinary intervention before surgery have fewer complications and shorter length of stay. The surgeon has the ultimate responsibility for a surgical patient; therefore, the surgeon should ensure that all the appropriate preoperative evaluations and interventions required are performed so that the patient can make informed decisions and receive the highest quality care. The primary care physician of the patient, the geriatric psychiatrist, and the surgeon should form a triangle of patient advocacy and further determine if the patient would require further consults A cardiologist referral for preoperative cardiac evaluation according to the American College of Cardiology/American Heart Association algorithm for patients undergoing noncardiac surgery. Identify patients with chronic obstructive/restrictive pulmonary diseases who are at risk of postoperative pulmonary complications and implement appropriate strategies for prevention. Patient baseline frailty score, functional status, and history of falls should be documented.

Screening for Cognitive Impairment/Dementia

A detailed history and a cognitive assessment should be performed for all patients with a known history of cognitive impairment or dementia, mental illness, strong family history of dementia, or history of transient ischemic attacks or strokes. A cognitive assessment can be easily performed using tools such as the Mini-Cog (Tables 33.3 and 33.4) [31]. Based on the Mini-Cog evaluation, if

Table 33.3 Cognitive assessment with the Mini-Cog: 3 Item Recall and Clock Draw

1. GET THE PATIENT'S ATTENTION, THEN SAY:
"I am going to say three words that I want you to remember now and later. The words are: banana, sunrise, chair. Please say them for me now." Give the patient 3 tries to repeat the words. If unable after 3 tries, go to next item.
2. SAY ALL THE FOLLOWING PHRASES IN THE ORDER INDICATED:
"Please draw a clock in the space below. Start by drawing a large circle. Put all the numbers in the circle and set the hands to show 11:10 (10 past 11)." If subject has not finished clock drawing in 3 minutes, discontinue and ask for recall items.
3. SAY: "What were the three words I asked you to remember?"

From Borson et al. [31], with permission

Table 33.4 Interpretation of the Mini-Cog

SCORING:
3 item recall (0 to 3 points): 1 point for each correct word Clock draw (0 or 2 points): 0 points for abnormal clock 2 points for normal clock
A NORMAL CLOCK HAS ALL OF THE FOLLOWING ELEMENTS:
All numbers 1 to 12, each only once, are present in the correct order and direction (clockwise) inside the circle. Two hands are present, one pointing to 11 and one pointing to 2.
ANY CLOCK MISSING ANY OF THESE ELEMENTS IS SCORED ABNORMAL. REFUSAL TO DRAW A CLOCK IS SCORED ABNORMAL.
Total score of 0, 1, or 2 suggests possible impairment. Total score of 3, 4, or 5 suggests no impairment.

From Borson et al. [31], with permission the patient has evidence of cognitive impairment, coordinate with the patient primary care physician and consider patient evaluation by a geriatric mental health specialist for further evaluation and optimization. Obtain a detailed history from the patient's primary care and family members to better determine the functional and cognitive decline over time. Patients with significant decline over a short period of time or those with recent decline will specially benefit from the evaluation by a geriatric mental health specialist. Postoperative decline in cognition and delirium are common postoperative complications. In order to correctly identify these complications and quantify the change from baseline, preoperative accurate documentation of the patient's preoperative cognitive and functional status is very important. Patients with preexisting cognitive impairment have an increased risk of postoperative delirium [32]. An episode of delirium in the elderly after surgery is associated with increased hospital length of stay, postoperative functional decline, and increased mortality [32, 33].

Screening for Depression

Screening of depression in elderly patients is recommended specially in those with risk factors like poor health status, cognitive impairment, living alone, divorced, diagnosis of a chronic illness, and socioeconomically challenged [34]. Other risk factors for depression among geriatric patients include female sex, disability, bereavement, sleep disturbance, and prior depression diagnosis [35]. Simple tools like the Patient Health Questionnaire-2 (PHQ-2, Table 33.5) is used [36]. Patients who screen positive on the PHQ-2 will require a referral to the geriatric psychiatrist for detailed evaluation. Preoperative depression has been associated with worse outcomes after surgery. For instance, preoperative depression has been shown to be associated with increased mortality and longer length of stay after cardiac surgery [37]. Similarly, the difficulty to differentiate between psychotic pain and distress in depression from somatic pain has been shown to be associated with higher pain perception and increased requirements of postoperative analgesia [38, 39].

Table 33.5 Screening for depression with the Patient Health Questionnaire-2 (PHQ-2)

ASK THE PATIENT THE FOLLOWING QUESTIONS:
1. "In the past 12 months, have you ever had a time when you felt sad, blue, depressed, or down for most of the time for at least 2 weeks?"
2. "In the past 12 months, have you ever had a time, lasting at least 2 weeks, when you didn't care about the things that you usually cared about or when you didn't enjoy the things that you usually enjoyed?"
If the patient answers YES to either question, then further evaluation by a primary care physician, geriatrician, or mental health specialist is recommended.

From Li et al. [36], with permission

Screening for Alcohol and Substance Abuse

All elderly patients undergoing surgery should be screened for alcohol dependence and substance abuse using the CAGE questionnaire (Cut down, Annoyed, Guilty, Eye-opener) [40]. Patients who screen positive should be motivated to see a substance abuse specialist for preoperative abstinence or medical detoxification. The patient should be educated on different platforms for help. Daily multivitamins with B6 and B12 and oral or parental thiamine are recommended in the perioperative period for patients with alcohol abuse disorder. In addition, strict monitoring in the perioperative period and the possible use of prophylactic medications to prevent withdrawals is also warranted in these patients.

A national survey during 2005–2006 showed that about 60% of older adults (50 years and older) were using alcohol [41]. The prevalence of binge-drinking among elderly men and women was 14.5% and 3.3%, respectively [42]. Different studies have shown the association of preoperative alcohol abuse and dependence and increased rates of postoperative complications, including but not limited to pneumonia, sepsis, wound infection, and disruption, as well as mortality [43].

Determining Capacity and Informed Consent

Assessing mental capacity in vulnerable patients is a necessary function of respecting patient autonomy. Assessing the patient's decision-making capacity, not often easy in the elderly, is critical in determining his or her ability to provide informed surgical consent. A detailed discussion about the need for surgery, indications, benefits, risks, and alternatives to surgery should be held with the patient. The patient can also include their loved one in this discussion too. After the discussion, the patient should be able to describe in their own words the salient features of the consent, risks, and benefits. In order to be able to sign the consent, the following criteria must be meant in order to determine decision-making capacity.

1. The patient acknowledges his or her medical condition, treatment options, and the likely outcomes.
2. The patient understands the relevant information communicated by the physician.
3. The patient can clearly indicate his or her treatment choice.
4. The patient can engage in a rational discussion about the treatment options.

If any of the above requirements is not met or if unable to determine capacity, a psychiatric consult should be placed for detailed evaluation.

Goals of Care Discussion

Goals of care discussion before surgical procedures is of great value and builds a trust between the physician and the patient. It is especially relevant in patients with multiple comorbidities requiring high-risk surgeries. The discussion about a curative surgery vs. a palliative surgery should also be discussed with the patient upfront. In all these discussions, treatment goals, and plans, the surgeon should always empathetically understand patients' wishes and expectations and respect them in all circumstances. These discussions about patients' preferences and goals of care should be clearly documented in the medical records. The surgeon should give a realistic expectation of the postoperative course and possible complications, and should preemptively arrange for any postoperative needs that need that may come up, e.g. the need for ostomy nurse, home healthcare, long-term IV antibiotics or need for dialysis. If relevant, include the discussion of possible functional decline and need for rehabilitation or nursing home care during the informed consent process.

Involve the Family

The involvement of family in the treatment of elderly patients with mental health issues is critical in the management of these patients. The determination of the patient's family and social support systems to minimize stressors and make a smooth postoperative transition of the patient back to his family. If the patient lacks social support or family preoperative involvement of physical therapy, social worker and case manager to determine the needs of the patients should be encouraged.

Advance Directives and Assigning Health Care Proxy

The surgeon should also carry a discussion with the patient about advance directives and designate a health care proxy or surrogate decision maker, in case the patient at some stage in their treatment lacks capacity. This discussion should include dependence on feeding tubes, tracheostomies, and ventilator. These documents should be placed in the medical chart. A study of deceased elderly individuals showed that about one-third of elderly individuals required medical decision making; however, they lacked decision-making capacity toward the end of life [44].

Multidisciplinary Team Approach

The optimal surgical preparation of patient with mental illness require multidisciplinary approach involving the primary care physician (PCP), the surgeon, the anesthesiologist, and the geriatric psychiatrist. The early involvement of all these pillars will help identify the areas that can be optimized before surgery and decrease postoperative adverse events.

Polypharmacy

Before surgery, a complete review and documentation of all the medications should be performed. This should include a complete list of all prescription and nonprescription agents (over-the-counter pain medications, vitamins, eye drops) and herbal products. The correct dosage and duration should be confirmed with the pharmacy, and if needed, a pharmacist should be involved as well. The risk for adverse drug reactions and drug–drug interactions can be minimized by identifying medications that can be discontinued before surgery or can be avoided, and by dose-reducing or substituting to another medication with safer profile. Polypharmacy is considered as a major risk factor for developing postoperative delirium. Avoid sedatives like benzodiazepines and consider reducing benzodiazepines when possible if the patient is already taking benzodiazepines. For sleep, the non-sedative hypnotics like melatonin and readjusting the sleep-awake cycle should be recommended. Avoid using narcotics; however, adequately control the pain with non-narcotic medications to reduce the risk for developing postoperative delirium. Other drugs with strong anticholinergic or sedative effects like the histamine (H1) antagonists and tricyclic antidepressants should be avoided if possible. Critical medications like antiplatelets/anticoagulants should be discontinued for the minimum possible duration after discussion with the primary care physician and cardiologist and resumed immediately postoperatively when possible, to reduce perioperative risks of adverse events (cardiac, stroke, etc.). The ACC/AHA guidelines should be followed for perioperative beta blockers and statins [45]. Preoperative statins should be started as soon as possible before surgery for patients who have known vascular disease, elevated low-density lipoprotein cholesterol, or ischemia on thallium testing. For patients undergoing noncardiac surgery, who are currently taking statins, statin therapy should be continued. Statin use may also be considered for patients undergoing vascular and intermediate risk surgery. For medications that are cleared renally, doses of medications should be adjusted based on glomerular filtration rate. If a patient develops a postoperative acute kidney injury, all the nephrotoxic medications should be discontinued. Continuous monitoring for polypharmacy and potential adverse interactions and discontinuation of non-essential medications preoperatively are recommended, if possible. The addition of new medications should be kept to a minimum postoperatively.

Intraoperative Care of Elderly Patients with Mental Health Issues

Aspiration Risk

Elderly patients with mental illness may be under the effect of psychotropic medications and are at an increased risk of aspiration. Care should be taken during the preoperative period and during intubation. The optimal NPO time should be determined by the anesthesia.

Correct Dosing

For elderly patients with mental illness who are taking other sedatives/tranquilizers, the anesthetic dose should be adjusted accordingly by the anesthesiologist.

Postoperative Care

Delirium

As discussed earlier elderly patients at risk of developing delirium should be identified before surgery, and these risk factors should be clearly documented in the patient chart. For patients at risk for postoperative delirium, the administration of benzodiazepines, antihistamines, and other sedative medications should be avoided if possible. Early identification of patients who develop postoperative delirium and minimizing the causative agents will help improve patient outcomes.

Pain Control

The use of non-narcotics (NSAIDs, acetaminophen, gabapentin) for pain control should be encouraged. Acetaminophen is considered to have the safest risk profile in elderly patients. NSAIDs can be used for a shorter period postoperatively if the creatinine is normal. Adequate hydration is recommended while using NSAIDs. Local anesthetic patches, regional nerve blocks, and pain catheters can provide adequate pain control without the use of narcotics and sedatives. Narcotics increases the risk of delirium in postoperative patients and should be avoided if possible.

Disposition: Intensive Care Unit (ICU) Versus Floor

Patients may require an initial ICU stay overnight for hemodynamic monitoring. Early discussion should be held with the ICU team and a low threshold kept for ICU. Certain large centers are advocating the need for geriatric intensive care units (GICUs) for the management of sick geriatric patients requiring critical care. Some studies have shown improved outcomes for patients managed at geriatric ICUs.

Discharge Planning and Care

Psychosocial Support

Patients should receive continuous psychosocial support and should be followed by a psychiatrist/mental health specialist in the hospital to titrate psychotropic medications.

Physical and Occupational Therapy (PT/OT)

Patients should be mobilized by physical therapy as soon as possible after surgery. Early physical and psychological rehabilitation is the key to prevent postoperative complications.

Family Involvement and Education

Early family involvement in the postoperative care of patient is pivotal for the early recovery after surgery in geriatric patients. Family education about the postoperative care and the needs post discharge should be initiated immediately postoperatively.

Discharge Goals

Discharge goals should be delineated, and a comprehensive discharge plane given to the patient. Patient and family should be educated about home medications and precautions and the signs and symptoms to watch after surgery. If a patient is going to a rehabilitation center or a skilled nursing facility, patient's plan should be clearly communicated to the accepting center.

Follow-Up

Early follow-up with the surgeon, primary care physician, and psychiatrist to track recovery and identify any potential complications is recommended.

Summary

As the US population is aging, the longevity comes at a cost of living with increased lifelong morbidities and disabilities, making the elderly susceptible to mental health problems. Clinical presentation of elderly patients with mental disorders may be different from that of other adults, making timely diagnosis and detection of treatable illness more difficult. Elderly patients are more likely to undergo inpatient and outpatient surgical procedures. Therefore, early identification of elderly patients with mental illness undergoing surgery and a multidisciplinary team approach to their preoperative optimization and timely interventions and resource allocation will help improve clinical outcomes of these patients.

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Part IV

Teaching Geriatric Surgery

34 How Do We Teach Medical Students to Care for the Elderly

Anitha Srinivasan

Geriatrics as a Component of Surgical Education

In the United States, the geriatric population is rising due to improved standards of living and better medical care. The population aged 65 and above is expected to double to 84 million from 2010 to 2050 [1]. With this comes the demand for medical and surgical care of this population. In surgical care there is a projected demand for vascular surgery to increase by 31% and general surgery by 18%. These patients need well-informed surgical providers with educational exposure to geriatric care to achieve positive results. This will become an unmet need in the future generation of healthcare unless it is addressed in today's medical education [2].

History and Current State of Geriatrics as Part of Surgical Education

The need for geriatric care and its awareness among specialty trainees was recognized in the mid-1990s [2]. However there still exists a lack of formalized training as part of surgical education and recognition of its importance toward caring for the future generations [3]. There are currently ongoing programs to educate surgical residents in training to orient them toward care of geriatric patients in surgery, e.g., Chief Resident Immersion Training program for care of the elderly (CRIT at Boston University) [4]. However this may not be the ideal teaching moment in a formative surgical career [5]. Given that geriatric patients are going to be a significant part of surgery in the future, it is important that the students understand what to expect if they choose surgery as their field of practice. There is enough rationale to inculcate geriatric surgical education in the medical school curriculum as part of the surgery teaching [6]. This, we hope, will lead to a well-informed medical graduate who chooses a career in surgery knowing the needs of the future population they will be serving.

The scope of teaching the medical students must include a holistic approach to create an awareness that is embedded within their decision-making in surgery [7]. Every geriatric patient presentation must not pose a new challenge to the future surgeon. Instead a well-trained surgeon should be capable of informed decision-making for the best outcome in that particular case, due to their training in geriatric surgery from an early stage of their careers. It is such knowledge one hopes to gain from surgical student education regarding geriatrics that will lead to the

A. Srinivasan (✉)
Metropolitan Hospital Breast Health Center, Department of Surgery, New York Medical College, School of Medicine, Valhalla, NY, USA

Metropolitan Hospital, New York, NY, USA
e-mail: anitha.srinivasan@nychhc.org

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unconscious selection of the right choices for the patient with knowledge of evidence-based practices in geriatrics.

The Components of Care of the Geriatric Surgical Patient and What a Student Should Learn and Expect

Here is a suggested format for introducing the surgical student to geriatric care in surgical disease (Table 34.1).

- Assessment and preoperative preparation
- Operative care and postoperative inhospital care
- Long-term outcomes, functional, and ethical considerations

Introductory Lectures

The student starts the rotation with the general introductory lectures in surgery and trauma. In addition, there should be a lecture given by the geriatric medical doctor, a surgeon who practices surgery in the elderly, and by a palliative care specialist. This will familiarize students with theoretical aspects of geriatric care related to surgery.

Understanding the Role of Multidisciplinary Care in Geriatric Surgery: Simulate Creation of an Ideal Team of Care for the Elderly Patient

The components of a geriatric surgical team must include the participation of a geriatric care team which includes specialists that address medical and palliative care components of the elderly patient's surgical condition. Often a social worker is essential to ensure smooth transitions of care and safe discharges and creation of goals of care. Family involvement and caregiver contribution is absolutely essential to decision-making and evaluation of an elderly patient in surgery. Role play of such scenarios with relevant case discussions will be informative for the students. Here the students are following the model of a flipped classroom acting as specialists in a geriatric care scenario. They create a checklist for the assessment of a geriatric patient and the necessary team members and present it to the class justifying the role of each team member.

Table 34.1 Format for introducing the surgical student to geriatric care in surgical disease

Assessment and preoperative preparation	Operative care and postoperative inhospital care	Long-term outcomes, functional, and ethical considerations
Introductory lectures	The art of multidisciplinary discussion in surgical decision-making	Surgical clinic shadowing and experience to asses post-op patients
Understanding the role of multidisciplinary care in geriatric surgery – simulate creation of an ideal team of care for the elderly patient	Observation of operative cases involving geriatric patients	ICU rotation in surgery and witness end-of-life discussions and understanding ethics committee
Role play and group discussion to simulate a clinic preoperative assessment	Shadowing the geriatrician and understanding postoperative care of the elderly patient	Shadowing rehabilitation post-surgery
Observation of the preplanning/ assessment of the geriatric patient in the clinic setting	Understanding the role of a palliative care physician in the surgical setting	
Simulation case scenarios – discuss rationale for decision in each case	Postoperative care and follow-up of the patient	

Role Play and Group Discussion to Simulate a Clinic Preoperative Assessment

In routine surgical preoperative assessment, a surgeon focuses on the technique of choice, method, timing of surgery, and the expected outcome and discusses the same with the patient regarding risks and benefits. In the geriatric patient, before embarking on such a discussion, one has to first asses the following: the frailty of the patient [8, 9], role of delirium expected post-operation, and overall effect of dementia in the patient. Students should be tested with various scenarios of patients presenting for different surgery needs and asked to assess them for their surgical risk, benefit summary, and the goal of the surgery [10, 11]. Simulation case scenarios such as the following must be set to educate the student and have them familiarized with the issues in planning surgery in the elderly population.

Simulation Case Scenarios: Discuss Rationale for Decision in Each Case

- Case #1: Asymptomatic inguinoscrotal hernia in the elderly – discuss in immobile, mobile, functional patient, and highly functional athletic elderly
- Case#2: Elderly patient seeking cosmetic surgery – minor procedure under local anesthesia – injections, fillers, liposuction, or abdominoplasty in an elderly woman
- Case#3: Independently living mobile patient with previous attacks of diverticulitis – currently asymptomatic with cardiac comorbidity
- Case#4: Patient with gallstones, New Hampshire resident with significant medical comorbidities, independently living patient with one previous attack
- Case#5: NH resident immobile patient with incidental breast mass that was biopsied and found to be a hormone-positive ductal carcinoma. Next steps

Observation of the Preplanning/Assessment of the Geriatric Patient in the Clinic Setting

The medical student in the surgery clinic plays a key role in the history-taking and observation of the clinical assessment by the surgeon. If this is done in consort with the geriatrician in the clinic setting, the student should witness and understand the role each and grasp the decision-making skill involved.

The Art of Multidisciplinary Discussion in Surgical Decision-Making

The decision to operate or not: Often surgeons play an authoritative role in decision-making regarding surgery and type of interventions. However, this role has to be collaborative in the care of the elderly and has to be adapted to a multidisciplinary approach with input from the entire care team and family. The goals maybe different from the one a surgeon would routinely make in the case of a non-elderly patient who does not exhibit signs of frailty or poor healing.

Ask the students to do a group discussion and role play of a geriatric patient visit who is seeking a surgical opinion (Fig. 34.1). Change the cases with varying diagnoses and the functional and frailty level of the patient. Ask the student to explain the rationale for the decision to operate or avoid surgery. Also ask the student to discuss how to elicit the patient goals of the surgical outcome. This is when the student should familiarize themselves with the need for multidisciplinary care in the decision-making process [5, 7]. The importance of the involvement of a geriatrician, the patient's primary care physician, the patient's wishes and healthcare designee, and long-term goals of care all have to play a role in this preoperative, decision-making process (Fig. 34.2). The geriatric portion of the medical student curriculum should use small-group instructional methods consistent with adult learning principles that

Fig. 34.1 Teaching methodologies for geriatric surgery medical student education

Fig. 34.2 Optimal geriatric surgical care

include practice-based learning, case-based learning, patient simulation using Objective Structured Video Examination (OSVE), and didactic sessions. Faculty instruction is a shared responsibility between geriatricians and general surgeons [2]. Pre- and postexposure and teaching assessments can be used to asses knowledge gain in the subject prior to direct patient involvement in surgery [10].

Observation of Operative Cases Involving Geriatric Patients

The students will gain a lot of knowledge by observation and assisting in the surgery of the elderly. Here an added emphasis is placed on anesthesia preparation, techniques, and the aim to minimize time under anesthesia. Cardiac assessments including risks posed by pacemakers and AEDs are taken into consideration as is the proclivity to venous thromboembolism. Positioning of the patient and the collaborative approach to a speedy surgery and smooth recovery is to be noted in the operating room environment.

Shadowing the Geriatrician and Understanding Postoperative Care of the Elderly Patient

A geriatrician is able to view the patient's course from an alternate window than that of a surgeon. He or she takes into consideration various factors in pre- and postoperative care of the elderly surgical patient [9]. The role of patient wishes, goals, medications, functionality, frailty, and unexpected events due to surgery (e.g., DVT, Delirium) are often in the purview of the geriatrician. Ideal surroundings and the environment of care post-operation are always of utmost importance in a speedy recovery and return to functionality. Preventing delays and prolonged hospitalizations in elderly, and its importance is often exemplified in the geriatrician's practice and follow-up.

Understanding the Role of a Palliative Care Physician in the Surgical Setting

A Palliative care physician provides insight into the limitations and resetting of goals of care according to the surgical findings, procedures, and any altered diagnosis encountered. In these cases, the palliative care physician often establishes the tenet that discussing issues with the family and placing patient wishes first is the primary aim. Has the intervention and/or future plan for interventions answer the critical question of, "have you improved patient's life and established the basis of 'do no harm' in every particular case"? The palliative care team often involves discussions with caregivers to understand decisional capacity of the patient and advanced directives and the role of a Do Not Resuscitate (DNR) order as the case may be. The role of palliation is indispensable in the care of an elderly surgical patient. Often there are decisions that are made that need review and reconsideration based on the surgical disease and findings, including the possibility of a malignancy in the diagnosis.

Postoperative Care and Follow-Up of the Patient

Depending on the patient's outcome and procedure performed, the student should be exposed to and participate in rounding in the intensive care unit and gain knowledge into the geriatric issues at hand. These may include medication management, reconciliation, drug interactions, renal dosing, signs of delirium, and worsening dementia. Often the nursing care of the ICU plays a key role in an elderly surgical patient's recovery – the prevention of pressure ulcers, the importance of turning and positioning, and the pulmonary toilet are keys in preventing hospital-acquired infections. The key roles of physical therapy in combating deconditioning, which is accelerated in the elderly population postoperatively and the occupational therapist in reaching functional levels of independence are essential. A multidisciplinary care plan, rounding, and joint decision-making should be witnessed by the student for full understating of the process. The student must familiarize himself or herself with hospital-acquired infections in the setting of postoperative recovery such as a ventilator-associated event (VAE), CLABSI, CAUTI, etc. and apply it to the relevance of the case observed and followed.

Surgical Clinic Shadowing and Experience to Assess Postoperative Patients

With the intended outcome for a successful hospital discharge achieved in the elderly, every effort must be made for the student to follow the patient and observe a typical postoperative clinic visit. This is essential in understanding the rate of wound healing and the return of functionality in the elderly patient. There is data suggesting the need for depression screening in the elderly after a major surgery, especially in post-cardia surgery. Mobility, quality of life, and independence in daily activities can be assessed at a postoperative outpatient visit.

ICU Rotation in Surgery and Witness End-of-Life Discussions and Understanding Ethics Committee

Some outcomes maybe less than ideal and unanticipated which lead to prolonged ICU stays, the need for reestablishing goals of care and, at times, the need to consider imitation or withdrawal of care. Such cases are done after an extensive evaluation of goals of care, futility of care, and the patient's directives in consort with the family discussions. Some cases may require the intervention of neurology to establish brain death protocol, which should be introduced in concept to the medical student. In some instances the patient-stated directives of care and the family and caregiver discussions may not align requiring the intervention of an ethics committee. The composition, role, and interaction of such an ethics committee are important for the student to comprehend the end-of-life discussion issues. The interested medical student should at every opportunity be allowed to shadow or observe, with the family's permission, on end-of-life discussions and also ethics committee meetings. The role of organ transplantation and donor establishment rules should be discussed with every instance of end-of-life withdrawal of care and explained to the student.

Shadowing Rehabilitation Post-surgery in Elderly Patients

An ideal education in elderly surgical care should include the role of an active rehabilitation unit and understanding its function the patient recovery. The student should follow-up the patient's path in an acute rehabilitation unit if available within the hospital. For example, witnessing a joint replacement in an elderly patient is incomplete if a student does not appreciate the crucial role of physical and occupational therapy in recovery of the patient. The student also completely grasps the surgical outcome when they visit and witness the work done in an offsite rehabilitation center which may vary for each elderly patient. Such opportunities if allowable by schedule will greatly enrich and ensure completeness of education about the surgical care of the elderly. The education of geriatric surgical patient care should thus be embarked upon during the early years of clinical training the medical student and ensure a comprehensive exposure to the various multidisciplinary aspects of care.

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