Chapter 22
Preoperative Evaluation of the Older Surgical Patient

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Simplified Assessment

	Questions	Tests
Identify comorbidities	• Thorough history and review of systems	• Thorough physical examination
Medications	• Name all the prescription, herbal, and over-the-counter pills you take on a regular or as-needed basis	• Check medication lists or bottles
Function	• Can you walk up a flight of stairs carrying a bag of groceries?	• Timed Get Up and Go
Nutrition	• Have you lost ≥10 pounds in the last 6 months without trying to do so?	• Serum albumin • BMI
Cognition	• How is your memory?	• Three item recall
	• Do you drink alcohol occasionally, with meals, or before going to bed?	• Clock drawing task
	• In the past month, have you been sad, blue, down in the dumps or depressed?	• Geriatric depression scale
	• In the past month, have you been a lot less interested in most things or unable to enjoy the things you used to enjoy?	

Introduction

Aging Epidemiology

Beginning in 2012, nearly 10,000 Americans will reach age 65, each day [1]. The number of older Americans is expected to increase from 35 million (12.4% of the total population) in 2000 to 71 million (19.6% of the total population) in 2030 [2]. As demonstrated in Fig. 22.1 [3], the proportion of adults who are ≥65 years of age is increasing, while the proportion of persons < age 55 is decreasing. In fact, individuals over age 85, dubbed the "oldest old," are the most rapidly growing segment of the population, and their number is expected to increase fivefold to almost 19 million by the year 2050 [2].

The aging of the American population has created the need to provide surgical care to an ever-increasing number of older persons. At present, 35% of all surgical procedures performed in the USA are on persons 65 years of age or older; the rate of surgical procedures performed per 10,000 is 4.4 in older patients compared with 1.5 in younger adults [4]. Approximately half of individuals over age 65 will have at least one major surgical procedure in the remainder of their lifetime [4]. Overall, workload varies considerably by specialty; persons of age 65 years and older represent 60% of the cases in general surgery and almost 90% of the cases in ophthalmology [5].

Over the past several decades, advances in surgical and anesthetic techniques have led to an overall decline in operative mortality in older patients [6]. The "risk" of surgery therefore has become somewhat less of a concern, whereas the need and ability to provide maximal disease management has increased. While age cannot be completely ignored, functional status and/or comorbid conditions usually contribute more to operative outcomes than age alone. However, there are physiological changes that occur with aging that warrant recognition in order to maximize perioperative outcomes. As the number of older surgical candidates continues to grow, it will become increasingly important for all surgeons to understand the special issues involved in the selection and evaluation of older patients for surgical care.

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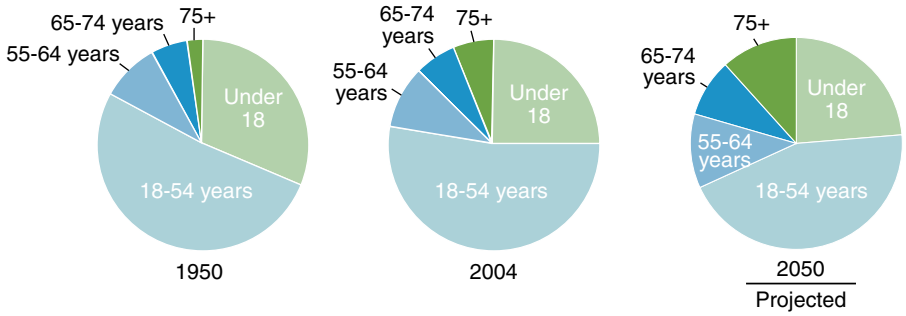

Figure 22.1 Population by age. Percent of population in five age groups: United States, 1950, 2004, and 2050 (from Centers for Disease Control and Prevention, National Center for Health Statistics, Health, United States, 2005).

Pattern of Surgical Disease in the Elderly

Before discussing the process of selecting and evaluating geriatric patients, it is important to note that the pattern of surgical disease in older patients is not always superimposable on the pattern seen in younger patients. The indication for surgery therefore may not be apparent until a complication has occurred. The absence of the classic signs and symptoms often leads to delays in treatment and errors in diagnosis. As a result, emergency surgical intervention is frequently necessary.

For example, older adults are twice as likely (33 vs. 16%) to have a right-sided colon cancer compared with younger adults [7]. As a result of this anatomical difference older adults may present more often with symptoms that are not initially associated with colorectal cancer, such as syncope and fatigue. Older adults with left-sided colon cancer often delay seeking medical care because they do not consider symptoms such as constipation to be abnormal. Thus, it is not surprising that up to 40% of older patients with colorectal cancer present for surgical intervention secondary to obstruction and/or perforation [7]. Further evidence of altered symptomatology in older persons is found in the pattern of presentation of biliary tract disease. The classic pattern of worsening biliary symptoms preceding the development of a complication is often absent in older adults. Consequently, up to two-thirds of the cholecystectomies in patients over the age of 65 are performed urgently or emergently compared with less than one-fifth in younger patients [8].

The high rate of emergency surgery in older adults is important because emergency surgery is associated with at least a threefold increase in mortality and morbidity. In one series of patients over the age of 70 years, emergency operations carried a mortality rate ten times greater than that for elective procedures [9]. Emergency surgery is also associated with a higher rate of long-term hospital stay (>30 days), more need for postoperative intensive care, larger decline in functional status, and increased need for postoperative nursing home placement [10].

Eliciting Patients' Preferences

Before the decision is made to proceed with elective surgery, a thorough discussion of the patient's goals of care and preferences is warranted. Items for consideration include the following:

- How clear is the indication for surgery, including the likelihood of progression of the disease?
- What is the likelihood of achieving equal or improved functional status?
- What degree of symptom improvement can be expected after the procedure?
- What quality of life can be expected with or without the surgery?
- Does the patient, and his or her family, understand the problem and the proposed solution?
- What is the risk of a negative outcome as determined by the nature of the procedure and the presence of comorbid conditions?

Fried et al. have shown that for older persons, the burden of treatment, the possible treatment outcomes (desirable vs. undesirable), and the likelihood of a particular outcome each influence treatment preferences [11]. Given various hypothetical situations, the majority of older patients (>70%) stated they would not want even a low-burden treatment if severe functional impairment or cognitive impairment was the expected outcome. As the likelihood of an adverse outcome increased, the number of patients who stated they would want treatment decreased. Thus, advance care planning that includes elucidation of patients' treatment preferences and designation of surrogate decision makers is one of the most important components of preoperative assessment for older surgical patients.

Objectives of Preoperative Assessment

Once these issues is addressed; the main thrust of the preoperative evaluation is to identify, and optimize, any coexisting disease processes or decline in physiologic reserve. With this

information, an accurate risk/benefit determination can be made for each surgical intervention in each elderly patient. Although we refer to risk primarily as the chance of postoperative mortality and morbidity, risk in the elderly should also be assessed in terms of restoration of preoperative functional status and quality of life. For older patients, maintenance of independence, quality of life, and symptom resolution may be as important as, if not more so, than survival.

Efforts are currently underway to develop process-based quality indicators to improve perioperative care and subsequent outcomes for older patients undergoing ambulatory, major elective, or nonelective inpatient surgery [12]. Additional work is needed both to determine the feasibility of implementing quality indicators into routine care and to demonstrate improved patient outcomes secondary to their use.

General Evaluation

Affect of Age on Perioperative Outcomes

The general approach to the preoperative assessment is directed toward identifying those factors that place the patient at increased risk for postoperative complications or death. Although some of these factors are related to the surgical disease itself and to the type of operation required, the most important factors in the determination of risk are related to the overall health, function level, cognitive abilities, and nutritional status of the patient.

Many studies have demonstrated comparable outcomes among older and younger adult surgical patients. A retrospective analysis of cardiac surgery among octogenarians in Germany demonstrated that morality was associated with comorbid conditions (e.g., chronic obstructive pulmonary disease or heart failure), nonelective surgery, and male gender, but not with age [13]. Follow-up with these patients 3–5 years after surgery revealed that approximately 85% were clinically better than they were prior to surgery. Another German study examined outcomes for colorectal cancer patients who underwent surgery. While mortality rates were higher for patients ≥80 years than for patients <80 years (8.0 vs. 2.6%), specific morbidity related to the operation was not significantly different (20.5 vs. 19.9%) [14].

Yet, some evidence suggests that even after adjusting for comorbid conditions, age itself is associated with higher risk for adverse outcomes among patients undergoing noncardiac surgery [15, 16]. The reason for this increased risk is presently unclear. It is possible that confounders associated with aging exist but are unrecognized, and thus unadjusted for, in multivariate analyses. If true, the increased risk observed with increasing age would in fact be due to the confounders, not age itself. Nonetheless, many older adults tolerate surgery if it is well conducted and free of complications. However, if complications arise, the additional stress associated with the complications exceeds the physiological reserves of many older adults.

Comorbidity

ASK the question	*Do a thorough history including review of systems 2*
DO the test	*Do a complete physical exam*

Over 80% of Americans aged ≥65 have at least one chronic condition and 50% have at least two [17]. The prevalence of comorbid diseases clearly rises with increasing age. The age-related increase in cardiac, pulmonary, renal, and hepatic comorbid conditions in a cohort of colon cancer patients over age 50 has previously been demonstrated [18]. The prevalence rates for some common chronic conditions experienced by older adults are depicted in Fig. 22.2 [1].

In a larger, more detailed review of comorbidity in elderly patients with colon cancer, Yancik et al. explored the increase in the number of additional conditions with age [19]. By age 75, patients with colon cancer had a mean of five disorders in addition to the primary cancer. For all adults, the influence of comorbid conditions on activity level increases substantially with age as demonstrated in Fig. 22.3 [3]. In addition, comorbid conditions more frequently contribute to the cancelation of surgery after hospital admission in older adults compared with younger adults [4].

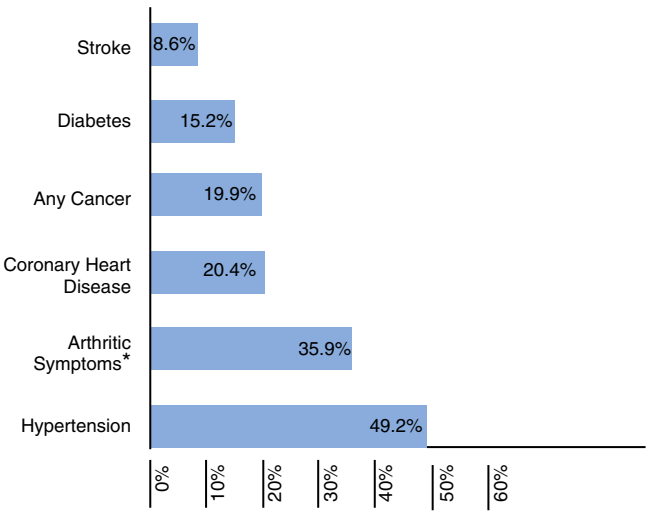

Figure 22.2 Prevalence of selected chronic conditions among adults age 65 and over, 2000–2001. *Asterisk* indicates a respondent was considered to have "arthritic symptoms" if s/he answered "yes" to the following questions: "During the past 12 months, have you had pain, aching, stiffness, or swelling in or around a joint?" and "Were these symptoms present on most days for at least one month?" (from Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey, 2000–2001).

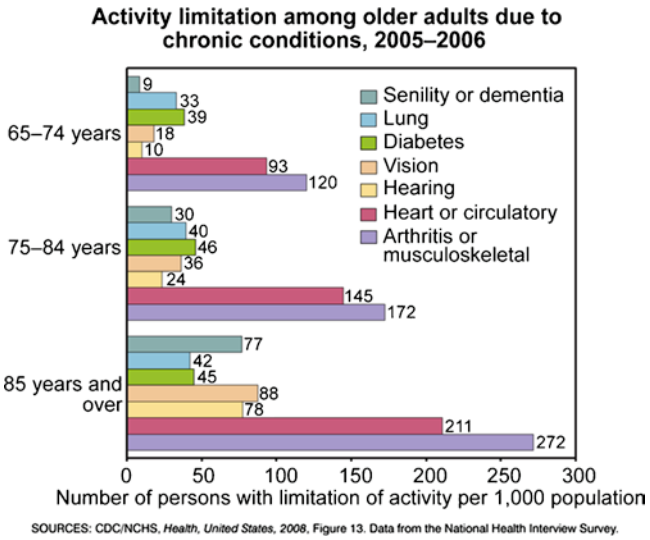

Figure 22.3 Limitation of activity caused by selected chronic health conditions among older adults, by age: United States, 2005–2006 (from [13]).

As the number of associated illnesses increases, so does the rate of perioperative complications. In a study on the effect of increasing comorbidity on outcome, Tiret and colleagues demonstrated a strong correlation between the number of conditions and the rate of perioperative complications. This effect was seen in all age groups but was most pronounced in the youngest and oldest patients [20]. Only a minimal increase in mortality and morbidity was seen in old patients who lacked coexisting disease. Such minimal increases were insignificant when compared with the threefold increase associated with as few as two additional comorbidities. Other studies of outcome for both surgical and medical treatment demonstrate a similar correlation between comorbidity and poor treatment outcome [19, 21].

As is true for surgical disease itself, older adults often do not present with the "classical" signs and symptoms typically attributed to comorbid conditions. The search for comorbid conditions must therefore be diligent. In the Framingham heart study for example, myocardial infarction was unrecognized or silent in more than 40% of persons of age 75–84 compared with fewer than 20% of those of age 45–54 [22]. Thyroid dysfunction (either hyper or hypo), cognitive impairment, and malnutrition are among the many other coexisting disorders that may not be recognized during the initial history and physical examination. For example, one study of hospitalized medical patients over age of 75 years revealed that 63% of patients meeting criteria for cognitive impairment were not identified as impaired on their discharge summary [23]. Earlier studies demonstrate that 46% of moderate to severe nutritional deficits identified among patients during hospital admission had not been recognized by the primary caregiver in the community (Fig. 22.4) [24].

Frailty is another comorbid condition that is frequently not recognized by providers. But recent evidence suggests that frailty may be an important predictor of postoperative mortality in one study, patients who had four of the following

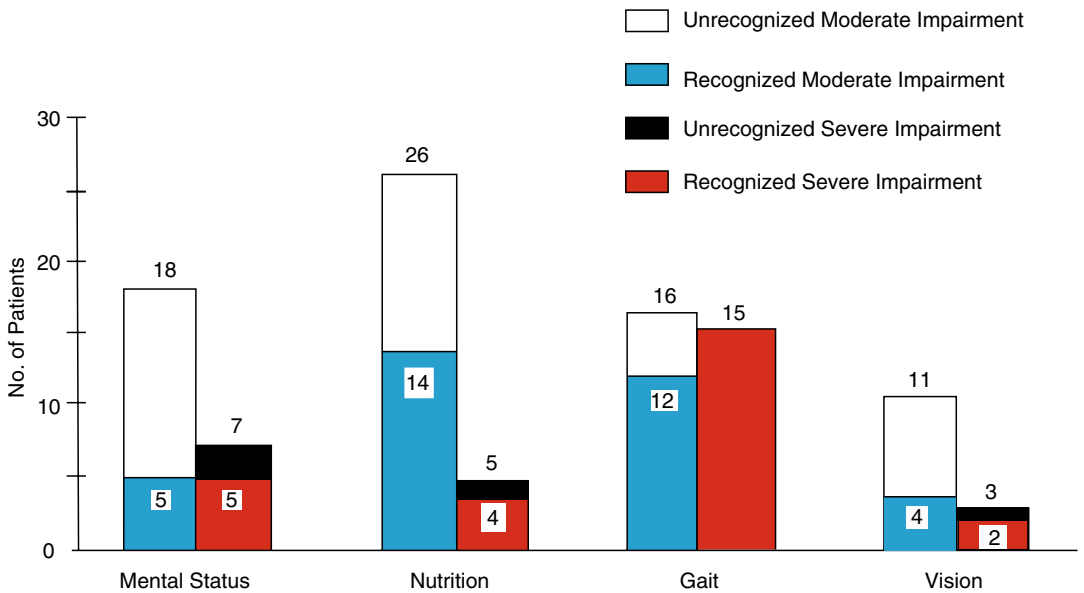

Figure 22.4 Patients found to have nutritional and mental status deficits during formal geriatric assessment at admission to the hospital compared to those identified by the primary caregiver in the community. *Lighter bars* indicate the results of formal assessment. It is seen that most of the nutritional deficits and a large percentage of mental status deficits were not recognized prior to admission to the hospital, indicating that these deficits are subtle and may not be appreciated without purposeful attempts to identify them (from Pinholt [24] with permission, Copyright © 1987 American Medical Association. All rights reserved).

Table 22.1 Herbal medicines and recommendations for discontinuation of use before surgery

Herb: common name(s)	Uses	Perioperative concerns	Preoperative discontinuation
Echinacea: purple coneflower root	Prophylaxis, treatment of viral, bacterial, fungal infections	Decreased effectiveness of immunosuppressants	No data
Ephedra: ma huang	Weight loss, increase energy	Tachycardia, hypertension	At least 24 h before surgery
Garlic: ajo	Lowers blood pressure, serum lipid and cholesterol level	May potentially increase risk of bleeding	At least 7 days before surgery
Ginkgo: duck foot tree, maidenhair tree, silver apricot	Cognitive disorders	Potential to increase risk of bleeding	At least 36 h before surgery
Ginseng: American ginseng, Asian ginseng, Chinese ginseng, Korean ginseng	Prevention of stress, restore homeostasis	Potential to increase risk of bleeding, hypoglycemia	At least 7 days before surgery
Kava: awa, intoxicating pepper, kawa	Anxiolytic sedative	Potential to increase sedative effect of anesthetics	At least 24 h before surgery
St. John's wort: amber, goat weed, hardhay, Hypericum, klamatheweed	Depression	Induction of cytochrome P450 enzymes, decreased serum digoxin levels	At least 5 days before surgery
Valerian: all heal, garden heliotrope, vandal root	Insomnia	Potential to increase sedative effect of anesthetics	No data

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six markers preoperatively had an increased risk of death within 6 months of their operation [25].

Mini_Cog score <4*
Albumin level <3.4 g/dL
≥1 fall within the prior 6 months
Hematocrit <35%
Katz disability score <6*
Charlson comorbidity score ≥3*

* For definition see below

Extensive testing for comorbidity in every organ system is neither cost-effective nor necessary for every patient. A thorough history and physical examination provide information that can direct further workup, if necessary. It is important, however, to adjust the history and physical examination to look for risk factors and signs and symptoms of the more common comorbid disorders. The addition of simple questions and simple tools for assessing functional, cognitive, and nutritional status significantly enhances understanding the individual elderly patient's true operative risk. When initial evaluation identifies specific disease or risk factors for disease, further workup may be indicated. Evaluation of specific organ systems is described later in the chapter.

Medication Assessment

ASK the question	*Can you tell me all the prescription, herbal, and over-the-counter pills you take on a regular or as-needed basis*
DO the test	*Check medication lists or bottles*

The vast majority of medications taken on a daily basis are consumed by adults over the age of 65 years. Thus, a comprehensive medication review is warranted for all older preoperative patients. Patients should specifically be queried regarding the use of herbal medications, given the potential for drug–herbal interaction and the low likelihood of self-report among patients. Education (≥12 years) and annual income (>$20,000) were found to be associated with herbal medication use in the multivariate logistic regression of one study [26]. A list of the most commonly taken herbal medicines, their uses, perioperative concerns, and recommended preoperative discontinuation time is found in Table 22.1 [27].

Geriatrics-Specific Evaluation

Functional Status Evaluation

ASK the question	*"Can you carry a bag of groceries up a flight of steps without getting short of breath?"*
DO the test	*Timed Get Up and Go*

Functional status can be measured in many different ways. Regardless of the methods, preoperative functional deficits have been shown to contribute to postoperative immobility, with associated complications such as atelectasis and pneumonia, multisystem deconditioning, increased length of stay, and increased mortality and morbidity. Individuals with poor preoperative function have longer hospitalizations, more surgical complications, and are more likely to die within 30 days of surgery when compared with individuals with good preoperative functional fitness [28]. Deconditioning is an important clinical entity that leads to further functional decline despite improvement in the acute illness [29]. The recovery period from deconditioning can be three or more times as

long as the period of immobilization that led to the decline. Methods of measuring functional status are described below.

Measures of Functional Status

American Society of Anesthesiologists Classification

For decades, the American Society of Anesthesiologists (ASA) Physical Status Classification has been one of the most reliable and accurate predictors of surgical mortality. This simple classification ranks patients according to the functional limitations imposed by coexisting disease (see Table 25.4). Despite its subjective nature, ASA classification has repeatedly been shown to accurately predict postoperative outcomes. Curves for mortality versus ASA class in older patients are superimposable on those of younger patients, thus demonstrating that coexisting disease, rather than chronologic age, has the most profound impact on surgical outcome [30]. Even for patients over age 80, ASA classification has been shown to predict postoperative mortality accurately [31].

The value of the ASA classification is further demonstrated by the results of a large, multicenter Department of Veterans Affairs (VA) study begun in 1991, later referred to as the National Surgical Quality Improvement Project (NSQIP), in which surgical patients were assessed prospectively for operative risk. Risk-adjusted models were then created to allow comparison of the quality of surgical care among institutions [32]. Sixty-eight preoperative and intraoperative variables were collected, and nine models for mortality and morbidity (one for each subspecialty and one overall) were created [33, 34]. Serum albumin and ASA class were the top two risk factors for both mortality and morbidity. Disseminated cancer was ranked third for mortality while operation complexity was ranked for morbidity [35]. The ASA functional classification was the second most predictive factor for mortality and the most predictive for morbidity after serum albumin. A discussion of the predictive value of serum albumin is found below under "Nutritional Assessment."

Activities of Daily Living

Activities of daily living (ADLs) are physical tasks performed routinely, namely bathing, dressing, personal grooming, toileting, transferring, walking, and eating [36]. Instrumental activities of daily living (IADLs) are higher order tasks performed regularly such as telephone use, transportation, meal preparation, shopping, housework, medication management, and managing finances. Studies have demonstrated an association between ADLs or IADLs and operative outcomes. For example, the Preoperative Assessment of Cancer in the Elderly (PACE) study conducted in the UK demonstrated that among older patients electively scheduled for cancer surgery, individuals with IADL dependence (RR 1.43), poor performance status (RR 1.52), and moderate/severe fatigue (RR 1.64) all had higher rates of postoperative complications [37]. Similar findings have also been demonstrated in less specific patient populations [38].

Exercise Capacity (in Metabolic Equivalents)

Exercise tolerance, as an indication of functional reserve, is the single most important predictor of cardiac and pulmonary complications following noncardiac surgery. In a study comparing Dripps Criteria (ASA), Goldman Clinical Criteria, pulmonary function tests, exercise tolerance, and several other variables, Gerson et al. demonstrated that the inability to raise the heart rate to 99 beats/min while doing 2 min of supine bicycle exercise was the most sensitive predictor of postoperative cardiac and pulmonary complications, and death [39, 40].

The physiologic basis for this finding has been further clarified by a study in which older patients performed supine ergometry while connected by mouthpiece to a metabolic cart [41]. The authors identified an anaerobic threshold – defined as the level of oxygen consumption above which circulatory supply could not meet metabolic demand – and correlated this threshold with surgical outcome. For those patients able to reach an anaerobic threshold of 11 ml/kg/min or more, the mortality was 0.8% compared with 18% for those unable to reach this threshold. Even in patients who experienced ischemia at the time of exercise testing, threshold levels were highly predictive of postoperative mortality (Table 22.2).

Formal exercise testing is neither readily available nor practical in a routine preoperative clinic. However, the metabolic requirements for many routine activities have already been determined and are quantified as metabolic equivalents (METs). The Duke's Activity Status Index is an example of a standardized self-assessment tool that quantifies METs [42]. One MET, defined as 3.5 ml/kg/min, represents the basal oxygen consumption of a 70-kg, 40-year-old man at rest. Estimated energy requirements for various activities are shown in Table 22.3 [43]. The inability to function above four METs has been associated with increased perioperative cardiac events and long-term risk. Functional capacity of the individual can be estimated by inquiring about the ability to perform these routine physical activities.

Table 22.2 Mortality in relation to anaerobic threshold

Anaerobic Threshold (ml/min/kg)	All patients		Patients with ischemia	
	No.	% Mortality	No.	% Mortality
<11	55	18	19	42
>11	132	0.8	25	4
	$p<0.001$		$p<0.01$	

Source: Reprinted with permission from Older et al. [41]

Table 22.3 Estimated energy requirements for various activities

	Can you…		Can you…
1 MET	Take care of yourself?	4 METs	Climb a flight of stairs or walk up a hill?
↓	Eat, dress, or use the toilet?	↓	Walk on level ground at 4 mph (6.4 kph)?
	Walk indoors around the house?		Run a short distance?
	Walk a block or 2 on level ground at 2–3 mph (3.2–4.8 kph)?		Do heavy work around the house like scrubbing floors or lifting or moving heavy furniture?
4 METs	Do light work around the house like dusting or washing dishes?		Participate in moderate recreational activities like golf, bowling, dancing, doubles tennis, or throwing a baseball or football?
		Greater than 10 METs	Participate in strenuous sports like swimming, singles tennis, football, basketball, or skiing?

Source: Reprinted from Fleisher et al. [43], with permission from Elsevier

Tests of Functional Ability

Preoperative gait speed, balance, and upper extremity strength have been shown to correlate with postoperative recovery. Utilizing the Timed Get Up and Go, Hand Grip Strength, and Functional Reach Test as measures of physical status, Lawrence et al. have shown that older adults with intact preoperative physical status recover more quickly than persons with preoperative physical limitations [44]. Results from a study by Moriello et al. support the use of gait speed as a measure of postoperative recovery [45].

In addition, Lawrence et al. [44] demonstrated that recovery of various functions may not occur concurrently. While cognitive status recovery was relatively quick (3 weeks), gait speed (6 weeks), balance (6 weeks–3 months), and IADL abilities (3–6 months) took longer to return to preoperative levels [44]. Upper extremity strength measured by grip strength took the longest to recover and had not returned to baseline levels even after 6 months for some individuals. A description of the Timed Get Up and Go, Hand Grip Strength, and Functional Reach Tests is included below.

Timed Get Up and Go: For this test, participants are seated in a straight back chair. They are instructed to rise from the chair without using the armrests, ambulate 10 ft, turn around, walk back to the chair, and sit down. Completing the test in 10 s or less is a normal result.

Hand Grip Strength: This measure is calculated as the kilograms of pressure applied to a handheld dyanometer. Preoperative mean grip strength for the population of older patients examined by Lawrence et al. was 27 ± 11 kg [44].

Functional Reach Test: For this test, participants are asked to lean against the wall with their arm outstretched and their hand clenched in a fist. They are instructed to lean forward as far as possible without losing their balance. Persons who can reach 10 in. or more are at lowest risk for falling in the future.

Prehabilitation

It seems intuitive that improving exercise capacity preoperatively would result in better postoperative outcomes. However, to date, little data exist about the effectiveness of prehabilitation – exercise therapy conducted before surgery. However, what data do exist have shown postoperative benefits for some, but not all, patient groups. Orthopedic surgery patients engaged in prehabilitation did not show improvements in their health-related quality of life (HR-QOL) or recovery [28]. As reported by Carli, one study demonstrated that 275 elderly patients electively scheduled for abdominal or cardiac surgery, who participated in prehabilitation, had improved HR-QOL, fewer postoperative complications, shorter hospitalization, and lower levels of functional disability compared with a control group of sedentary patients [28]. More research in the area is clearly needed.

Nutritional Assessment

ASK the question	*"Have you lost 10 pounds or more in the last 6 months without trying to do so?"*
DO the test	*Height & weight (BMI), serum albumin*

Poor nutrition has been long recognized as a risk factor for pneumonia, poor wound healing, and other postoperative complications. Malnutrition, defined as a decrease in nutrient reserves, occurs in approximately 0–15% of community dwelling elderly persons, 35–65% of older patients in acute care hospitals, and 25–60% of institutionalized elderly [46] (see Chap. 6). Physiological changes that occur with aging, such as increased total body fat, loss of lean body mass, decreased bone density, and decreased total body water, may all affect nutritional requirements [47].

The assessment of nutritional status begins by understanding the risk factors for nutritional deficiency in older adults.

Factors that may lead to inadequate intake and utilization of nutrients include inability to access food (e.g., financial constraints, availability of food, limited mobility), lack of the desire to eat food (e.g., living alone, impaired mental status, chronic illness), inability to eat and/or absorb food (e.g., poor dentition, chronic gastrointestinal problems such as gastroesophageal reflux disease or diarrhea), and medications that interfere with appetite or nutrient metabolism.

Preoperative Serum Albumin

Serum albumin is a strong predictor of outcome in both nonsurgical and surgical patients. Evidence demonstrates that low serum albumin in hospitalized elderly patients correlates with increased length of stay, increased rates of readmission, decreased rates of discharge to home, and increased all-cause mortality [48]. In surgical patients, low preoperative serum albumin has also been shown to correlate with postoperative morbidity and mortality [49]. Data from the NSQIP demonstrate an inverse relationship between serum albumin and 30-day morbidity and mortality (Fig. 22.5) [50].

Nutrition Screening Tests

Complicated markers of malnutrition exist [46] but are not necessary in the routine surgical setting. Subjective assessment by history and physical examination, in which risk factors and physical evidence of malnutrition are assessed, has been shown to be as effective as objective measures of nutritional status [51]. Additionally, there is evidence to support the use of a simple screening question "Have you lost 10 pounds or more in the last 6 months without trying to do so?" to diagnose malnutrition in older adults [52].

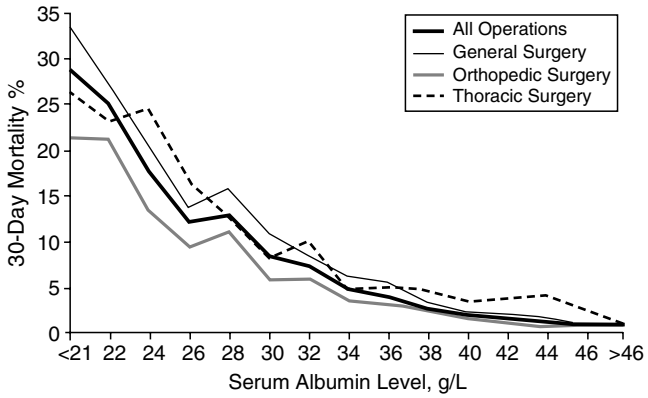


Figure 22.5 Relationship between albumin and 30 day mortality. Data from the National Surgical Quality Improvement Program showing 30-day operative mortality as a function of serum albumin for several different surgical specialties and for all specialties combined (reprinted with permission from [49]. Copyright © 1999 American Medical Association. All rights reserved).

Body Mass Index (BMI) measured by weight in kilograms divided by height in meters squared, has been shown to correlate with surgical outcomes. Underweight and overweight persons have both been shown to have worse surgical outcomes compared with persons with normal weight [53, 54].

The Subjective Global Assessment (SGA) is one relatively simple reproducible tool for assessing nutritional status from the history and physical exam [55]. SGA ratings are most strongly influenced by loss of subcutaneous tissue, muscle wasting, and weight loss. In a study of patients undergoing elective gastrointestinal surgery, both SGA and serum albumin were predictive of postoperative nutrition-related complications [56].

The Mini Nutritional Assessment (MNA) is another instrument that is designed to identify older adults at risk for malnutrition [57]. A short form of the MNA has been developed and used preoperatively (Table 22.4) [58].

Preoperative Nutritional Supplementation

Data confirming that the reversal of nutritional defects, by using enteral or parenteral supplementation prior to surgery, improves outcomes are few and inconclusive. However, some initial studies suggest that improving preoperative nutrition may positively impact perioperative outcomes. In one such study, cardiac surgery patients who received a preoperative oral immune-enhancing nutritional supplement had lower rates of pneumonia compared with individuals who did not receive supplementation; rates of urinary tract and wound infections did not differ [59].

Information obtained during the preoperative nutritional assessment will be particularly useful for perioperative decisions regarding nutritional support. A flow diagram regarding which patients should be considered for nutritional support perioperatively is illustrated in Fig. 22.6 [47].

Cognitive Assessment

ASK the questions	*"Do you have problems with your memory?"* *"Do you drink alcohol during the day or before going to bed at night?"*
DO the test	*Mini-Cog*

The perioperative cognitive assessment tends to be undervalued and underapplied as a predictor of postoperative outcome. However, cognitive dysfunction as either a presurgical condition or postoperative complication can interfere with surgical treatment and postsurgical recovery. Patients with dementia and/or delirium have worse perioperative outcomes. Dementia, the clinical manifestation of chronic cognitive impairment, is *the* major risk factor for delirium, an acute

Table 22.4 Mini-nutritional assessment-short form

Question	Score
A. Has food intake declined over the past three months due to loss of appetite, digestive problems, chewing or swallowing difficulties? 0 = severe loss of appetite 1 = moderate loss of appetite 2 = no loss of appetite	
B. Weight loss during last 3 months 0 = weight loss greater than 3 kg (6.6 lbs) 1 = does not know 2 = weight loss between 1 and 3 kg (2.2 and 6.6 lbs) 3 = no weight loss	
C. Mobility 0 = bed or chair bound 1 = able to get out of bed/chair but does not go out 2 = goes out	
D. Has suffered psychological stress or acute disease in the past 3 months 0 = yes 2 = no	
E. Neuropsychological problems 0 = severe dementia or depression 1 = mild dementia 2 = no psychological problems	
F. Body Mass Index (BMI) (weight in kilograms)/(height in meters)^2 0 = BMI less than 19 1 = BMI 19 to less than 21 2 = BMI 21 to less than 23 3 = BMI 23 or greater	
Screening score (subtotal max. 14 points) 12 points or greater: Normal – no need for further assessment 11 points or below: Possible malnutrition – continue assessment	

Source: Reprinted from Rubenstein et al. [58], with permission from the Oxford University Press

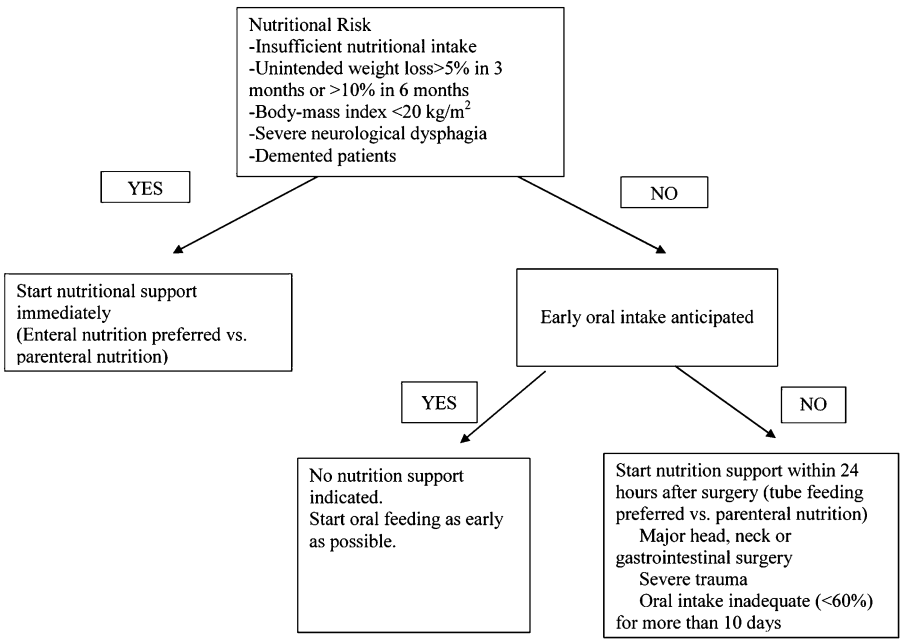


Figure 22.6 Decision flow chart for implementing perioperative nutrition support in geriatric patients (modified from Lugli [47], with permission from Elsevier).

reversible state of confusion, during hospitalization. As such, it is important to identify patients who have baseline cognitive impairment, even at mild levels, in the preoperative period.

Screening Tools for Dementia

There are several methods for evaluating baseline cognitive function in the elderly. Each of these instruments, although extremely informative, may take 5–10 min to administer which may not be practical in a busy preoperative clinic. The exception is the Mini-Cog, a quick and practical screening tool for dementia that can be completed in 2–4 min.

The Mini-Cog has sensitivity and specificity rates similar to the Folstein Mini Mental Status Examination (MMSE) and a standardized neuropsychological battery [60]. Participants are asked to recall three words and to draw a clock indicating an abstract time such as one forty five (1:45) or ten after 11 (11:10). The three item word recall assesses short-term memory, while the clock drawing task assesses for key features of executive function such as initiation, planning, and multistep processing. The instructions for the administration and scoring of the Mini-Cog can be found in Appendix 22.1.

The Folstein Mini Mental Status Examination (MMSE) has become widely accepted for its ease of administration and reliability [61]. The MMSE allocates a total of 30 points to five areas (1) orientation, (2) registration, (3) attention/calculation, (4) recall, and (5) language. MMSE scores are influenced by several factors including age and educational attainment. As such, MMSE scores should be interpreted according to population-based norms for age and educational level as shown in Table 22.5 [62].

The Telephone Interview for Cognitive Status (TICS) is a validated, reliable modification of the MMSE, which can be easily administered over the telephone [63]. The TICS has a maximum score of 38.

The St. Louis University Mental Status (SLUMS) Examination is a dementia screening instrument that allocates 30 points to four areas (1) orientation, (2) memory, (3) attention, and (4) executive function (Appendix 22.2) [64]. The sensitivity and specificity of the SLUMS has been shown to be similar to the MMSE; the SLUMS may be better able to detect mild cognitive impairment.

Delirium

Estimates of postoperative delirium rates vary significantly depending upon the type of surgery performed. Delirium is reported in <5% of older patients after cataract surgery, 35% of patients after vascular surgery, and 40–60% of older patients after hip fracture repair [65]. Delirious surgical patients have more major complications, longer hospitalizations, costlier hospital stays, higher rates of discharge to long-term care facilities, and higher rates of death compared with nondelirious patients [66]. In addition, postoperative delirium has been shown to persist for several months after surgery, up to three, in a significant percentage of older patients [67]. Thus, identifying preoperative patients at highest risk for delirium has the potential to significantly improve perioperative outcomes. Marcantonio et al. developed a clinical prediction rule for postoperative delirium from a large prospective study of major elective noncardiac surgery patients over age 50 years [66]. The independent correlates for postoperative delirium and the point system devised to quantify the risk of delirium are illustrated in Table 22.6. For additional information on delirium, please refer to Chap. 16.

Unrecognized alcohol abuse should always be included on the list of potential causes of delirium. Older adults may not report their intake of alcohol with meals or prior to bedtime. Forced abstinence as a result of hospitalization may present in a mild form such as evening agitation or

Table 22.5 Norms for the mini-mental state examination by age and education

	Age range							
Education	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85+
0–4 years								
Mean	23	22	23	22	22	21	20	19
SD	2.6	2.7	1.9	1.7	2.0	2.2	2.9	2.3
5–8 years								
Mean	27	26	26	26	26	25	25	23
SD	2.4	2.9	2.3	1.7	1.8	2.1	1.9	3.3
9–12 years								
Mean	28	28	28	28	27	27	25	26
SD	2.2	2.2	1.7	1.4	1.6	1.5	2.3	2.0
13 or more years								
Mean	29	29	29	29	28	28	27	27
SD	1.9	1.5	1.3	1.0	1.6	1.6	0.9	1.3

Source: Reprinted with permission from Crum et al. [62]. Copyright © 1993 American Medical Association. All rights reserved

Table 22.6 Clinical prediction rule for postoperative delirium

Risk factor	Points
Age ≥ 70 years	1
Alcohol abuse	1
TICS score < 30	1
SAS class IV	1
Markedly abnormal preoperative sodium, potassium, or glucose level	1
Aortic aneurysm surgery	2
Noncardiac thoracic surgery	1
Total points	Risk of delirium, %
0	2
1 or 2	11
≥3	50

Source: Marcantonio et al. [66]. Copyright © 1994 American Medical Association. All rights reserved

"sundowning" or in a more severe form such as delirium tremors (DTs). Older patients should be specifically asked about mealtime and/or bedtime alcohol use. More comprehensive alcohol screening tools specifically designed for older adults, such as the Michigan Alcohol Screening Test-Geriatric Version [68] (see Appendix 22.3), are available.

Mental status changes in older surgical patients are often the earliest signs of a postoperative complication. If an older patient presents with an altered mental status in the perioperative period, knowledge of his or her preoperative cognitive status provides critical information for determining the extent and aggressiveness of intervention warranted.

Depressive Symptoms

Not all patients who perform poorly on screening examinations will have cognitive impairment. Patients with depressive symptoms may appear to have cognitive impairment as a result of providing little effort during testing. In addition, patients with depressed mood may exhibit less desire to participate in rehabilitation activities. Interestingly, one study [69] demonstrated an association between number of depressive symptoms reported by older adults on the Geriatric Depression Scale (GDS) and delirium. Persons who reported more depressive symptoms preoperatively had higher incidence rates, and more days, of delirium postoperatively.

The GDS [70] is a 15-item questionnaire that can be administered in person or over the telephone. Respondents provide a yes or no response to the questions posed. A score ≥5 indicates depression is a possibility. The GDS is reprinted in Appendix 22.4.

Specific Organ System Evaluations

Although cardiac and pulmonary complications are the most common postoperative events for older patients, physiological changes in the renal and hepatic systems also place older adults at risk. Complications due to specific organ system problems may prolong hospitalization and contribute to functional decline, necessitating the addition of rehabilitation services upon discharge. Thus, preoperative history or physical examination findings consistent with clinically significant cardiac, pulmonary, renal or hepatic disease warrant investigation, monitoring, and/or intervention.

Pulmonary Assessment

Comparatively much more attention has been paid to the preoperative evaluation and optimization of cardiac risk factors than pulmonary risk factors. However, there is evidence to support the assertion that pulmonary complications are equal determinants of postoperative morbidity, mortality, and length of stay for older surgical patients [71]. This assertion is supported by the findings of a large study in which the 30-day mortality rate for persons with postoperative pneumonia was 21 versus 2% for persons without postoperative pneumonia [72]. In the literature, pulmonary complications refer to a variety of conditions including pneumonia, respiratory insufficiency, respiratory failure, atelectasis, acute respiratory distress syndrome, and pleural effusions. It is important to remember that aspiration is one of the leading causes of these complications. While aspiration is possible in any age group, monitoring for aspiration is especially important in the elderly. As with all adverse surgical outcomes, pulmonary complications are more common following emergency operations. Given the high prevalence of emergency surgery in persons over the age of 65, this is of particular significance for older adults.

Risk Factors

Patient, procedure, and laboratory factors have all been implicated as increasing the odds of developing postoperative pulmonary complications. A recent systematic review examined the literature regarding risk factors and subsequent pulmonary complications [71]. The patient and procedure-related factors for which there was good or at least fair evidence to support the association between the risk factor and postoperative pulmonary complications are presented in Tables 22.7 and 22.8.

Patient-Related Risk Factors

Subtle nasopharyngeal dysfunction is frequently unrecognized in the elderly but is known to be a factor predisposing to aspiration pneumonia. Devices that traverse the oropharynx may further disrupt the normal swallowing process and

Table 22.7 Potential patient-related risk factors for postoperative pulmonary complications

Risk factor	Odds ratio
Advanced age	2.09–3.04
ASA class ≥ II	2.55–4.87
Heart failure	2.93
Functionally dependent	1.65–2.51
Chronic obstructive pulmonary disease	1.79
Weight loss	1.62
Impaired sensorium	1.39
Cigarette use	1.26
Alcohol use	1.21

Source: Modified from Smetana [71], with permission from the American College of Physicians

Table 22.8 Potential procedure-related risk factors for postoperative pulmonary complications

Risk factor	Odds ratio
Aortic aneurysm repair	6.90
Thoracic surgery	4.24
Abdominal surgery	3.01
Upper abdominal surgery	2.91
Neurosurgery	2.53
Prolonged surgery	2.26
Head and neck surgery	2.21
Emergency surgery	2.21
Vascular surgery	2.10
General anesthesia	1.83
Perioperative transfusion	1.47

Source: Modified from Smetana [71], with permission from the American College of Physicians

further increase the risk of aspiration. In one multivariate analysis, postoperative nasogastric intubation was the single most important variable associated with postoperative pulmonary complications [73]. In another study of cardiac surgery patients, the use of transesophageal echocardiography probes intraoperatively was significantly associated with the development of postoperative aspiration [74].

Several conditions, commonly found in older adults, increase the risk of aspiration. These include cognitive impairment, prior stroke, xerostomia (dry mouth), poor dentition, gastroesophageal reflux disease (GERD), and diabetes. Thus, aspiration precautions are particularly important in this population.

Several studies have examined the impact of age on postoperative pulmonary complications with equivocal results. Studies that were not controlled for the presence of comorbid conditions indicate 4–45% of persons over the age of 70 develop postoperative pulmonary complications. More recent reviews of the literature suggest that older age remains an independent predictor of postoperative pulmonary complications even after adjusting for comorbid conditions [71].

The ASA classification, a subjective assessment of overall functional and physical well-being (see above), has been shown to be an accurate predictor of postoperative cardiac and pulmonary status [75]. Similarly, functional dependence is an important determinant of postoperative pulmonary complications. Individuals who are either unable to complete any ADLs or require assistance from another person or device have been shown to have worse pulmonary outcomes compared with functionally independent persons [76].

The most commonly identified risk factor for postoperative pulmonary complications is chronic obstructive pulmonary disease. In multivariate analyses [72], the degree of obstructive disease (none to mild vs. moderate to severe) contributed to the degree of risk. Unintentional weight loss ≥10% in the prior 6 months, acute cognitive changes secondary to delirium, cigarette smoking within the past 1 year, and consumption of >2 drinks/day in the past 2 weeks have all been shown to increase the risk of postoperative pulmonary complications [72]. Of note, individuals who discontinue smoking ≤8 weeks prior to surgery have higher rates of complications compared with individuals who were still actively smoking at the time of their operation.

Although obesity is widely thought to be associated with postoperative pulmonary complications, the incidence of pulmonary complications following surgery even for patients with morbid obesity is no higher than would be expected in a group of procedure-matched nonobese patients. In addition, there is little evidence that diabetes or well-controlled asthma affect postoperative pulmonary complication rates [71].

Procedure-Related Risk Factors

Procedure-related risk factors implicated in the development of postoperative pulmonary complications include the site of incision, type of anesthesia, duration of the procedure, amount of blood loss, type of repair (e.g., open vs. endovascular), and urgency of the operation (e.g., emergency vs. elective) [71].

The proximity of the surgical incision to the diaphragm has been long known to influence the rate of postoperative pulmonary complications. Upper abdominal incisions are accompanied by a 13–33% [77, 78] pulmonary complication rate, compared with a 0–16% [78, 79] rate for incisions in the lower abdomen. Rates as high as 40% are reported with thoracic incisions [79, 80]. Minimally invasive procedures, such as laparoscopic cholecystectomy, are associated with little risk of pulmonary complications. In several large series rates as low as 0.3–0.4% were reported [81, 82].

The importance of the type of anesthesia and the length of operation in terms of the incidence of postoperative pulmonary complications is less clear. Although most studies support the lower complication rate following regional anesthesia compared with general anesthesia, these results are not uniform. Duration of anesthesia of more than 3 h has been shown to be significant [73, 83].

In one retrospective analysis, intraoperative blood loss of more than 1,200 ml was an independent predictor of postoperative pneumonia [84]. This may be an indication of the complexity of the procedure or of underlying comorbidity. Although multiple transfusions are known to be immunosuppressive, the relation of transfusion to postoperative infection is not clear [85]. However, when combined with the declining immunologic competence associated with aging, a transfusion-related alteration in host defenses may facilitate the development of pneumonia in the elderly.

Pulmonary Assessment Tools

Tests for Aspiration Risk

Evaluation for aspiration is important for all older adults with conditions that place them at higher risk for aspiration, such as persons with a history of stroke, poor dentition, or GERD. The 3-ounce water swallow test is a time-efficient method to clinically screen individuals who are at risk for aspiration [86]. Individuals are asked to swallow 3 ounces (90 cc) of water without pausing. Persons who choke, cough, are unable to complete the task, or have a wet quality to their voice after completing the task are typically referred for fiberoptic endoscopic evaluation. One study of 3,000 individuals, 20% of whom were surgical patients, demonstrated that the water swallow test has high sensitivity and negative predictive value [86]. Thus, individuals who pass the swallow test have a high likelihood of passing a fiberoptic endoscopic evaluation. However, the swallow test had a high false positive rate such that half of the individuals who failed the swallow test did not demonstrate aspiration on a fiberoptic evaluation. Fiberoptic evaluation should, therefore, be reserved for those persons with known risk factors for aspiration. Aspiration precautions, however, should be observed for any patient with either a failed water swallow test or has a know risk factor for aspiration.

Laboratory/Radiology Tests

There is good evidence that an albumin level <35 g/L increases the odds of postoperative pulmonary complications by 2.53 [71]. The evidence that other laboratory tests, such as chest radiography, contribute to the predictions of postoperative risk, is less convincing. Even though chest radiographs are routinely ordered as part of a preoperative evaluation, it is rare that the radiograph illustrates issues that were not discovered during the history and physical examination [71]. Preoperative chest radiographs are arguably only beneficial for patients with established cardiopulmonary disease and/or adults over the age of 50 who will likely receive an incision close to the diaphragm [71].

Pulmonary Function Evaluation

Although previous guidelines for preoperative pulmonary function testing suggested that spirometry was indicated for every patient over the age of 70 years [87], more recent data refute that claim. The few studies that have compared clinical findings with spirometric measures do not uniformly support the use of spirometry over a comprehensive history and physical examination [71]. Abnormal chest findings on physical examination and chest radiography have been shown to be highly associated with postoperative pulmonary complications; the data for spirometry is equivocal.

Table 22.9 ACP guidelines for preoperative spirometry

Planned lung resection
Potential coronary artery bypass graft candidate
Known asthma
Known chronic obstructive pulmonary disease (COPD)
Probable undiagnosed COPD

Source: Data from Quaseem et al. [76]

Present guidelines from the American College of Physicians for the use of preoperative pulmonary function tests are shown in Table 22.9 [76]. There is consensus that all patients undergoing lung resection should have pulmonary function tests. Individuals with uncharacterized pulmonary disease, known COPD or asthma, and questionable CABG candidacy should also be tested. However, those patients with normal physical examinations and good exercise tolerance do not benefit from additional studies.

A risk index has been developed to indentify the patients at highest risk for developing postoperative pneumonia [72]. Points are assigned depending upon the presence of various risk factors (Table 22.10); the maximum point value is 164. Individuals are classified into five risk classes: class I (0–15 points), class II (16–25 points), class III (26–40 points), class IV (41–55 points), or class V (>55 points). Persons in the lowest risk class have an average predicted probability of postoperative pneumonia of 0.24%; those in the highest class have a probability of 15.3%.

Cardiovascular Assessment

With the aging of America it is estimated that the annual number of noncardiac surgical procedures performed in older adults will increase from the present level of six million to approximately 12 million over the next 30 years [43]. Four procedures that constitute one-fourth of the surgeries performed in older adults, namely major intraabdominal, thoracic, vascular, and orthopedic procedures, have been associated with significant cardiovascular morbidity and mortality. Because cardiovascular events are a leading cause of perioperative complications and death, preoperative evaluation of cardiac risk has been studied extensively. The American College of Cardiology (ACC)/American Heart Association (AHA) Task Force on Practice Guidelines routinely publish guideline on perioperative cardiovascular evaluation and care for noncardiac surgery patients [43]. The recommendations provided in the guidelines are based upon the available scientific evidence as well as expert opinion; the objective is to improve patient care. Use of the guidelines is intended to clarify which patients would benefit from additional cardiac evaluation and what evaluation should be pursued, if any.

Table 22.10 Postoperative pneumonia risk index

Preoperative risk factor	Point value
Type of surgery	
Abdominal aortic aneurysm repair	15
Thoracic	14
Upper abdominal	10
Neck	8
Neurosurgery	8
Vascular	3
Age	
≥80 years	17
70–79 years	13
60–69 years	9
50–59 years	4
Functional status	
Totally dependent	10
Partially dependent	6
Weight loss > 10% in past 6 months	7
History of chronic obstructive pulmonary disease	5
General anesthesia	4
Impaired sensorium	4
History of cerebrovascular accident	4
Blood urea nitrogen level	
<2.86 mmol/L (<8 mg/dL)	4
7.85–10.7 mmol/L (22–30 mg/dL)	2
≥10.7 mmol/L (≥30 mg/dL)	3
Transfusion > 4 units	3
Emergency surgery	3
Steroid use for chronic condition	3
Current smoker within 1 year	3
Alcohol intake > 2 drinks/day in past 2 weeks	2

Source: Modified from Arozullah [72], with permission from the American College of Physicians

Table 22.11 Clinical predictors of increased perioperative cardiovascular risk

Active cardiac conditions
Unstable coronary syndromes
Recent myocardial infarction (>7 days but <30 days) with evidence of important risk based on clinical symptoms or noninvasive study
Unstable or severe angina (Canadian class III or IV) [58]
Decompensated heart failure
Significant arrhythmias
High-grade atrioventricular block
Symptomatic ventricular arrhythmias in the presence of underlying heart disease
Supraventricular arrhythmias with uncontrolled ventricular rate
Severe valvular disease
Revised cardiac risk index
History of ischemic heart disease
History of cerebrovascular disease
History of compensated or prior heart failure
Diabetes mellitus
Renal insufficiency
Minor predictors
Advanced age (greater than 70 years)
Abnormal electrocardiographic findings
Left ventricular hypertrophy
Left bundle branch block
ST-T abnormalities
Rhythm other than sinus
Atrial fibrillation, for example
Uncontrolled systemic hypertension

Source: Reprinted from Fleisher et al. [43], with permission from Elsevier

Clinical Risk Factors

The previous terminology of major and intermediate risk factors has been replaced, respectively, with active cardiac conditions and Revised Cardiac Risk Index clinical risk factors. The terminology of minor clinical predictors remains the same. The clinical risk factors are listed in Table 22.11.

Perioperative Algorithm (Appendix 22.5)

Step 1: Determine the Urgency of Noncardiac Surgery

Preoperative cardiac evaluation is not necessary for emergency surgery. Patients should proceed directly to surgery; risk stratification and management can be performed perioperatively.

Step 2: Determine If Any Active Cardiac Conditions Exist

The presence of ≥1 active cardiac conditions warrants intervention and, unless deemed emergent, may result in a delay or cancelation of surgery. If no active cardiac conditions are present, proceed to the next step. Evidence suggests that cardiovascular intervention does not influence surgical outcomes in asymptomatic patients without active cardiac conditions. Therefore, preoperative cardiovascular screening is not necessary.

Step 3: Consider the Risk of the Planned Surgery

Cardiac risk stratification according to surgical procedure is listed in Table 22.12. If the proposed surgery is a low-risk procedure, stable patients may proceed to surgery without cardiovascular evaluation since the results of testing are unlikely to warrant a change of plans.

Step 4: Consider the Functional Capacity and Symptom Status of the Patient

Highly functional asymptomatic patients may proceed to surgery without cardiovascular evaluation, since the results of testing are unlikely to warrant a change of plans. As mentioned

Table 22.12 Cardiac risk stratification for noncardiac surgical procedures

Vascular (reported cardiac risk often more than 5%)
Aortic or other major vascular surgery
Peripheral vascular surgery
Intermediate (reported cardiac risk generally 1–5%)
Carotid endarterectomy
Head and neck surgery
Intraperitoneal and intrathoracic surgery
Orthopedic surgery
Prostate surgery
Low (reported cardiac risk generally less than 1%)
Endoscopic procedures
Superficial procedures
Cataract surgery
Breast surgery
Ambulatory surgery

Source: Reprinted from Fleisher et al. [43], with permission from Elsevier
Risk denotes combined incidence of cardiac death and nonfatal myocardial infarctions

above, questioning patients on their ability to perform certain activities for which the estimated MET values are known provides individual scoring of functional capacity (Table 22.3). Utilizing METs, functional capacity can be classified as excellent (>10), good (7–10), moderate (4–6), or poor (<4). Patients unable to meet a four-MET demand during most normal daily activities are at increased risk for perioperative cardiopulmonary and long-term complications.

Step 5: Determine If Clinical Risk Factors Are Present For Patients with Poor Functional Capacity or Symptoms

If no clinical risk factors are present, the patient may proceed to surgery without further evaluation. If ≥3 clinical risk factors are present, cardiac risk stratification (Table 22.12) must be considered.

Renal Assessment

Physiological Changes of the Aging Kidney

Renal insufficiency is often asymptomatic in older adults. Preoperative renal insufficiency is a strong predictor of perioperative cardiac and pulmonary morbidity [88]. Moreover, impaired preoperative kidney function increases the likelihood of perioperative kidney failure. Physiological changes that occur with aging, namely decreases in renal plasma flow and glomerular filtration rate (GFR), contribute to the increased rates of renal insufficiency among older adults. Muscle mass also decreases with age. As a result, serum creatinine level may not accurately estimate renal function in older adults. (A complete discussion of changes in renal physiology can be found in Chap. 76.)

Glomerular Filtration Rate

Accurately assessing GFR is an essential component of the preoperative renal evaluation for older adults. GFR can be estimated via the Cockcroft–Gault equation for creatinine clearance (CrCl):

$$\text{CrCl} = (140 - \text{age}) \times \text{Ideal body weight} / (\text{Serum creatinine} \times 72) \ (\times 0.85 \text{ for women})$$

$$\text{Ideal body weight} = 2.3 \text{ kg for every inch over 5 ft} + [50 \text{ kg (men) or } 45.5 \text{ kg (women)}]$$

More recent formulas, such as the Modification of Diet in Renal Disease (MDRD) equation, may also be used to calculate GFR and stage chronic kidney disease [89]. The MDRD equation takes into account serum creatinine level, age, race, and gender. A free online MDRD calculator can be accessed at http://www.mdrd.com.

In addition to calculating GFR, identifying patient medications that are cleared by the kidneys is warranted during a preoperative assessment. Medications that are cleared by the kidney may need to be administered at a lower dose, with a longer dosing interval, or avoided altogether in individuals with impaired GFR (<30 mg/dL). Avoiding dehydration preoperatively and perioperatively is a vitally important management issue. Older adults are predisposed to dehydration due to impairments with the thirst drive with increasing age. Thus, monitoring for appropriate hydration, especially in patients recently restarted on a diet after a period of nothing-by-mouth (NPO) status is warranted.

Hepatic Assessment

Liver failure is an important predictor of poor perioperative outcomes [88]. Physiological changes that occur with aging may increase the risk of hepatic dysfunction. Liver blood flow, size, and mass all decrease with increasing age, as does cytochrome P450 content. As a result, medications that undergo a first pass effect, such as nitrates, may have a higher serum concentration or higher bioavailability in older adults. Additionally, the metabolism of medications, in particular anesthetic agents, can be impaired in adults over the age of 65. Obtaining an accurate history of current and previous alcohol use should be incorporated into the preoperative hepatic assessment. Laboratory evaluation of liver function tests including albumin, and the coagulant profile are also recommended.

Processes of Care to Improve Outcomes

Preoperative Evaluation of Postoperative Needs

Once the decision to proceed with surgery has been made, planning for the postoperative period should begin. In particular, knowledge of the geriatric surgical patient's social support structure will help guide postoperative discharge decisions. A functionally independent individual living with involved family members, for example, requires far less ancillary support than a frail individual living alone. Preoperative patients who do not receive adequate support from family, friends, or paid professionals are unlikely to be discharged home postoperatively, when their needs are likely to be greater, unless additional support can be arranged. If a patient's needs exceed the level of assistance home services can provide, then short-term rehabilitation or long-term care placement may be indicated. Assistance with housework, laundry, and driving are just a few examples of needs that may originate during the postoperative period. If possible, patients should be encouraged to make arrangements for additional home support, prior to surgery. If informal assistance is not available, involving care coordination as early as possible may smooth the transition from hospital to home. Determining the level of additional support required and preparing for this support prior to surgery allows the patient to prepare for their entire recovery period and may positively affect compliance with follow-up care.

Surgery–Geriatrics Comanagement Models

As previously discussed, older adults have an increased risk of postoperative adverse outcomes including mortality, longer hospitalization, and new discharge to a long-term care facility. A combined surgery–geriatrics comanagement care model has been utilized in various hospitals outside of the USA for several years; some US hospitals have recently implemented similar models. Comprehensive Geriatric Assessment (CGA) is a common component of comanagement models instituted for patients scheduled for elective surgery. CGA typically includes preoperative cognitive, functional, and nutritional assessments; mood evaluation; and medication review. In one study, older patients who had CGA as part of a comanagement model had shorter hospitalizations (11.5 vs. 15.8 days) and fewer delayed discharges (24.1 vs. 70.4%) [90]. In another study, older hip fracture patients who were assessed by the geriatrics service within 24 h of admission and subsequently comanaged by geriatrics and orthopedic surgery throughout the remainder of their hospitalization had lower rates of delirium (RR = 0.64) and severe delirium (RR = 0.4) compared with patients who received usual care [91]. A collaboration of surgeons and geriatricians in Japan has used the functional and cognitive components of CGA to predict which thoracic surgery patients are at highest risk for postoperative complications [92]. Additional studies are necessary in order to fully understand all the benefits afforded to older surgical patients who receive care via combined surgery–geriatrics comanagement programs. Perhaps comanagement programs will emerge as a low risk, cost-effective means to improve perioperative and postoperative outcomes for older surgical patients. Given the expected increase in the number of older adults in the next few decades, any intervention or model of care that improves outcomes for geriatric surgical patients would likely make a significant contribution to the overall US healthcare system.

Summary

Successful surgical care of the older patient requires a full understanding of the factors that will influence the postoperative recovery of each individual. Determining these factors need not take an excessive amount of time or require elaborate testing. A thorough history and physical examination will identify serious comorbidity that may direct additional specific testing. Assessment of the factors specific to the older patient can be done by asking these simple questions:

1. "Can you carry a bag of groceries up a flight of steps without getting short of breath?"
2. "Have you lost 10 pounds or more in the last 6 months without trying to do so?"
3. "Do you have problems with your memory?"
4. "Do you drink alcohol occasionally, with meals, or before going to bed?"

…and doing these three tests:

1. Timed Get Up and Go
2. Height, weight, BMI, serum albumin
3. Mini-Cog

The need for further testing or preoperative preparation will be guided by the results of these simple assessments.

Improving the care of the older surgical patient presents special challenges. However, these challenges may be overcome by developing patient-centered treatment plans that recognize individual preferences, geriatric-specific issues, and the physiological changes that occur with aging.

Appendix 22.1 Mini-Cog Screen for Dementia

Administration

1. Make sure you have the patient's attention. Instruct the patient to listen carefully to and remember three unrelated words and then to repeat the words back to you (to be sure the patient heard them)
2. Instruct the patient to draw the face of a clock, either on a blank sheet of paper, or on a sheet with the clock circle already drawn on the page. After the patient puts the numbers on the clock face, ask him or her to draw the hands of the clock to read a specific time (1:45 or 11:10 are commonly used). These instructions can be repeated, but no additional instructions should be given. If the patient cannot complete the clock-drawing test (CDT) in 3 min or less, move on to the next step
3. Ask the patient to repeat the three previously presented words

Scoring

Give 1 point for each recalled word after the CDT distractor. Score 0–3 for recall

Give 2 points for a normal CDT, and 0 points for an abnormal CDT. The CDT is considered normal if all numbers are depicted, once each, in the correct sequence and position, and the hands readably display the requested time. Add the recall and CDT scores together to get the Mini-Cog score

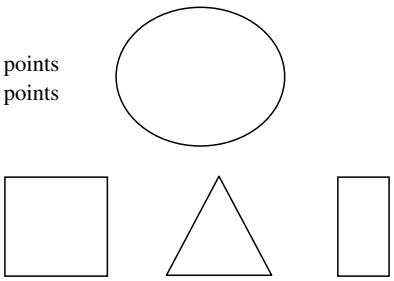
0–2 positive screen for dementia

3–5 negative screen for dementia

Source: Data from [60]

Appendix 22.2 St. Louis University Mental Status (SLUMS) Examination

1.	What day of the week is it?	1 point
2.	What is the year?	1 point
3.	What state are we in?	1 point
4.	Please remember these five objects	I will ask you what they are later
	Apple Pen Tie House Car	
5.	You have $100 and you go to the store and buy a dozen apples for $3 and a tricycle for $20	
	How much did you spend?	1 point
	How much do you have left?	2 points
6.	Please name as many animals as you can in 1 min	
	0–5 animals	0 points
	5–10 animals	1 point
	10–15 animals	2 points
	15+ animals	3 points
7.	What were the five objects I asked you to remember?	1 point for each one correct
8.	I am going to give you a series of numbers and I would like you to give them to me backwards. For example, if I say 42, you would say 24	
	87	0 points
	649	1 point
	8,537	2 points
9.	This is a clock face. Please put in the hour markers and the time at 10 min to 11 o'clock	
	Hour markers okay	2 points
	Time correct	2 points
10.	Please place an X in the triangle	



Which of the above figures is the largest?

(continued)

Appendix 22.2 (continued)

11. I am going to tell you a story. Please listen carefully because afterwards, I'm going to ask you some questions about it
    Jill was a very successful stockbroker. She made a lot of money on the stock market. She then met Jack, a devastatingly handsome man. She married him and had three children. They lived in Chicago. She then stopped work and stayed at home to bring up her children. When they were teenagers, she went back to work. She and Jack lived happily ever after

What was the female's name?	2 points
What work did she do?	2 points
When did she go back to work?	2 points
What state did she live in?	2 points

Scoring

High school education		Less than high school education
27–30	Normal	20–30
20–27	Mild cognitive impairment	14–19
1–19	Dementia	1–14

Source: Available at http://www.medschool.slu.edu/agingsuccessfully/pdfsurveys/slumsexam_05.pdf. (See also 64)

Appendix 22.3 Michigan Alcoholism Screening Test: Geriatric Version (MAST-G)

1.	After drinking have you ever noticed an increase in your heart rate or beating in your chest?	Yes	No
2.	When talking with others, do you ever underestimate how much you actually drink?	Yes	No
3.	Does alcohol make you sleepy so that you often fall asleep in your chair?	Yes	No
4.	After a few drinks, have you sometimes not eaten or been able to skip a meal because you didn't feel hungry?	Yes	No
5.	Does having a few drinks help decrease your shakiness or tremors?	Yes	No
6.	Does alcohol sometimes make it hard for you to remember parts of the day or night?	Yes	No
7.	Do you have rules for yourself that you won't drink before a certain time of the day?	Yes	No
8.	Have you lost interest in hobbies or activities you used to enjoy?	Yes	No
9.	When you wake up in the morning, do you ever have trouble remembering part of the night before?	Yes	No
10.	Does having a drink help you sleep?	Yes	No
11.	Do you hide your alcohol bottles from family members?	Yes	No
12.	After a social gathering, have you ever felt embarrassed because you drank too much?	Yes	No
13.	Have you ever been concerned that drinking might be harmful to your health?	Yes	No
14.	Do you like to end an evening with a nightcap?	Yes	No
15.	Did you find your drinking increased after someone close to you died?	Yes	No
16.	In general, would you prefer to have a few drinks at home rather than go out to social events?	Yes	No
17.	Are you drinking more now than in the past?	Yes	No
18.	Do you usually take a drink to relax or calm your nerves?	Yes	No
19.	Do you drink to take your mind off your problems?	Yes	No
20.	Have you ever increased your drinking after experiencing a loss in your life?	Yes	No
21.	Do you sometimes drive when you have had too much to drink?	Yes	No
22.	Has a doctor or nurse ever said they were worried or concerned about your drinking?	Yes	No
23.	Have you ever made rules to manage your drinking?	Yes	No
24.	When you feel lonely, does having a drink help?	Yes	No

Scoring: Five or more "Yes" responses are indicative of an alcohol problem
Source: from [67]

Appendix 22.4 The Geriatric Depression Scale (Short Form)
Choose the best answer for how you felt over the past week.

Date / /	Please tick ✓	
1. Are you basically satisfied with your life?	Yes ☐	**No** ☐
2. Have you dropped many of your activities and interests?	**Yes** ☐	No ☐
3. Do you feel that your life is empty?	**Yes** ☐	No ☐
4. Do you often get bored?	**Yes** ☐	No ☐
5. Are you in good spirits most of the time?	Yes ☐	**No** ☐
6. Are you afraid that something bad is going to happen to you?	**Yes** ☐	No ☐
7. Do you feel happy most of the time?	Yes ☐	**No** ☐
8. Do you often feel helpless?	**Yes** ☐	No ☐
9. Do you prefer to stay at home, rather than going out and doing things?	**Yes** ☐	No ☐
10. Do you feel you have more problems with memory than most?	**Yes** ☐	No ☐
11. Do you think it is wonderful to be alive now?	Yes ☐	**No** ☐
12. Do you feel pretty worthless the way you are now?	**Yes** ☐	No ☐
13. Do you feel full of energy?	Yes ☐	**No** ☐
14. Do you feel that your situation is hopeless?	**Yes** ☐	No ☐
15. Do you think that most people are better off than you?	**Yes** ☐	No ☐
TOTAL SCORE		

Answers in **bold** indicate depression and receive one point. Scores greater than five suggest the presence of depression.
Source: material available at http://www.chcr.brown.edu/GDS_SHORT_FORM.PDF. See also Sheik and Yesavage [70]

Appendix 22.5 Cardiac Evaluation and Care Algorithm
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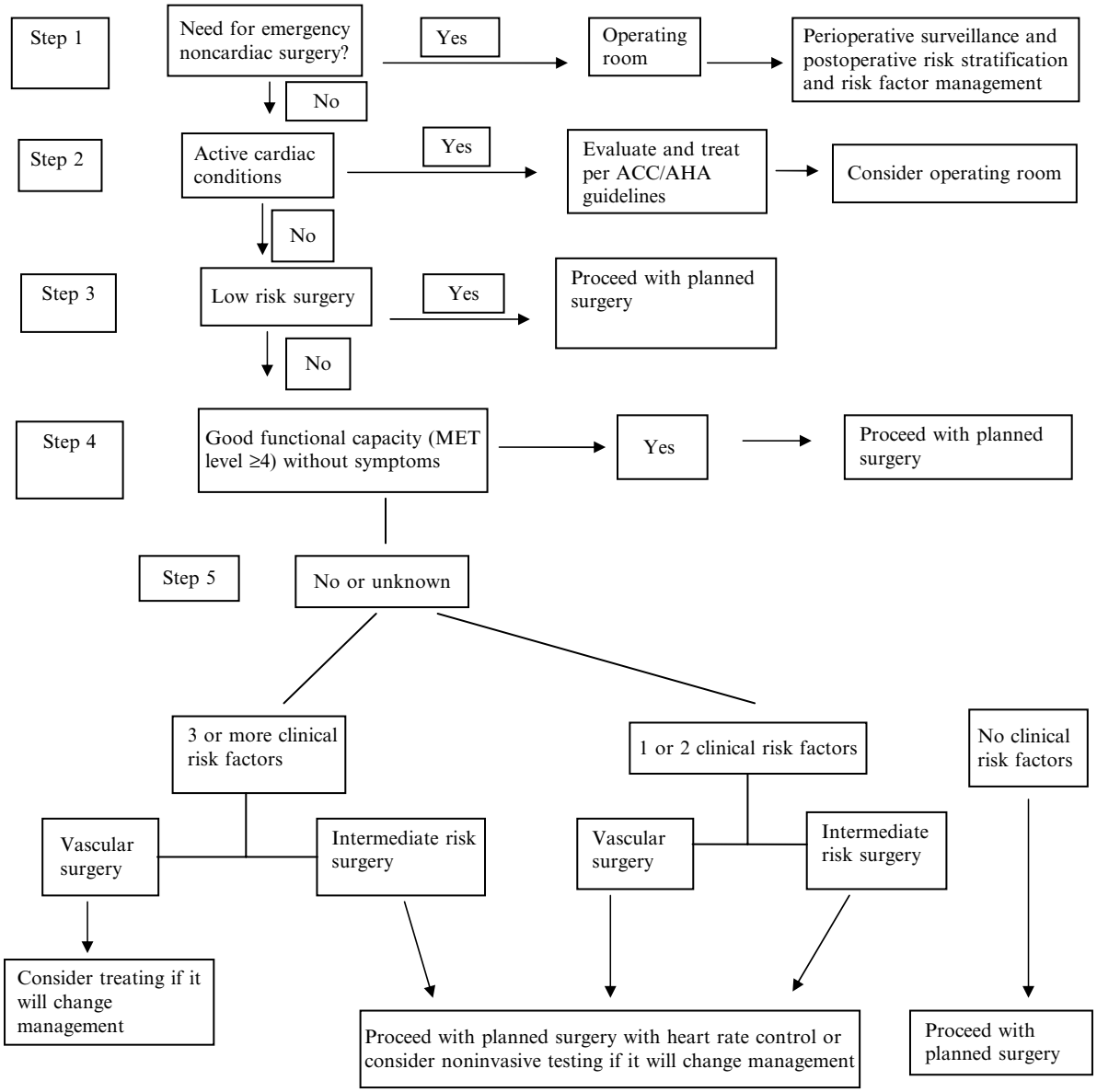

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