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## Take Home Pearls

- Pre operative risk stratification in the elderly patient is important not only to predict mortality and morbidity but also to predict return to baseline function.
- These processes also facilitate targeted interventions prior to surgery.
- There are both medical and surgical assessment tools that are useful.
- Geriatric assessment tools are equally important in elderly surgical patients and may identify patients with a reduced functional reserve which conventional tools may miss.
- Due to heterogeneity, morbidities are better quantified rather than described.
- Outcome measures should not only include morbidity and mortality but also return to functional baseline.

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### 3.1 Introduction

Preoperative risk stratification for the elderly is extremely important and serves three functions:

1. Assist in the decision to offer surgery or not
2. Assist in the perioperative management of the patient
3. Assist in presenting the patient with adequate information for informed consent

Of particular importance, and perhaps uniquely in the geriatric population, the decision to choose between a surgical intervention or not can be a complex process. Typically, when a patient is diagnosed with a malignancy that is resectable, surgery generally follows. However, in the geriatric population, one must consider whether the cure, i.e., surgical intervention to extend life, will compete with the patient's expectation with regard to quality of life. If surgery can extend life but comes with a high risk of mortality and morbidity and result in a patient unlikely returning to their baseline function, then, is he or she better served by foregoing surgery and an extended but low-quality lifespan and instead choose to live a shorter lifespan but with a better quality of life? One must ask whether an otherwise high-functioning patient would desire surgery if there is a substantial risk that he or she will become bed bound or lose their independence permanently.

The second reason for the need for risk stratification is to allow for better perioperative management of the patient that chooses to undergo surgery. This allows recognition of specific physiological problems that may be better optimized preoperatively or require close postoperative monitoring. In the elderly patient, this is no simple task as a significant number of patients will present with more than one comorbidity and may be on multiple medications that will impact perioperative care. Coupled with age-related decreases in functional reserves, a thorough and holistic risk analysis can be a daunting task.

It also goes without saying that in order to provide patients with proper informed consent, the surgical risks and their likelihoods is a very important area of concern that requires adequate discussion prior to surgery. Moreover, the impact on the patient's quality of life will need to be discussed in detail both for decision making and for the patient to make adequate plans for long-term postoperative care.

Lastly, one should also keep in mind the goals of treatment. It is certainly obvious that, if the patient has decided on surgery for treatment, the goals are to maximize the therapeutic benefit of the intervention leading to cure and to minimize perioperative morbidity and mortality. However, just as important, as alluded to previously, is for the geriatric patient to return to baseline function. In some ways, this goal is even more difficult than the others. As such, unique to geriatric surgery, is the need to document a patient's baseline function, have a plan to return to this baseline, and measure if this occurs postoperatively.

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### 3.2 General Risk Scoring Systems

A number of general risk scoring systems are in common use today. These are either physiological-based or organ system-specific systems that deal with perioperative morbidity and mortality.

**Table 3.1** American Society of Anesthesiologists Physical Status classification system

ASA status	Criteria
1	A normal healthy patient
2	A patient with mild systemic disease
3	A patient with severe systemic disease
4	A patient with severe systemic disease that is a constant threat to life
5	A moribund patient who is not expected to survive without the operation
6	A declared brain-dead patient whose organs are being removed for donor purposes

### 3.2.1 ASA Physical Status Scoring System

In 1941, the American Society of Anesthetists made the first attempt by any medical specialty to risk stratify patients in the form of the ASA physical status classification system (Table 3.1). A three-person committee was tasked to develop a system to collect and tabulate anesthetic data. It is thus useful for record keeping and for statistical analyses looking at perioperative data. This widely used classification system determines risk solely on the basis of a patient's preoperative history and is relatively easy to use.

Of note is that the ASA classification was not designed as a tool to predict post-operative morbidity or mortality. There is no attempt to quantify the risk. As such, it is a relatively crude instrument for the analysis of operative risk. However, there have been studies that have sought to validate the ASA scoring system and have shown that the ASA score does correlate with outcomes such as unplanned ICU admissions, cardiopulmonary adverse events, and prolonged hospital stay. As such, it is still widely used by anesthesiologists for perioperative planning.

In the context of geriatric surgery, it is important to note that age is not a criteria along with other important variables such as type of surgery, degree of weight loss, etc. As well, it is to be noted that this scoring system uses subjective measures as opposed to objective, measured indicators.

### 3.2.2 Goldman and Detsky Index

In an attempt to better determine and quantify risk, Goldman, in 1977, developed a risk assessment tool using nine variables to determine cardiac risk for noncardiac surgery patients (Goldman et al. 1977). Each variable is assigned a point value and a patient's risk is determined based on the overall score (Table 3.2). The highest possible score in this system is 53. Based on this scoring scheme, patients can be classified into four distinct categories of risks (Table 3.3). His tool was derived retrospectively using a database of 1,001 patients.

This multifactorial tool certainly was a step forward from the ASA scoring system as it is an objective scale that is designed to give a predicted score. However, it only is designed to predict the possibility of a cardiovascular event and therefore

**Table 3.2** Goldman's multifactorial index

Variable	Points
History	
Myocardial infarction within 6 months	10
Age over 70	5
Physical examination	
S-3 or jugular venous distension	11
Important aortic stenosis	3
Electrocardiogram	
Rhythm other than sinus or sinus plus APBs on last preoperative ECG	7
More than 5 premature ventricular beats per minute at any time preoperatively	7
Poor general medical status – O <sub>2</sub> pressure <60 mmHg, CO <sub>2</sub> pressure >50 mmHg, Serum K <sup>+</sup> <3 mmol/L, Serum HCO <sub>3</sub> <sup>-</sup> <20 mmol/L, serum urea >18 mmol/L, serum creatinine >260 mmol/L, AST abnormal, signs of chronic liver disease, and/or bedridden from noncardiac causes	3
Intraperitoneal, intrathoracic, or aortic surgery	3
Emergency operation	4

**Table 3.3** Risk of cardiac complications based on Goldman's score

Total score	Risk of cardiac complications (%)
0–5	1
6–12	7
13–25	14
26–53	78

will under evaluate the total mortality and morbidity risk. As well, the authors did not subsequently perform hypothesis testing after the score was developed. It is still a useful tool given the fact that cardiovascular problems are the most common comorbidity encountered in the geriatric population.

In 1986, Detsky further refined Goldman's original system by adding newer criteria such as pulmonary edema (Detsky et al. 1986a) (Table 3.4). As well, a further attempt was made to incorporate the type of surgery that the patient was to undergo into the risk calculation. The surgical categories were major vascular surgery, orthopedic, intrathoracic/intraperitoneal, and minor surgery. This generated a pretest probability ranging from 1.6% to 13.6%. Then, a nomogram was used in conjunction with the modified multifactorial index to generate a posttest probability of a severe cardiac complication. Both the original Goldman index and Detsky index continue to be used, and web-based calculators are easily found and can be quickly used to calculate both scores and predicted risk of complications.

**Table 3.4** Detsky modified multifactorial index

Variables	Points
Coronary artery disease	
1. Myocardial infarction <6 months	10
2. Myocardial infarction >6 months	5
Canadian Cardiovascular Society Angina	
1. Class 3	10
2. Class 4	20
3. Unstable angina within 3 months	5
Valvular disease: suspected critical aortic stenosis	20
Arrhythmias	
1. Sinus plus atrial premature beats or rhythm other than sinus on last preoperative ECG	5
2. More than 5 ventricular premature beats at any time prior to surgery	5
Poor general medical status: O <sub>2</sub> pressure <60 mmHg, CO <sub>2</sub> pressure >50 mmHg, Serum K <sup>+</sup> <3 mmol/L, Serum HCO <sub>3</sub> <sup>-</sup> <20 mmol/L, serum urea >18 mmol/L, serum creatinine >260 mmol/L, AST abnormal, signs of chronic liver disease, and/or bedridden from noncardiac causes	5
Age over 70 years	5
Emergency operation	10

### 3.2.3 American College of Cardiology/American Heart Association Guidelines

Subsequently, the American College of Cardiology and the American Heart Association developed a joint guideline for preoperative cardiovascular evaluation for noncardiac surgery. The latest guideline was updated 2007 (Fleisher et al. 2007) and is available for download at <http://content.onlinejacc.org/cgi/content/full/50/17/e159>. Although the algorithm is not strictly a tool to calculate risk, it is a useful guide with respect to determining which patients may benefit or require further pre-optimization. One of the strengths of the tool is that there is an emphasis on minimizing unnecessary procedures and tests, which would undoubtedly lead to a longer preoperative course.

### 3.2.4 POSSUM Scoring

Coming out of the need to develop a useful surgical audit tool to compare performance across hospitals, Copland in 1991 published a paper wherein they performed a multivariable analysis to determine independent risk factors affecting morbidity and

mortality (Copeland et al. 1991). This led to the development of the Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM). The score comprises 12 preoperative and 6 intraoperative variables to predict for both mortality and morbidity (Table 3.5). Thus, a physiologic score based on the patient's preoperative risk factors is combined with six intraoperative findings to give a more comprehensive predictor. Further analysis of this tool in the literature noted that the POSSUM score tended to overpredict mortality in low-risk patients.

Subsequently, Prytherch and colleagues developed a modification of the score known as the (Portsmouth) P-POSSUM (Prytherch et al. 1998). This score was developed in response to the short coming of overpredicting low-risk patient's mortality and was based on the same data set used for the original POSSUM score. However, the P-POSSUM score tends to underestimate the risk in both the elderly and in emergency surgeries. Used together, the POSSUM score can be used for morbidity and the P-POSSUM is then used for mortality. Both of these scores have been validated as a tool for the use in general surgery and are widely used in the western world.

A further refinement to the POSSUM score is the Cr-POSSUM score (Table 3.6) that is specifically designed for use in colorectal surgery (Tekkis et al. 2004). Of the three, the Cr-POSSUM appears to predict mortality better than both of the above. Lastly, in 2010, Tran developed the E-POSSUM score that is further defined for use in the elderly population undergoing colorectal surgery (Tran et al. 2010). It has yet to be externally validated.

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### 3.3 Geriatric Risk Assessment

What is of utmost importance with regard to the geriatric patient is that none of these above risk stratification systems deal with what Bernard Isaacs termed "the giants of geriatrics": immobility, instability, incontinence, and cognitive impairment (Issacs 1997). Immobility of course is a big issue with regard to postoperative mobilization and the prevention of such conditions such as venous thromboembolism and pneumonia. Instability, of course, can lead to falls which again will cause other comorbidities such as fractures and, one of the most concerning problems, which is headtrauma. Incontinence places the patient at risk of soilage and cross-contamination. And lastly, cognitive impairment is one of the biggest risks for postoperative confusion and delirium.

#### 3.3.1 Charlson Weighted Comorbidity Index

It is therefore fitting to look toward the geriatric literature to better understand risk assessment in the geriatric population. One risk assessment tool commonly used in the geriatric population is the Charlson weighted comorbidity index (Charlson et al. 1987). This tool was initially developed to assess long-term mortality in this population of patients. However, subsequently, it has been used to predict outcomes for acute

**Table 3.5** POSSUM scoring and formula for predicted morbidity and mortality

	1	2	4	8
<b>POSSUM physiological score</b>				
Age	<60	61–70	>71	
Cardiac + CXR	No failure	Diuretic, digoxin, antianginal/hypertensive	Dyspnea on exertion, moderate COPD	Resting dyspnea, RR>30/min, fibrosis, consolidation
Systolic BP	110–130	131–170 or 100–109	>171 or 90–99	<90
Heart rate/min	50–80	81–100 or 40–49	101–120	>121 or <40
GCS	15	12–14	9–11	<8
Hb	13–16	11.5–12.9 or 16.1–17.0	10.0–11.4 or 17.1–18.0	<9.9 or >18.1
WBC	4–10	10.1–20.0 or 3.1–4.0	>20.1 or <3.0	>15.1
Urea	<7.5	7.6–10.0	10.1–15.0	>15.1
Sodium	>136	131–135	126–130	<125
Potassium	3.5–5.0	3.2–3.4 or 5.1–5.3	2.9–3.1 or 5.4–5.9	<2.8 or >6.0
ECG	Normal		Atria fibrillation (rate 60–90/min)	Any abnormal rhythm, >5 ectopics/min, Q waves, ST/T wave changes
<b>POSSUM operative severity score</b>				
Severity score	Minor	Moderate (colectomies)	Major (APR)	Major +
Multiple procedures	1		2	>2
Blood loss (mls)	<100	101–500	501–999	>999
Contamination	None	Minor (serous)	Local pus	Free bowel content, pus or blood
Presence of Ca	None	Primary	Nodal mets	Distant mets
Mode of surgery	Elective		Urgent	Emergency (immediate <2 h)

$$x = (0.16 \times \text{physiologic score}) + (0.19 \times \text{operative score}) - 5.91$$

$$\text{Predicted morbidity rate} = 1 / (1 + e^{-x})$$

$$y = (0.13 \times \text{physiologic score}) + (0.16 \times \text{operative score}) - 7.04$$

$$\text{Predicted mortality rate} = 1 / (1 + e^{-y})$$

**Table 3.6** Colorectal POSSUM

	1	2	3	4	8
Physiological parameters					
Age	<61	-	61-70	71-80	>80
Cardiac failure	No/mild	Moderate	Severe	-	-
Systolic BP (mmHg)	100-170	>171 or 90-99	<89	-	-
Heart rate (beats/min)	40-100	101-120	>121 or <39	-	-
Hb level (g/dL)	13-16	10-12.9 or 16.1-18	<9.9 or >18.1	-	-
Urea level	<10	10.1-15	>15	-	-
Operative parameters					
Operation type	Minor	-	Intermediate	Major	Complex major
Peritoneal contamination	None/serous fluid	Local pus	Free bowel content, pus or blood	-	-
Malignancy status	No cancer/dukes A or B	Dukes C	Dukes D	-	-
Urgency	Elective	-	Urgent	-	Emergency (<2 h)



**Table 3.7** Weighted index of comorbidity from Charlson comorbidity index

Comorbidity condition	Assigned weighted index
Acquired immune deficiency syndrome (AIDS)	6
Metastatic solid malignancy	6
Liver disease – moderate or severe	3
Malignant lymphoma	2
Leukemia	2
Any malignancy	2
Diabetes with end organ damage	2
Renal disease – moderate or severe	2
Hemiplegia	2
Diabetes	1
Liver disease – mild	1
Ulcer disease	1
Connective tissue disease	1
Chronic pulmonary disease	1
Dementia	1
Cerebrovascular disease	1
Peripheral vascular disease	1
Congestive heart failure	1
Myocardial infarction	1

medical events such as a cerebral vascular accident. Furthermore, it has been adapted for use in the surgical arena in such diverse conditions such as transplantation, mesenteric ischemia, and also perforated diverticular disease. In the realm of colorectal surgery in particular, a recent study found that a comorbidity score higher than 5 predicted for a 5 times higher risk of morbidity.

The scale itself consists of a number of comorbidities that are given a weighted value (Table 3.7). The aggregate score thus gives the clinician a tool to quantify the burden of disease. Of note is that this is primarily a geriatrician's tool and not a surgeon's tool.

### 3.3.2 Frailty

A more recent and emerging concept is that of frailty. Frailty is fast becoming as recognized as another “giant” of geriatrics as the term tries to capture the overall patient's hardiness and resilience to injury (Crome and Lally 2011). The core concepts of frailty are not in doubt, and there is consensus that frailty is a condition in which patients have impairments in multiple, interrelated systems that lead to increased vulnerability to physiological challenges and stressors. There is a loss of resiliency due to decreased functional reserves. What is interesting in regard to this concept is that it is not necessarily comorbidity based. There are patients who have multiple comorbidities and are not frail, but conversely, there are patients who have no comorbidities but are frail.

Where there is a lack of consensus is how frailty should be defined. In the literature, the most commonly cited definitions are by Fried and Rockwood. Fried's model (Fried et al. 2001) is based on the assessment of five physical indicators: weight loss, walking speed, grip strength, physical activity, and exhaustion (Table 3.8). A finding of impairment in three or more categories meets the diagnosis of frailty. The scale has been shown to predict for falls, disability, hospital admission, and mortality. Most recently, our institution has shown that that in patients who meet the criteria for frailty, the odds ratio related to postoperative major complications was fourfold (4.083 [CI 1.433–11.638]) (Tan et al. 2011). A recent study by Makary using the Fried criteria found that it predicted for postoperative complications, length of stay, as well as discharge from hospital into a facility (Makary et al. 2010).

Some drawbacks to the Fried model are that it is difficult to apply to patients who are acutely ill and that it lacks direct measurement of mental health and psychosocial status.

Rockwood's model proposes that the risk of becoming frail is related to the development of certain deficits. As such, as more and more deficits accumulate, the greater the risk of frailty will be. However, the model has yet to be fully accepted in the clinical setting and has not been tested in the surgical literature (Rockwood et al. 2005).

### 3.3.3 Baseline Function

The various standard systems noted previously reflect the typical risk stratification tools that measure the risk of mortality and perioperative complications. However, one of the biggest critiques of the state of geriatric surgery is that outcomes studies are missing the mark and that these outcome measures of morbidity and mortality, though extremely useful, do not address possibly the biggest concern of the geriatric population: what will be the quality of life after surgery? Surgeons are adept at looking into morbidity and mortality rates to best contemplate whether a surgical intervention is worthwhile and can compare it to the natural history of the disease as well as the possibility of cure based on the tumor type and surgical procedure. What is not commonly addressed both by surgeons and the literature is what is the rate of return to baseline function and, hence, quality of life after surgical intervention. There is a need to remind caregivers that health is not merely absence of disease or cancer in this case, but the state of complete physical, mental, and social well-being. As well, the affect on postoperative function can have a direct impact on survival that is separate from any tumor stage considerations.

Currently, there is a dearth of tools and knowledge as to the affect that colorectal rectal surgery has on quality of life and return to baseline function. At the minimum, any surgical unit that performs geriatric surgery should consider using a tool such as Barthel's activities of daily living index (Table 3.9) to use as a baseline score and then follow this out postoperatively and to collect this data prospectively to better understand and quantify the impact that surgery has on baseline function.

**Table 3.8** Criteria for definition of frailty

Components	Details of criteria		Satisfy criteria
Gender	Male	Female	
Weight loss	Greater than 10 lbs or 5% weight loss in the last 1 year		Yes/no
15 – foot walk time	Height less than or equal to 173 cm	More than or equal to 7 s	Yes/no
	Height more than 173 cm	Height less than or equal to 159 cm	
Grip strength	BMI less than or equal to 24	More than or equal to 6 s	More than or equal to 7 s
	BMI 24.1–26	Less than or equal to 29	More than or equal to 6 s
	BMI 26.1–28	Less than or equal to 30	Less than or equal to 17
	BMI more than 28	Less than or equal to 30	Less than or equal to 17.3
Physical activity (MLTA)	Less than 383 kcal/week	Less than or equal to 32	Less than or equal to 18
Exhaustion		BMI more than 29	Less than or equal to 21
	A score of 2 or 3 on either of the question on CES – D below:	Less than 270 kcal/week	Yes/no
	How often in the last week did you feel this way?		
	1. I felt that everything I did was an effort		
	2. I could not get going		
	Score: 0 = 1 day, 1 = 1–2 days, 2 = 3–4 days, 3 = more than 4 days		

One is *frail* having satisfied three or more of above criteria (i.e., three or more “Yes”)

**Table 3.9** Modified Barthel's index

Components	Unable to perform task	Attempts task but unsafe	Moderate help required	Minimal help required	Fully Independent
Personal hygiene	0	1	3	4	5
Bathing self	0	1	3	4	5
Feeding	0	2	5	8	10
Toileting	0	2	5	8	10
Stair climbing	0	2	5	8	10
Dressing	0	2	5	8	10
Bowel control	0	2	5	8	10
Bladder control	0	2	5	8	10
Ambulation	0	3	8	12	15
(wheelchair)	0	1	3	4	5
Chair-bed transfer	0	3	8	12	15
Total score	/100				

This will continue to be an ever expanding area of inquiry and concern. The aim, of course, is to be able to nurture patients back to their baseline function should they decide on surgery.

### 3.3.4 Comprehensive Geriatric Assessment

The above three parameters form part of a comprehensive assessment which has potential implications that are wider than surgical risk assessment alone and thus have been mentioned in other chapters in this book as well.

#### Conclusion

With the myriad of tools that have been developed, colorectal surgeons should become familiarized with at least one physiological scoring system and one that looks at frailty. At this time, the best tools available appear to be the Cr-POSSUM score as well as Fried's frailty index. Using a combination of these tools will allow the clinician to better consider the appropriateness of surgery for each individual patient and also use this information to better allow the patient to give informed consent.

An increasing emphasis needs to be placed on the patient's return to baseline function. We need to expand our definition of surgical success not only on tumor cure and absence of morbidity and mortality, but also on the patient's ability to return to their prior level of function. For patients who are undergoing surgery, Barthel's index should be used to document baseline function and subsequently allow for postoperative goal setting as well as quality assurance. As hinted above, having a geriatrician as an active part of the team is invaluable and the use of the Charlson index can be added.

As the geriatric population increases, the need for more colorectal surgery will also increase and more and better tools will be required to better help select which patients will benefit from surgery. The need though is for better tools to predict not just morbidity or mortality, but to also predict for quality of life and the ability of the patient to return to baseline function. A further challenge is for the development of effective tools to mitigate and/or alleviate the problem of frailty. As such, all colorectal units have an obligation to prospectively collect and routinely analyze their data to develop newer and better protocols to treat the elderly patient with colorectal cancer.

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