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SURGICAL CARE (F LUCHETTE, SECTION EDITOR)

The Impact of the Aging Population on Surgical Diseases

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Abstract

Purpose of Review The portion of the population comprised by those aged 65 years and older is the fastest growing age group. With the aging of Americans, so goes the age of a surgeon's patients. It is also well established that with aging, the incidence of various diseases also increases. Thus, more surgical care will be consumed by the elderly. The cost of care however will be greater for geriatric patients when compared to younger patients due to the greater incidence of comorbidities in the elderly. The surgical community will need to develop new protocols for the perioperative care of these frail patients in order to provide safe care with acceptable morbidity and mortality rates.

Recent Findings Over the past 5 years, there have been notable changes in the surgical management of geriatric patients. Increased evidence in several surgical specialties supports that minimally invasive techniques for traditional open procedures improve outcomes. Additional knowledge regarding the effect of aging on organ function has led to improved stratification and preoperative preparation of patients prior to surgery. An example of this is the establishment of specific triage criteria for geriatric trauma patients. These changes have resulted in reduced morbidity and mortality rates.

Summary The elderly form a large portion of surgical patients, and this portion will continue to grow as life expectancy improves. Surgeons must adapt to this changing environment to provide optimal care to geriatric patients.

Keywords Geriatric surgery · Geriatric trauma · Geriatric emergency general surgery · Frailty · Elderly surgery

Introduction

As the USA continues to age and greater proportions of Americans are over 65 years old, the landscape of surgical practice is changing. The US Census forecasts that the current geriatric population will double by 2060 and make up almost a quarter of the population [1]. The delivery of surgical care in the USA has already begun adapting to the increasing number of elderly in the country. Healthcare will need to continue preparing for the ongoing increasing numbers of geriatric patients requiring surgical interventions. In this review, the authors look to discuss the recent literature regarding optimal surgical treatment of geriatric patients, the impact that a large aging population has on surgical practice, and the future of surgery regarding geriatric patients.

The US healthcare system has seen the beginnings of the "silver tsunami" with the increasing proportion of the population that is defined as geriatric. With the continually increasing life expectancy, the elderly will occupy a greater number of hospital beds and make up a larger percentage of surgical patients [2, 3]. Unfortunately, timely delivery of care will be strained due to the looming surgeon shortage which is projected to number at least 17,100 by 2033 [4•, 5]. Since 2000, geriatric patients have been increasing annually and account for the highest proportion of inpatients. With Medicare as the primary insurer for 88–91% of the geriatric population from 2000 to 2015 and the mean cost of inpatient care increasing, there will continue to be a significant financial burden on the healthcare system [6, 7]. The term geriatric in this paper will be used to describe patients aged over 65 years unless otherwise specified.

This article is part of the Topical Collection on *Surgical Care*

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Geriatric-Specific Factors

The geriatric population differs from the general adult population in multiple facets, and as a result, practitioners need to approach these patients differently. In 2012, the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) and American Geriatrics Society (AGS) collaborated to develop a comprehensive preoperative evaluation for the geriatric surgical patient [8]. Nine categories of preoperative assessment were identified for these unique patients: cognitive and behavioral, cardiac evaluation, pulmonary evaluation, functional status, frailty, nutritional status, medication management, patient counseling, and preoperative testing.

Frailty has been defined as a state of increased vulnerability with associated risks of morbidity and mortality and has specific relevance in the geriatric population [9, 10•, 11]. Multiple models have been identified for use in frailty evaluation preoperatively, including the Fried Frailty Phenotype, Frailty Index, and the Comprehensive Geriatric Assessment [12]. Patients identified as frail, having a poor functional status, or malnourished prior to elective surgery benefit from multimodal prehabilitation optimization. Prehabilitation programs result in decreased postoperative morbidity including delirium and a faster return to baseline function, but have not been associated with decreased mortality [13, 14•, 15]. Optimizing comorbidities, including via cardiac and pulmonary risk stratifications, and minimizing polypharmacy are two important measures to address preoperatively [16•]. When able, specific care should be taken to discuss patient goals of care, advance directives, and healthcare proxy with geriatric patients prior to surgery [17].

Anesthesia care for the elder is also unique. Intraoperative coordination with anesthesia in geriatric surgery is imperative for improved outcomes. Regional pain control should be used when possible to decrease opioid intake. Local anesthesia techniques should be implemented to avoid the risks associated with general anesthesia [18]. Hypothermia and judicious fluid administration should be monitored closely.

In the postoperative period, geriatric patients are at high risk for delirium, falls, and functional decline [17]. Risk factors for postoperative delirium should be identified promptly, including chronic cognitive impairment, uncontrolled pain, and infection. Adequate analgesia and early treatment of infection will reduce delirium and complications [17, 19•]. Additional specific strategies for preventing delirium include early and regular physical activity, family presence at the bedside, providing adaptive devices (hearing aids, glasses), and minimizing tethers (foley, intravenous fluids) [16, 20]. Fall precaution interventions should also be implemented. Lastly, geriatric patients should undergo evaluation for malnutrition and dysphagia.

Postoperative care is improved when a geriatrician is involved with managing medications for medical conditions. Ideally, a geriatric multidisciplinary team should be involved with postoperative care [21•, 22, 23]. Early involvement of these specialists facilitates the transition of care and early discharge while also reducing readmission rates. Patients should be evaluated while inpatient for needs upon discharge, including social support, therapy, and discharge instructions including medication directions.

Consideration of the urgency of the procedure also plays a large role in geriatric surgery. Emergent procedures have significantly higher rates of morbidity and mortality [24]. When an elderly patient is deciding whether to undergo an emergent procedure, the surgeon should have a thorough discussion regarding the goals of care and risks of the procedure, with specific attention regarding the quality of life. Depending on the patient's concerns and wishes, it may be appropriate to consider having palliative care involved [24].

Field-Specific Discussions

General Surgery

Emergency General Surgery

Emergency general surgery (EGS) is an evolving subset of general surgery defined as distinct from trauma and other subsets of surgery by the American Association for the Surgery of Trauma in 2003 [25]. It encompasses the acute surgical diseases requiring urgent attention and treatment. Scott et al. described the seven operations that encompass 80% of all EGS procedures. These include appendectomy, cholecystectomy, partial colectomy, lysis of adhesion, small bowel resection, surgical management of peptic ulcer disease, and laparotomy [26]. As the population ages, more of these presentations are occurring in the elderly. Approximately 1.5 million Americans annually over the age of 60 present with an EGS-associated diagnosis and 25% of these patients required emergency surgery [16]. As discussed, the elderly population present specific challenges for the treatment of these diseases. The diagnosis for each is complicated by atypical presentations due to the physiologic changes that occur with aging. They include vital sign perturbations, comorbidities, polypharmacy, and blunting of the immune response. As such, patients often present with an advanced state of disease. While the overall treatment strategies do not often vary from those utilized for managing younger patients with the same disease, due to the effect of aging on various organ function, the ultimate choice of treatment strategy is more complex.

Acute Appendicitis

Appendicitis is commonly described as a disease of the young and the very old. The lifetime risk of appendicitis is 7%, but after the age of 50, this risk decreases to 2–3% with 5–10% of all patients diagnosed with appendicitis occurring in individuals over the age of 60 [27]. Elderly patients are more likely to present with complicated appendicitis [28]. Also, the morbidity and mortality rates associated with appendicitis are higher in the elderly population with 70% of deaths from appendicitis occurring in geriatric patients [29]. The etiology of luminal occlusion and subsequent appendicitis in the geriatric patient is felt to be due to a higher incidence of luminal fibrosis, fecalith, and neoplasm [30]. In particular, the odds ratio of a malignancy-induced appendicitis is 3.6 for patients over 50 years when compared to their younger counterparts [31]. Overall, the treatment strategy for appendicitis does not differ in the elderly, although with the higher likelihood of comorbidities and associated complications in the elderly, non-operative management is more common. Multiple studies have shown the efficacy and non-inferiority of treatment with antibiotics. The CODA Collaborative recently published a randomized, non-inferiority study comparing a 10-day course of antibiotics to appendectomy. Excluding patients with an appendicolith, complication rates in the two groups were similar and of those in the antibiotic group 25% required appendectomy within 90 days [32••]. Efficacy rates have been shown to be as high as 90% with antibiotic therapy. However, the recurrent appendicitis rate is high. The APPAC trial reported that 5 years after non-operative management, there was a 39.1% rate of recurrent appendicitis, but none of the patients suffered a major complication [33, 34]. If the decision is made to proceed with antibiotic therapy in the elderly, colonoscopy must be performed after recovery to rule out malignancy. When determining whether or not an interval appendectomy needs to be performed, surgeons should take into account life expectancy and published recurrence rates.

Acute Cholecystitis, Cholangitis, Biliary Pancreatitis

The incidence of gallstones and biliary disease increases with aging. By age 70, 15% of males and 24% of females have gallstones. The incidence increases over the next two decades to 24% and 35% of men and women, respectively, by age 90 [35]. This may be due to perturbations in bile production and reduced flow that occurs with increased age. These changes also affect the incidence of other biliary diseases. As discussed previously, the elderly present diagnostic challenges due to comorbidities, changes in physiology, and medications which alter their presentation. Often, patients will present with an altered mental state due to the underlying acute illness such as acute cholecystitis or cholangitis. While early laparoscopic cholecystectomy is the standard of care for cholecystitis in the elderly, current studies reveal 30% of geriatric patients presenting with acute biliary diseases are managed medically and often require a second admission in up to 38% of patients [36]. Increasing age is associated with lower rates of surgical intervention and increased use of adjunctive interventions [37]. The rate of percutaneous cholecystostomy was twice as high in patients over 70 years of age with 8.6% versus 1.7% 30-day mortality for patients managed with early cholecystectomy. Similarly, the hospital length of stay was 13.2 days versus 7.5 [38]. For cholangitis, age has been shown to be a negative risk factor for outcomes and age > 75 is included in the Tokyo guidelines for severity grading of the disease at the time of presentation. There is some evidence, however, to suggest that while age was a factor in severity of disease, mortality was unaffected by age and related to the timing to biliary drainage [39]. Biliary pancreatitis has worse outcomes in the elderly. The mortality rate for patients over the age of 55 years is approximately 19.1% compared to 7.9% in younger patients [40]. Acalculous cholecystitis is also more common in the geriatric patients with mortality rates reported to be as high as 30%. There is an ongoing debate regarding whether cholecystectomy is required after being treated with percutaneous cholecystostomy. Kirkegard et al. concluded that in 80% of elderly patients that developed acute acalculous cholecystitis, percutaneous cholecystostomy served as definitive therapy [41].

Diverticular Disease

It is well known that the incidence of diverticular disease increases with age. The reported incidence is approximately 50% in those over the age of 60 and 60% in those over the age of 80. The aging colon develops changes in collagen with altered ratios of type I to type III collagen. Additionally, the elderly commonly suffer slow transit time which contributes to constipation with increased transluminal pressures [42]. Amongst patients with diverticulosis, 25% will develop a related complication [43]. Complicated diverticulitis in the elderly is treated similarly as in younger patients with emergent surgery for perforation with peritonitis, and antibiotics with percutaneous drainage procedure for abscess. For patients who suffer from recurrent episodes of uncomplicated diverticulitis, the treatment strategy has shifted to individualize the need for resection. Factors that should be considered when discussing colectomy with the patient include altered physiology, comorbidities, frailty, deconditioning, and polypharmacy which are all associated with increased operative morbidity and mortality.

Intestinal Obstruction

Ogola et al. described intestinal obstruction as one of the most common diagnoses requiring emergency general surgery

admission. The peak incidence of operative intervention occurs in the seventh decade of life [44]. The most common cause of small and large bowel obstruction remains consistent despite age with adhesions being the most common followed by hernia and neoplasm. Small bowel obstruction occurs three times more often than colon obstruction. The elderly have a higher incidence of less common etiologies of intestinal obstruction; for instance, gallstone ileus represents only 1–4% of small bowel obstruction etiology but is seen almost exclusively in the geriatric population [45•]. In addition, elderly patients have an increased incidence of sigmoid volvulus. The mean age is 70 years in patients diagnosed with sigmoid volvulus, which represents less than 10% of causes for intestinal obstruction [46]. The rate of failure for endoscopic decompression in the elderly is similar to that for younger cohorts. However, increasing age has been shown to significantly increase the risk of strangulated bowel at laparotomy and mortality in intestinal obstruction [47••]. Outcomes for elderly patients undergoing laparotomy for intestinal obstructive disease are worse when compared with younger patients [48]. In an elderly patient managed non-operatively for intestinal obstruction, preoperative optimization should also be occurring to decrease the morbidity and mortality in anticipation of possible treatment failure and necessary surgery.

Gastrointestinal Bleed

The overall incidence of gastrointestinal bleeding (GIB) in the USA is 100 per 100,000 with upper gastrointestinal bleeding (UGIB) being twice as common. Not surprising, the incidence of GIB in people aged over 75 is significantly higher at 425 and 380 per 100,000 for UGIB and lower GI bleeding (LGIB), respectively [49, 50]. Mortality rates associated with GIB increase with age; in patients aged 65–84 years, it is 3% and increases to 5.2% for those over the age of 85 [51]. The most common cause of UGIB in the elderly is peptic ulcer disease followed by esophagitis and varices; the most common cause of LGIB is diverticulosis followed by neoplasm. Treatment starts with resuscitation. Due to comorbid conditions, elderly patients are commonly prescribed anticoagulants and antiplatelet medications and must be reversed early in the resuscitation phase to reduce bleeding. The use of these medications may be the reason for the increased incidence of GIB in the geriatric population. Despite the therapeutic benefits of newer direct oral anticoagulants, there is a 25% increased risk of GIB when compared with the incidence for warfarin [52]. One of the more common antidotes used to restore normal coagulation is prothrombin complex concentrate (PCC). When compared to fresh frozen plasma (FFP) and vitamin K, PCC is faster and more effective at restoring normal coagulation. It has been shown to result in a twofold decrease in 7-day mortality and a decreased need for invasive procedures for patients anticoagulated with warfarin when compared to use of FFP and vitamin K [53, 54]. Endoscopic examination should be performed early to confirm the etiology of GIB and to also offer early intervention to control the hemorrhage. Elderly patients are at increased risk for complications when undergoing endoscopic procedures, including aspiration with EGD, dehydration with colonic preparation, and cardiopulmonary complications from periprocedural sedation medications. The American Society of Gastrointestinal Endoscopists recommends avoiding sodium phosphate and magnesium-based solutions for bowel preparation. They recommend the use of a split-dosage prep with balanced poly-ethylene glycol-based solutions. Lastly, minimal use of sedatives results in less periprocedural complications [55]. When the bleeding cannot be controlled with endoscopic techniques, the next intervention in hemodynamically stable patients should be angiography with possible embolization. If the patient is experiencing hypotension, then surgical control should be entertained. As previously discussed, elderly patients have worse surgical outcomes and multiple attempts at non-surgical control should be attempted if possible.

Ventral and Inguinal Hernia

Inguinal and ventral hernias are common surgical problems seen with occurrences increasing in the elderly [56]. Contributing factors to the development of hernias in the elderly include decreased abdominal wall strength and comorbidities including COPD and BPH [56]. Amongst those patients that undergo surgical repair, elderly patients are less likely to have minimally invasive techniques utilized, despite evidence that minimally invasive techniques are safe and result in decreased morbidity and improved quality of life [57•, 58, 59]. Elective hernia repair in geriatric patients is preferable to avoid the increased morbidity and mortality associated with emergent repair [60]. When appropriate, the operation should be performed under spinal anesthesia or with monitored anesthesia care which are associated with decreased operative time and complications [61]. Lastly, Becher et al. concluded that older patients who underwent emergent surgery for a complicated hernia had improved outcomes when the surgery was performed at a high-volume facility [62•].

Gastrointestinal and Oncologic Surgery

Mastalerz points out, the elderly "are not simply 'older adults'" and must therefore be approached differently than the general adult population [63]. With aging, there are several changes throughout the gastrointestinal (GI) tract. These include slower motility, diminished mucosal immunity, and nervous degeneration with increased age [47••]. Older patients requiring a major abdominal operation are known to have increased rates of morbidity and mortality compared to adults less than 65 years [64].

Colon and Rectal Cancer

The majority of newly diagnosed colon and rectal cancers occur in the geriatric population. The incidence is expected to increase as the elderly population continues to increase [65–67]. Despite this trend, the U.S. Preventative Task Force only recommends colorectal cancer screening until age 75 [68]. Completing the oncologic resection electively can mitigate some of the additional risks encountered when performing the resection emergently for bleeding or obstruction [47••, 69]. With increased age, higher rates of in-hospital and 1-year postoperative mortality, discharge to facility, prolonged length of stay, and postoperative complications are observed [66, 67, 70]. Minimally invasive techniques in colorectal resection reduce morbidity and postoperative complications without compromising the oncologic outcome. Additionally, there is earlier return of gastrointestinal function and resumption of diet [71]. Implementation of Enhanced Recovery After Surgery programs has also shown to improve short-term outcome [65].

Gastric Cancer

Similar to colorectal cancers, there is an increased prevalence of gastric cancer diagnoses in the elderly, with most cases diagnosed between the ages of 65 and 74 [72•]. Despite evidence of safety and efficiency of surgical intervention for gastric cancer, elderly patients are often under-treated due to concerns related to safety [72•]. Though advanced age is associated with increased morbidity and mortality, gastrectomy offers an overall survival benefit when compared with optimal chemotherapy treatment [72•, 73, 74]. A D2 lymphadenectomy with R0 resection is the ideal resection for gastric malignancy. Even in the geriatric patient, inclusion of D2 lymph node resection has improved overall and disease-free survival with no increase in morbidity [75].

Surgical Oncology—Pancreatic, Hepatobiliary Cancer

Outcomes for patients undergoing resection for gastric, pancreatic, and hepatic neoplasms are improved when care is provided by surgeons who perform a high volume of the operations and also when the operation is performed at a high-volume facility [63, 72•, 76, 77]. Pancreatic cancer is a highly fatal disease of which more than half of patients diagnosed are of geriatric age [78•]. Surgical resection is the only treatment that offers a potential cure. However, the 5-year survival remains only 20% [79•]. Compared to their younger counterparts, geriatric patients are less likely to be in clinical trials, achieve a R0 resection, or undergo adjuvant chemotherapy [78•, 80]. Meta-analysis by Tan et al. demonstrated similar postoperative mortality between elderly and non-elderly [78•].

Hepatic neoplasms include hepatocellular carcinoma (HCC), cholangiocarcinoma, and colorectal carcinoma (CRC) metastases. As with other malignancies, these three tumors are more frequent in the elderly [81, 82]. With increased age, there is decreased liver volume, decreased number of functional hepatocytes, and reduced regenerative capacity [83, 84]. Hepatectomy is the optimal curative treatment for HCC and CRC metastases [83, 85]. Minimally invasive surgical techniques have improved outcomes when compared to traditional open operations including reduced length hospital length of stay and complications [84, 86]. Compared with younger patients, the elderly experience increased rates of pulmonary and cardiovascular complications while recovering but no increase in liver-related complications [83, 85].

Trauma and Critical Care

Trauma Surgery

As noted earlier, the elderly represents the fastest growing group of Americans. In contrast to younger patients, falls are the most common mechanism of injury followed by motor vehicle collisions (MVC) [16•]. The cost associated with caring for these geriatric patients exceeds $34 billion annually [87]. Increased age is an independent predictor for mortality in the setting of trauma [87]. Case fatality rates increase with age in both falls and MVCs, ranging from 4 to 8% and 7 to 15%, respectively [88]. When analyzing mortality rates for specific Injury Severity Scores (ISS), age has been shown to be an independent risk factor related to increased fatality [88]. Elderly patients are often undertriaged for activations. When this occurs, the patient's hemodynamic status may rapidly decompensate due to the decreased physiologic reserve that occurs with aging [16•]. A thorough history, when able, should be obtained making sure to note comorbidities and medications, especially anticoagulants and cardiac medications. Evaluating a geriatric patient for frailty is beneficial, as frail patients have worse outcomes following trauma [10•]. When an injured patient is anticoagulated, reversal should be immediately pursued to prevent potential hemorrhage.

Amongst elderly populations, traumatic brain injuries (TBI) are the leading cause of death [87]. Due to factors such as decreased brain volume and vessel fragility, TBI are common but patients may not be initially symptomatic [89•]. Physicians should therefore have a lower threshold to perform early imaging in these patients in an effort to allow for prompt treatment that then improves outcome.

Due to high rates of osteoporosis, muscle mass loss, and overall decrease in structural support, geriatric patients are at high risk of fractures following trauma. The most common skeletal fracture in the elderly involves the rib cage. The number of fractured ribs is directly correlated with mortality [89•].

Aggressive pulmonary toilet and pain control including local anesthesia should be pursued to mitigate risks of pneumonia and other pulmonary complications. Pelvic fracture has a four-fold increase in mortality in geriatric patients, with advanced age, ISS, mental status, mechanical ventilation, and blood product administration found to be independent predictors of mortality [89•, 90]. Other common fractures involve the forearm and hip [87]. Efficient surgical fixation of hip fractures, within 48 h of injury, reduces morbidity and mortality [91]. While less common, pelvic fractures have increased rates of hemorrhage and are associated with increased mortality [87]. Geriatric trauma rates continue to rise, and trauma surgeons should be well-versed in the additional risks in this population.

Critical Care

Critical care for the geriatric patient presents multiple new challenges due to changes in physiology that result from aging. The elderly comprise approximately 50% of ICU admissions and greater than half of ICU days annually [47••]. There is a significant increase in mortality amongst elderly patients during both the ICU stay as well as during the 6 months after discharge [20]. By understanding the physiologic changes with increased age as discussed here, physicians are better able to assess the risks associated with caring for elderly patients. All critically ill patients are at increased risk for delirium. However, the geriatric patients are the most vulnerable for development of delirium with the highest rate of this adverse event. Delirium is also associated with increased rate of postoperative complications [16•]. Risk factors for delirium include medications, reduced renal function, preoperative cognitive impairment or poor functional status, depression, and a previous episode of delirium [16•]. Joyce and Reich note it is "better to prevent delirium rather than to treat it" [20]. Implementation of ABCDE Bundles (Awakening, Breathing, Coordination, Delirium Assessment, Early Mobility) into daily practices in the ICU has been shown to reduce the rate of delirium [20]. Aging of the heart results in reduced cardiac output due to deposition of collagen and fat. These changes lead to higher rates of arrhythmias, heart failure, and valvular disease. Close monitoring of volume status and for arrhythmias reduces the incidence of these complications and allows for early intervention when they occur. The incidence of acute respiratory failure increases with aging [92]. In the postoperative setting, any respiratory complication is associated with increased morbidity and is an independent predictor for death [16•]. The incidence of acute kidney injury is greater in the elderly [20]. When complications such as prolonged respiratory failure requiring mechanical ventilation and/or the need for renal replacement therapy (RRT) occur, it is important to confirm the patient's stated goals of care when considering placement of tracheostomy or initiating RRT.

Burn Surgery, Wound Care

With impairments in judgment, coordination, and reaction time, the elderly are at high risk for burn injuries [93]. With age, the skin thins and has decreased adnexa leading to decreased ability to respond to injury and re-epithelialize [94]. Elderly patients experience significantly higher morbidity and mortality with burn injuries compared to the general population [94]. The revised Baux score (r-Baux) was designed to estimate mortality following a burn injury, incorporating age, percent total burn surface area, and inhalation injury [95]. Treatment of elderly patients with large burns can be difficult given the necessity of fluid resuscitation, which can result in fluid overload and resultant pulmonary edema or abdominal compartment syndrome [96]. The challenges noted for other critically ill patients also pertain to the critically ill burn, with additional difficulties given the need for burn excision, pain control, infection risk, and nutritional supplementation [94].

Chronic soft tissue wounds affect a significant portion of the geriatric population and result in a large financial burden to the healthcare system [97]. Malnutrition, diabetes mellitus, peripheral vascular disease, and neuropathy are known risk factors for the development of skin and soft tissue wounds [47••]. Pressure ulcers are common in elderly patients who are infirmed due to the loss of fat padding, decreased mobility, and incontinence [98]. While some are deemed to be unavoidable, the best method for wound treatment is prevention [47••, 99].

Plastic Surgery

As the geriatric population increases, there has been growing interest within the field of plastic surgery in the management of the aging process on the skin. According to the American Society of Plastic Surgeons, over a quarter of the 18 million cosmetic procedures performed in 2019 were in patients age 55 years and older, a 24% increase when compared to 2010 [100]. The overwhelming majority of cosmetic surgical procedures performed in this age group involve the face, which play a vital role in human esthetic perception [100]. As such, there has been a significant number of studies in the esthetic literature aimed at understanding senescent changes of the facial skin and its appendages [101,102•, 103, 104]. For the geriatric population, these changes are an inevitable process as a result of extrinsic and intrinsic factors associated with aging resulting in varying degrees of diffuse lipoatrophy, heterogeneous facial skeletal reabsorption, and inelastic, coarse, dyschromic changes of the skin [101, 103, 104]. While cosmetic procedures are reported to have a positive impact on self-esteem and quality of life, there is data to suggest that this effect might be diminished in geriatric patients due to potentially higher prevalence of preexisting depression or personality disorders and unrealistic expectations preoperatively [105,

106]. However, the risk of complications in geriatric patients undergoing cosmetic surgery is determined more by the physiologic rather than chronologic age. Studies have demonstrated no difference in complication rates in the elderly when compared to younger patients with an American Society of Anesthesiologist (ASA) class 1 or 2 score [107]. Despite a lower surgical risk, careful selection and preoperative counseling is paramount to ensuring optimal outcome in geriatric patients desiring an esthetic procedure.

Vascular Surgery

Risk factors for peripheral vascular disease such as smoking, hypertension, and dyslipidemia are often cumulative over time. Thus, the aging population makes up a significant proportion of the patients benefitting from vascular intervention. Partridge et al. demonstrated that comprehensive preoperative assessment and optimization in the elderly is associated with a lower incidence of postoperative complications [108]. Compared to traditional open approaches, endovascular techniques result in reduced morbidity and mortality. These percutaneous interventions are now considered to be the standard of care [109•, 110]. Amongst elderly patients undergoing abdominal aortic aneurysm (AAA) repair, mortality is decreased 5-fold when an endovascular approach is used compared to open aneurysmorrhaphy [111]. When considering AAA repair in a geriatric patient, surgeons must take into account the elevated risk of mortality and weigh the potential benefits of repair [110,111, 112•]. In contrast to elective AAA repair, around 2/3 of AAA ruptures occur in elderly patients and are associated with a very high mortality rate [112•]. The non-frail elderly patients who are functionally independent have a lower incidence of complications and mortality with AAA repair [111].

Lower extremity ischemia, including lifestyle limiting claudication and chronic limb ischemia, are frequent presentations in the geriatric population. The incidence of peripheral arterial disease is 15–20% [112•]. Independent of the open or endovascular approach, morbidity and mortality rates are increased in the elderly [112•, 113]. Medical management coupled with exercise programs can resolve the patient's symptoms and avoid surgical intervention. However, the decision of when to operate and which surgical approach in geriatric patients requires thoughtful consideration taking into account the patient's physiologic reserve, rehabilitation potential, comorbid disease burden, and desired outcome [112•].

Conclusion

As Americans enjoy living longer, surgeons must be prepared to care for geriatric patients. Many surgical diseases are more prevalent in the elderly. Risk stratification and comorbidity optimization will continue to have greater importance in selecting and preparing the geriatric patient for an operation. Surgeons should be mindful of the physiologic differences in the elderly and incorporate changes as necessary into their practice.

Compliance with Ethical Standards

Conflict of Interest The authors have no conflicts to declare.

Human and Animal Rights and Informed Consent All reported studies/experiments with human or animal subjects performed by the authors have been previously published and complied with all applicable ethical standards (including the Helsinki Declaration and its amendments, institutional/national research committee standards, and international/national/institutional guidelines).

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