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Age associated issues: geriatrics

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As the population ages there will be an ever-increasing number of elderly patients who will require surgical care (Fig. 1). The estimated species-specific life span for human beings is approximately 110 years. The point of reference for the definition of being elderly is taken as an age greater than 65 years. Murvachick [1] further subdivides this group into: elderly (ages: 65–74), aged (ages: 75–84), and the very old (ages 85 and above). Currently patients aged 65 and above comprise at least one quarter of the surgical population and one quarter to one half of the ICU admissions [1,2]. How to best optimize the care that an elderly patient receives is a fundamental problem that has enormous financial, social, and medical implications.

The difference between physiologic and biologic age, and the complexity and the heterogeneity of the range of response in the elderly is exemplified by the following case. An 87-year-old woman who has a past medical history significant for hypertension, for which she takes atenolol, fell while rushing to answer her doorbell. This 87-year-old patient is pleasant, sprightly, and neurologically intact. She lives alone at home and takes care of herself. She undergoes a successful hip pinning with a short stay in rehab and an uneventful discharge back to her own home. In sharp contrast to this 87-year-old patient is the patient's 66-year-old daughter who is unable to come to the hospital because she is recovering from pneumonia and COPD exacerbation after undergoing a hernia operation. The 66-year-old daughter has a complex medical history including smoking, diabetes, and coronary artery disease.

The physiologic response to injury and surgery exhibited by the biologically younger patient is far different than that exhibited by the very old patient even

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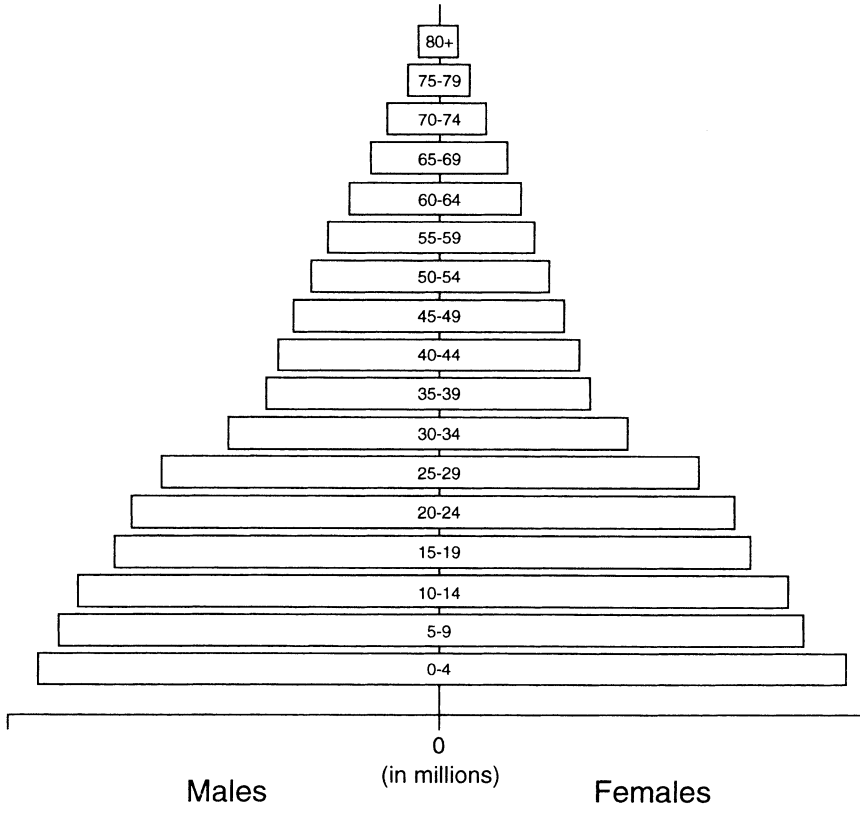

Fig. 1. Age pyramid for humans before 1900. (*From* Cassel CK, Leipzig RM, Cohen HJ, et al. Geriatric medicine: an evidence based approach. 4th edition. New York: Springer; 2003. p. 39; with permission.)

though both patients are members of the geriatric population and also of the same family.

This illustration also emphasizes that the decision to operate should not be based on age alone (Fig. 2). Increased life expectancy, safer anesthesia, and less invasive surgical techniques have made it possible for a greater number of geriatric patients to be considered for surgical intervention. Although age has been shown to be a predictor of poor operative risk, it is difficult to separate the effect of age from ASA status or underlying co-morbidity [3]. Thus, it is hard to pinpoint how aging alters surgical risk. One thing for certain, as aging occurs there is a progressive loss of function. Previously many disease-related changes were attributed to aging; but as physicians and scientists are examining aging and attempting to quantify the changes, prior dictums are increasingly coming under scrutiny and are now being studied. The best predictor of postoperative level of functioning seems to be preoperative level of functioning. It is likely that the

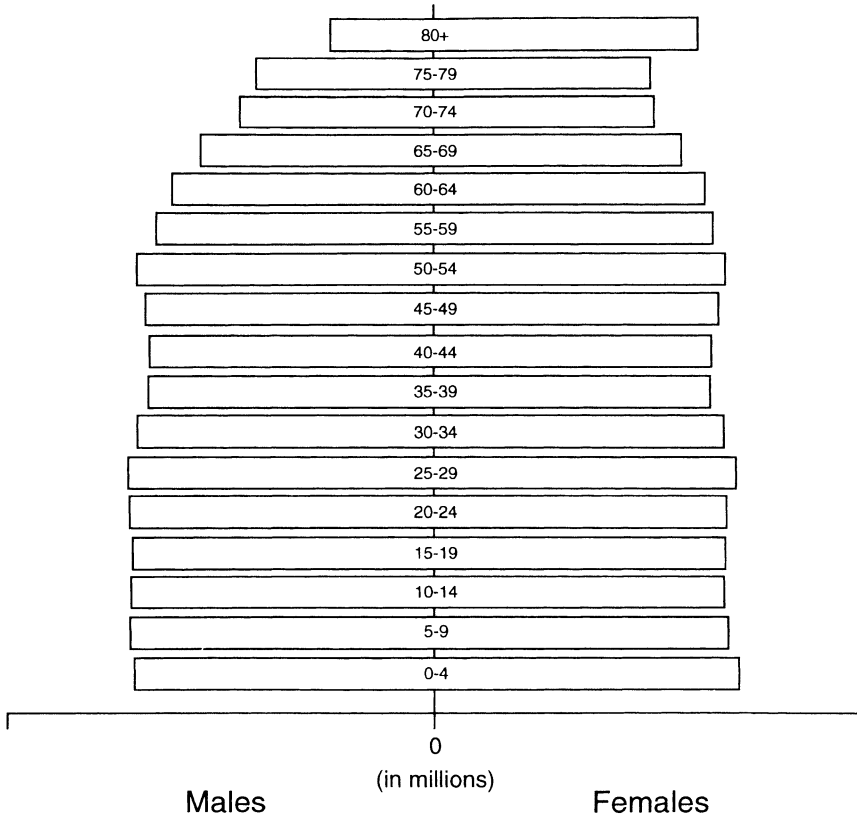

Fig. 2. Age pyramid of the future. (*From* Cassel CK, Leipzig RM, Cohen HJ, et al.Geriatric medicine: an evidence based approach. 4th edition. New York: Springer; 2003. p. 39; with permission.)

association between age and surgical risk is related to the aging process and its ongoing decrease in functional organ reserve and associated loss of function.

Risk factors

The authors look at previous studies to help focus the preoperative evaluation of the elderly. According to Jin and Chung [4], the elderly surgical patient is at increased risk for perioperative morbidity and mortality under certain conditions. There is increased risk for elderly patients with high ASA physical status (ie: ASA III, IV, or V) who undergo emergency surgery or major vascular or prolonged surgery with large blood or fluid shifts, who have co-existing diseases: cardiac, pulmonary, renal, hepatic, diabetes; who have poor nutritional status, limited functional status (ie: <4 METs), and who are bedridden, or not living with family [4]. Assessing the geriatric patient with regard to these risk factors allows

the anesthesiologist to anticipate adverse outcomes and prepare with closer monitoring (ie, more invasive monitors), have tighter hemodynamic control of the patient's vital signs, and thus, help to optimize the geriatric patients perioperative course.

Emergency surgery and surgical procedure

Emergency surgery is an independent predictor of adverse postoperative outcomes in older surgical patients undergoing noncardiac surgery [5,6]. Poorer preoperative physiology and preparation has a large influence on these results. Emergent care presents special problems, such as atypical presentations, alterations in pulmonary and circulatory system, fluid and electrolyte balance changes secondary to modifications in metabolic needs and body composition, and aging that complicates resuscitation.

Surgical mortality in the elderly varies widely according to procedure [6–8]. The current guidelines for cardiovascular evaluation of patients undergoing noncardiac surgery provide a useful means of categorizing procedures into those of low, intermediate, and high risk [9]. These guidelines discussed later.

Organ focused preoperative evaluation

The preoperative assessment of the geriatric patient should involve a focused organ systems approach with particular emphasis on cardiac, pulmonary, renal, and hepatic functional reserve.

Cardiac

Nagappan and Parkin [2] summarize and point out that the following cardiovascular changes occur in the elderly patient. There is an increase in left ventricular thickness, mass, and cavity size. Although in women ventricular cavity size does not increase. Myocardial contractility remains at baseline values while the patient is at rest, and rises, but to a lesser extent than in younger patients when stressed. In the supine position the resting heart remains the same as a younger patient; but the resting heart rate decreases in the sitting position, and has a lesser rise in rate in response to exercise than in a younger patient. The aortic pulse wave velocity increases with aging. There is a greater increase in systolic blood pressure than diastolic blood pressure and the pulse pressure widens with aging. There is also an increase in systemic vascular resistance in women. The baseline ejection fraction of a patient remains the same as the patient ages, but the ability to increase ejection fraction in response to stress decreases with aging. In men the cardiac index remains unchanged, whereas in women there is a slight decrease. Overall with aging the heart and the vascular system become less compliant [4,10]. Diastolic dysfunction and an increasing dependence on the atrial contribution to cardiac output can occur with aging.

In assessing patients from a cardiovascular perspective for surgery the American College of Cardiology/American Heart Association task force for preoperative evaluation recommends evaluating clinical history, surgical risk, and exercise tolerance [11,12]. Clinical history is focused on those factors that lead to congestive heart failure, myocardial infarction, and death and thus increased perioperative cardiovascular morbidity and mortality. Major clinical predictors of increased cardiovascular risk are unstable coronary syndromes—such as a myocardial infarction within the last 7 days or unstable angina; decompensated heart failure; significant arrhythmias—such as high grade atrioventricular block, symptomatic ventricular arrhythmias in patients with underlying heart disease, supraventricular arrhythmias with uncontrolled ventricular response; and severe valvular disease. Intermediate risk factors include mild angina, prior MI or Q waves, prior congestive heart failure and diabetes. Minor risk factors include advanced age, abnormal electrocardiogram (with left ventricular hypertrophy, left bundle branch block, ST-T abnormality or non-sinus rhythm); low functional capacity, and history of stroke or uncontrolled hypertension.

Surgical risk has also been assigned into high-risk procedures, intermediate risk procedures, and low risk procedures by the task force. High-risk surgical procedures have a perioperative incidence of death and myocardial infarction of greater than 5%. Such high-risk procedures include major emergency operations, aortic and major vascular surgery, peripheral vascular surgery, and prolonged surgical procedures with large fluid shifts or blood loss. Intermediate risk procedures are those procedures that have a perioperative incidence of death and myocardial infarction of less than 5%. Carotid endarterectomies, head and neck surgery, thoracic and abdominal surgery, orthopedic surgery, and prostate surgery are considered to be intermediate risk procedures. Low-risk procedures have a perioperative cardiac risk for death and myocardial infarction of less than 1%. Examples of low-risk procedures included endoscopies, superficial procedures, cataracts, and breast surgery [11,12].

Assessment of exercise tolerance involves the calculation of energy requirements for different activities in terms of metabolic equivalents or METs. Activities equivalent to 1 MET include the activities of daily living and self care such as eating, dressing and using the bathroom, and walking around the house. Activities corresponding to 4 METs include doing the dishes, doing light housework such as dusting, climbing a flight of stairs, or walking up a hill. Brisk walking, running a short distance, doing heavy housework such as scrubbing the floors, or moving furniture, engaging in sports such as golf, bowling, doubles tennis, softball, or dancing correspond to an energy expenditure or activity level of 4 to 10 METs. Activities with values greater than 10 METs include swimming, singles tennis, football, basketball, or skiing.

Although Goldman's criteria [13] and the American College of Physicians guidelines [14,15] are validated clinical perioperative cardiac risk indices, as Fleisher [16] points out, what is essential for the anesthesiologist is an accurate assessment of the patient's ventricular function and the patient's potential for developing ischemia. The best approach to obtain this information is to perform a

thorough history and physical examination. Then a resting 12-lead electrocardiogram should be analyzed [17,18]. All the information obtained should then be assessed in a stepwise fashion in the context of the ACC/AHA perioperative guidelines [11,12].

The first step in this analysis is to assess whether the surgery is emergent. If the surgery is emergent then there is usually not time for a detailed preoperative cardiac evaluation, but a postoperative evaluation should be considered. The second step is to determine if the patient has undergone coronary revascularization within the last 5 years. If the patient has been clinically stable without any signs or symptoms of recurrent ischemia, then further cardiac work up is not usually necessary. The third step is to determine if the patient has had a detailed cardiac evaluation within the last 2 years. Unless there were adverse findings or the patient has developed signs and symptoms of new or unstable ischemia then there is no need to repeat the work up. The fourth step is to determine if the patient has one of the earlier mentioned major clinical predictors of cardiac risk. If this is the case and the surgery is nonemergent, then the surgery should be delayed until an appropriate cardiac work up has been done.

The fifth step is to assess patients with intermediate clinical predictors of cardiovascular risk in terms of exercise capacity and surgical risk to determine further appropriate work up. The sixth step in analysis involves assessing patients with intermediate clinical predictors of perioperative cardiac morbidity and mortality. If they have good exercise capacity–that is 4 METs or greater, and they are undergoing intermediate risk surgical procedures then there is no need for further cardiac evaluation. If, on the other hand, they have poor exercise capacity or they are to undergo high-risk surgery, then further noninvasive work up is recommended. The seventh step in the analysis involves the examination of patients with low clinical predictors of perioperative cardiac risk. Further evaluation is not necessary unless the patient has multiple risk factors, or poor exercise capacity, and is going to undergo high-risk surgery. The eighth step involves the assessment of noninvasive test results in patients with known coronary artery disease, to determine whether further invasive testing and correction of the coronary artery disease is appropriate or will significantly improve the patient's overall long term prognosis [11,12].

As Jin and Cheung [4] point out, and in keeping with ACC/AHA guidelines [11,12], conduction abnormalities such as Mobitz 2-second degree heart block or complete third degree heart block should be treated with a pacemaker before elective procedures. Because the elderly are at increased risk for significant valvular disease, the presence of a murmur on physical exam should prompt an echocardiographic evaluation to assess valvular pathology and cardiac function.

Because peripheral vascular disease and limited exercise capacity are more prevalent in the elderly, dypyridamole thallium scanning [19,20] and dobutamine stress echocardiography [21] are useful tools in evaluating the high risk elderly patient from a cardiovascular perspective. The importance of correct risk stratification and appropriate preoperative evaluation is further emphasized by the over 50% mortality rate associated with a perioperative myocardial infarction [12].

Pulmonary

Pulmonary complications make up a significant component of early perioperative complications. According to Brooks-Braun, pulmonary complications are frequent and are associated with a high mortality rate in the perioperative period [22,23]. Arozullah et al [24], in their work, had a 30-day postoperative mortality rate greater than 20% in patients with pneumonia. In Metersky, Tate, et al's [25,26] study, as age increases, so does the mortality from perioperative pneumonia. Thus examining the pulmonary system is an important component of the preoperative evaluation in geriatric patients.

As summarized by Nagappan and Parkin [2] there are significant pulmonary changes that occur with aging. Chest wall compliance, the elastic recoil of lung, and respiratory muscle strength all decrease. In terms of lung capacities there is a decline in the vital capacity and total lung capacity of the elderly patients. The FEV1 also decreases. Closing volume and functional residual capacity increase with aging. The peak expiratory flow rate and maximal expiratory flow, however, decrease with age. Aging reduces maximal inspiratory and expiratory pressures whereas airway resistance remains unchanged. In the elderly patient, the alveolar-arterial oxygen gradient increases as the P_aO_2 decreases, but the P_aCO_2 remains unchanged [2].

The basis of pulmonary evaluation and analysis of risk closely parallels the guidelines established for the cardiac system. According to Arozullah et al [24], the type of surgery such as abdominal aneurysm repair; thoracic, upper abdominal, neck, neurosurgery, or vascular surgery has a greater relative risk value than emergency procedures or those requiring transfusion of more than 4 units. They postulate that these surgeries have a greater impairment of swallowing and respiratory clearance mechanisms, which may contribute to the increased risk for pulmonary complications. Age is another important contributor to risk [27] because each decade after the seventh decade of the life increases the risk for postoperative pneumonia. Patient specific risk factors are also a telling category. It is here that the inability to carry out activities of daily living independently, is a major warning sign of postoperative pneumonia. A greater than 10% weight loss within the last 6 months is a predictor of perioperative risk for pneumonia. These two factors seem to be of greater importance than the commonly thought of contributors—smoking and chronic obstructive pulmonary disease. The definition of a positive smoking history as a risk factor includes smoking up until 1 year before surgery. Two neurologic risk factors that presage an increased risk for preoperative pneumonia are a cerebrovascular accident and an impaired sensorium—probably caused by an impaired ability to protect the airway. The use of steroids for chronic conditions and the consumption of more than 2 drinks of alcohol per day also increased the risk for perioperative pneumonia. The role of obesity and nutritional status however was not evaluated by Arozullah et al [24].

In keeping with the American Society of Anesthesiologists task force on preanesthetic evaluation [28,29] and the findings mentioned earlier, the most important and fundamental step in evaluating an elderly patient is to do a thorough

history and physical examination. After the history and physical there should be an analysis of the chest X ray. As pointed out by Szekely et al [30] in their examination of COPD patients undergoing lung reduction surgery, the best predictor of an increase in perioperative morbidity and mortality is an assessment of the patient's ability to walk a minimal distance within a defined period of time, or an elevated resting P_aCO_2 on room air. The ASA Task Force recommendation is that anesthesiologists take into consideration the patients underlying lung function, prior lung evaluations, and invasiveness of the surgical procedure in the context of the clinical assessment before proceeding to further pulmonary evaluation [28].

Renal

As stated by Muravchick [1], there is a high rate of pre-existing renal dysfunction in elderly patients. Acute renal failure contributes to one in five deaths among geriatric surgical patients in the perioperative period. Murvachick summarizes the renal changes that occur as the patient ages. There is loss of both renal mass and glomeruli with almost half the glomeruli present in a young patient gone or nonfunctional by the time the patient reaches his ninth decade of life. There is also a significant decrease in renal blood flow caused by loss in renal mass and changes in the fine renal vasculature. Although there is a significant decrease in creatinine clearance with aging, there is not a corresponding increase in serum creatinine because of skeletal muscle atrophy. As the patient ages there is decreased urine concentrating ability, impaired absorption of glucose, and decreased responsiveness to antidiuretic hormone.

The loss of potassium stores within the body subjects the elderly patient to an increased risk for hypokalemia [1].

Because the kidney not only regulates fluids and electrolytes but also the metabolism of medicines and the production of blood, the American Society of Anesthesiologists task force on preanesthetic evaluation recommends as evaluations of renal function a complete history and physical examination, followed by a laboratory evaluation of serum chemistries, and hemoglobin and hematocrit. Even though urinary tract infections are a common perioperative infectious complication in the elderly, the task force does not recommend a routine urinalysis unless urinary tract symptoms are present; or there is a procedural indication such as prosthesis implantation or a planned urologic surgery procedure [28].

Hepatic

The hepatic system is another system that plays a key role in the patient's well-being, especially as the patient ages. The elderly in the course of their lives have often been exposed to hepatotoxic agents such as acetaminophen, alcohol, and various prescription medicines, in addition to various disease states. As Muravchick [1] summarizes there is a marked decrease in the size of the liver by almost 40% in the 80-year-old patient. In proportion to the decrease in liver size

there is a corresponding decrease in splanchnic blood flow. But, biopsy specimens in the elderly have shown that actual hepotocellular function remains intact in the absence of disease. The key consideration becomes a loss of functional reserve within the liver as aging progresses, and thus, the ability to respond to surgical stresses such as hypotension with hypoperfusion, the generation of free radicals from cellular damage, and hypothermia. Key on the assessment of the geriatric patient for surgery is a detailed history and physical examination.

The ASA task force on preanesthetic evaluation does not advocate routine liver function tests; but they do recommend routine hemoglobin and hematocrit in addition to cardiac assessment. Depending on the invasiveness and type of surgery, further liver function tests may be warranted [28]. The best means of assessing the liver's intrinsic function is the coagulation test—prothrombin time. The ASA task force does recommend coagulation studies if there is a potential for hepatic dysfunction.

Diabetes

Diabetes is an important co-morbidity to assess for in determining perioperative risk. The severity of end stage disease associated with diabetes may be associated with increased cardiovascular morbidity. In addition, diabetes is an independent predictor of a long-term decrease in quality of life following surgery [31].

Malnutrition

Surgical patients who are malnourished have increased morbidity and mortality [32] and increased length of stay [33]. In the community dwelling aged population malnutrition has been reported to occur in 16.9% of women and 11.4% of men [34]. Among the hospitalized elderly the prevalence of malnutrition ranges from 15% to 26% [35,36]. The diagnosis of malnutrition should be made based on both preoperative history and physical and laboratory tests. The criteria for malnutrition vary depending on patient disposition. For the elderly living within the community, involuntary weight loss, abnormal body mass index, hypoalbuminemia, hypocholesterolemia, and vitamin or nutrient deficiencies are used to define malnutrition.

In hospitalized patients, dietary intake; hypoalbuminemia; and hypocholesterolemia are useful criteria, whereas in nursing home patients weight loss and dietary intake are determinants [37].

Issues specific to the geriatric population

Activities of daily living

An important concept in preoperative evaluation of the geriatric patient is to determine preoperatively the activities of daily living and instrumental activities

[38]. The successful endpoint of surgical intervention should be, at the very least, to return the patient to their previous level of activity and independence. Preoperative functional assessment provides a baseline to determine whether quality of life has been maintained by surgical intervention. Activities of daily living are important predictors of outcome [39]. Functional measures have been shown to be strong predictors of 90-day and 2-year mortality after hospitalization [40]. The concept of measuring functional activities of daily living is not unique to evaluation of the geriatric population and has been incorporated into the evaluation process of specific organ systems. For example, the concept of METs (metabolic equivalent of activities of daily living) has been integrated into the cardiac evaluation (see earlier)[9]. Various instruments are available to evaluate functional activity including SF-36 [41], and have been used to evaluate heath related quality of life following various types of surgery [42]. For purpose of ease, activities of daily living and instrumental activities of daily living may be assessed using standardized forms [43].

Cognitive status

Dementia is common in the elderly population. Alzheimer's disease is present in 6% to 8% of patients 65 years of age and older. Preoperative cognitive deficit has a direct bearing on postoperative emergence and perioperative morbidity. For one, cognitive deficits are associated with poorer rehabilitation outcomes [44] and higher surgical mortality [45]. Perhaps most important, dementia is a predictor of postoperative delirium [46].

Accurate diagnosis of dementia is not always an easy task. For the purposes of preoperative evaluation, the mini-mental state examination allows for quick screening of baseline cognitive status [47]. In addition, insight may be gained by speaking with the patient's family concerning baseline function and activities of daily living. The mini-mental state examination is available on numerous websites (eg, .www.fpnotebook.com/NEU67.htm).

Cognitive and sensory difficulties frequently jeopardize informed consent in frail elderly patients. Dementia, depression, hearing difficulties, and stroke all may interfere with the ability to make independent decisions. If one's ability to make decisions becomes severely impaired then a surrogate must give consent. Advance directives, when available, can be helpful, but even with them difficult problems remain. Issues of consent and end of life decisions in the elderly are complex, and familiar to the practicing anesthesiologist. Often there are no easy answers to these ethical dilemmas.

The issue of routine preoperative testing

Current data suggests that routine testing based on age alone is not indicated. In low- risk procedures, such as cataract surgery and routine preoperative testing does not decrease the incidence of intra or postoperative complications [48]. For intermediate risk procedures, such as total hip replacement, studies suggest that

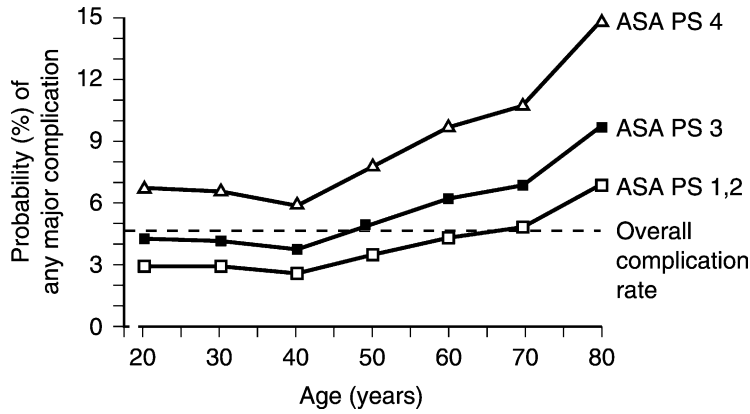

Fig. 3. Perianesthesia risk by age, ASA class. (*From* Miller RD, editor. Anesthesia, edition 5. Philadelphia: Elsevier; 2000; with permission.)

healthy patients should undergo selective laboratory testing based on the history and physical [49]. For all types of non-cardiac surgery, when patients are over 70 years of age, the significant predictors of adverse outcomes are not specific laboratory abnormalities, but rather ASA status (Fig. 3) and surgical risk [50]. These results suggest that routine preoperative testing based on age will have a low yield. Instead, selective testing should be performed based on the history and physical and surgical procedure.

Summary

The effects of aging on the body are numerous, but the most important point with regard to surgery is to differentiate the effects of aging from those of the pathology associated with a disease process that may also be present in the elderly patient. Studies tend to validate the premise that there are no labs mandated solely because of a patient's age. Rather, the physician should analyze the geriatric patient with reference to the nature of the surgery—emergent versus elective; the degree of risk for the surgical procedure itself—that is high-risk, intermediate--risk, or low-risk surgery; while bearing in mind the patient's overall physiologic state. In assessing a patient's overall physiologic state an organ systems based approach focusing on the cardiac, respiratory, renal, hepatic, endocrine, nutritional, and neurologic systems may be warranted and beneficial. In the elderly population one of the key predictors of perioperative complications seems to be the geriatric patient's preoperative condition and preoperative level of functioning.

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