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FIVE PRACTICAL TIPS FOR THE OLDER SURGICAL PATIENT:
FROM A GERIATRICIAN’S PERSPECTIVE

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UNIVERSITY OF SOUTH CAROLINA SCHOOL OF MEDICINE
Tip One: All Older People Are Not Alike!

- Don’t base judgments on age alone
- Don’t deny surgery unnecessarily (agism)
- Don’t press for surgery if benefit is minimal

Visualize a patient who is 80 years old. What does he or she look like?
Aging Heterogeneity

Why is there so much variance in older adults?

- Genetic Differences
- Environmental Stresses Differ
  - Tobacco
  - Alcohol
  - Exercise
- Aging Dependant Diseases

Source: Solomon, UCLA Review Course 2002
Aging Changes from the Geriatric Perspective

We must differentiate disease from normal aging. The elderly have decreased reserve capacity of organs & systems. This varies between and within individuals. After Age 30, most “typical” declines are 5–10% declines in Physiologic Function.

An important consideration is that of homeostenosis: An impaired response to physical, emotional, and environmental stresses

Example: Fluid Challenge of 1000cc: what are the likely consequences in a:

- 35 YEAR OLD

- 70 YEAR OLD
Relevant Changes That Occur With Aging

Physiology
- Pulmonary
- Cardiac
- Pharmacologic
- Wound Healing
- Immune function

Anatomic
Functional
Social

We will consider each of these briefly in turn...
Pulmonary Changes with Aging

The thorax becomes stiffer with age, increasing the work of breathing and decreasing the vital capacity. Additionally, there is a decline in ciliary function and increase in dead space.

The net effect is a gradual decrease in $\text{PO}_2$ and increase in $\text{Aa-}$gradient.

Additionally, there is a narrowing of the gap between tidal volume and closing capacity, increasing the risk of atelectasis and post-operative complications.
Impact of Training on VO2Max with Age

A 25–year old healthy but completely out of shape individual has the same VO2Max as an elderly “master athlete” (your marathon-running grandmother, for example). Elderly individuals in worse condition have severe limitations on maximum oxygen utilization.
Airway Changes

Declines in
- Alveolar surface area
- Diffusion capacity
- Hypoxic drive
- Arterial PO₂

Expected PaO₂ = 100—(Age/3)
- 20yr old: 93mmHg
- 90yr old: 70mmHg

- Swallowing changes predispose to aspiration
- Decreased numbers and function of cilia
- Diminished cough
- Pneumonia more common
Cardiac Changes with Aging

CHANGES IN CONDUCTION

Multiple changes, net results: decline in maximum heart rate (estimated maximum is (220–age))

Decreased beta-2 receptors & decreased response to beta agonists

HEART RATE AND AGE

Rounds on Two Post Op Patients:
- 20 year old with HR of 100
- 95 Year old with HR of 100

What is your Level of Concern for Each?

Calculate Predicted Maximum Heart Rate
- 20 year old = 220 - 20 = 200 → 50% of predicted
- 95 Year old = 220 - 95 = 125 → 80% of predicted

80% of predicted maximum heart rate in the 95 year old patient is equivalent to an ongoing Cardiac Stress Test!
Functional Cardiac Changes in the Elderly

- Resting cardiac output – little change
- Maximum cardiac output – declines significantly

- Decreased LV compliance
- Increased diastolic dysfunction
- Increased importance of atrial contraction
- Decreased tolerance for atrial fibrillation
Atrial fibrillation and Ageing

GFR and Ageing
Tip Two: Be Gentle!

- In Relationship
- In Caring
- In Doing Anything!
Tip Three: Medications are Dangerous

- Start low, go slow
- Avoid all medications, if possible
- Particularly avoid certain medications

Medications in Older Adults
- Older people take more medications
- Drug–drug interactions more likely
- Adverse drug reactions more serious

Consider two patients who receive 1mg of Ativan: one is 20 and the other is 80. If both patients suffer a fall because of unsteady gait after the sedation, there is relatively little risk to the 20 year old, but for the 80 year–old a fall may bring terrible morbidity (hip fracture, sub–dural hematoma, etc) and even mortality.
Delirium
Delirium in post-operative patients is often due to medications. Other considerations:
- Hypoxia
- Pain
- Infection
- Sleep Deprivation
- Others

Adding a medication to treat delirium may be hazardous. There is an increased risk of drug interactions and adverse reactions and often does not help the patient!

Mortality of Delirium
Mortality of in-hospital delirium: 25–33%
Unrecognized by Physicians 30–50% of the Time!

Diagnosing Delirium
1. Acute Onset & Fluctuating Course
2. Inattention
3. And One Of The Following:
   - Disorganized Thinking
   - Altered Level of Consciousness
Drugs that should be avoided in older people

- Propoxyphene (Darvon, Darvocet)
- Meperidine (Demerol)
- NSAID’s - (Indocin, Toradol)
- Diphenhydramine (Benadryl)
- Muscle Relaxants (Flexeril, Robaxin)
- Benzo’s -especially Valium, Dalmane

Start Low ...

...Go Slow...
Tip Four: Function is Paramount

- Pre op
- Post Op
- Long Term

Pre Operatively
- Baseline function predicts morbidity and mortality
- 4 MET equivalent is key cutoff for risk
- Consider "prehab" for low-functioning patients
- Ensure realistic goal setting is occurring
- Planning for post operative care

Post Operatively
- Early mobilization is beneficial
- Rehabilitation is key

Long Term
- Prevention of functional decline should be goal
- Planning, ethical issues take precedence in this stage
Tip Five: There is no “Benign” Procedure

Where I First Learned About iatrogenesis

Summer of 1979 Mr. Monroe H., a 76 year-old admitted with diarrhea and weight loss. Admission U/A showed 10-20 WBC’s and many epithelial cells.

To Catheterize or Not To Catheterize for a repeat U/A?

“It’s a Benign Procedure”

Patient was catheterized & had a vagal reaction. He became unresponsive, a code was called. Right central line placed for access. Patient moved to the ICU.

Post central line CXR showed pneumothorax. Chest tube placed. He had a long, tortuous, hospital course and died about 1 month after admission.

There are NO Benign Procedures in Someone over Age 65!
Five Practical Tips: Summary

1. All older people are not alike
2. Be gentle
3. Medications are dangerous
4. Function is paramount
5. There is no “benign” procedure
Geriatric Anesthesia
Literature Review

David J. Cook, M.D.
An aging population carries profound implications for the practice of anesthesiology. Geriatric issues impact every aspect of anesthesiology. First, the preoperative evaluation of the geriatric patient is typically more complex than that of the younger patient because of the heterogeneity of this patient group and the greater number and complexity of comorbid conditions that usually accumulate with age. Perioperative functional status can be difficult to predict because many elderly patients have reduced preoperative function as a consequence of deconditioning, age-related disease, or cognitive impairment. This makes it difficult to adequately assess the patient’s ability to respond to the specific stresses associated with surgery. A common example is trying to determine cardiopulmonary reserve in a patient very limited by osteoarthritis. Physiologic heterogeneity and decreased functional reserve are also manifested perioperatively. Normal aging results in changes in cardiac, respiratory, and renal physiology, and the response of the elderly patient to surgical stress is often unpredictable. The pharmacokinetics and pharmacodynamics of elderly and younger patients also differ; moreover, the elderly patient’s use of multiple medications may alter homeostatic mechanisms.
This review of research on anesthesia for elderly patients first summarizes the normal physiologic changes that occur with aging, an overview that is essential to frame the discussion of research in the three sections that follow, on preoperative assessment, intraoperative management, and postoperative management of the older surgical patient. Postoperative respiratory complications and delirium are emphasized, and issues of acute and chronic pain management for elderly surgical patients are also highlighted. The goal throughout is to identify needed research in geriatric anesthesiology.

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METHODS

The literature search was conducted on the National Library of Medicine’s PubMed database. The time period covered was from 1980 to April 2001. The search strategy combined various terms for anesthesia, sedation, analgesics, and opiates with terms for surgical procedures (general or specific commonly performed operations), the terms elective and emergency, and various terms for the many elements of surgical care: preoperative assessment and management, intraoperative care, perioperative care, postoperative care, complications, and outcomes. Additional requirements were either that the publication be a review, clinical trial, randomized controlled trial, or meta-analysis, or that terms for risk or age factors be present as title words or MeSH headings. Terms denoting age were age factors, age, aging, elderly, geriatric, gerontologic, older, or octogenarian, nonagenarian, or centenarian. Finally, the term aspirin was excluded, as it had generated a large number of irrelevant titles in early iterations of this search.
AGE-RELATED PHYSIOLOGIC CHANGES AND PERIOPERATIVE CARE

The physiology of aging bears on preoperative assessment, intraoperative and postoperative management, and the types and likelihood of major adverse events. Age-related changes in cardiac, respiratory, neurologic, and renal function as well as in pharmacokinetics have been well defined. The most important generalization from physiologic studies of aging is that the basal function of the various organ systems is relatively uncompromised by the aging process. However, functional reserve, and specifically the ability to compensate for physiologic stress, is greatly reduced (see Figure 2.1). This fact has profound implications for the preoperative assessment and the perioperative care of geriatric patients.
CARDIOVASCULAR CHANGES

Numerous changes in cardiovascular function with aging have implications for anesthetic care. With aging, the progressive decrease in the elasticity of the arterial vasculature leads to an increase in systolic blood pressure. Diastolic blood pressure increases through middle age and typically declines after age 60. The cross-sectional area of the peripheral vascular bed also decreases, resulting in a higher peripheral vascular resistance. A decrease in the peripheral vasodilatory response to α-adrenergic stimulation may also contribute to the hypertension of aging.

Progressive ventricular hypertrophy develops in response to increased afterload, resulting in both cellular hypertrophy and deposition of fibrotic tissue. Ventricular hypertrophy increases both wall stress and myocardial oxygen demand and makes the ventricle more prone to ischemia.

Although intrinsic contractility and resting cardiac output are unaltered with aging, the practical effect of ventricular hypertrophy and stiffening is that they limit the ability of the heart to adjust stroke volume. Ventricular hypertrophy impairs the passive filling phase of diastole, making ventricular preload more dependent on the contribution of atrial contraction. At the same time, fatty infiltration and fibrosis of the heart increases the incidence of sinus, atrioventricular, and ventricular conduction.
defects.  

Myocardial responsiveness to catecholamines also decreases with age; maximal heart rate response is correspondingly decreased.  

The reduction in ventricular compliance and the attenuated response to catecholamines compromise the heart’s ability to buffer increases in circulatory volume, which results in a predisposition to congestive heart failure. Similarly, even modest decreases in circulatory volume produce hypotension. 

From the standpoint of perioperative hemodynamic stability, age–related changes in the autonomic control of heart rate, cardiac output, peripheral vascular resistance, and the baroreceptor response are as important as the chronic changes in the myocardium and vasculature. It is evident that age–related changes in the cardiovascular system involve alterations in both mechanics and control mechanisms.

PULMONARY CHANGES

The pulmonary system also undergoes age–related changes in both mechanics and control mechanisms independently of comorbid disease processes. Functionally, there are remarkable parallels with changes in the heart. With aging, the thorax becomes stiffer. This may not be evident in the sedentary patient, but reduced chest wall compliance increases the work of breathing and reduces maximal minute ventilation. Loss of thoracic
skeletal muscle mass aggravates this process. Because of a decrease in elastic lung recoil, the closing volume increases such that by age 65 it exceeds functional residual capacity. Inspiratory and expiratory functional reserve decrease with aging, and the normal matching of ventilation and perfusion decreases. The latter process increases the alveolar–arterial O2 gradient and decreases the resting Pao2. The respiratory response to hypoxia also diminishes in the aged patient. (See Figure 2.2.) In addition, ciliary function is decreased and cough is reduced. Finally, pharyngeal sensation and the motor function required for swallowing are diminished.

These changes have important implications in the perioperative period. First, it is difficult to predict from a preoperative interview how an inactive, elderly patient will respond to the perioperative respiratory challenges. Anesthetics, postoperative pain, the supine position, narcotics, as well as thoracic and upper abdominal operations impair pulmonary function and further depress respiratory drive. Although blood gas analysis or spirometric tests may offer some value prior to thoracic operations, the alterations in pulmonary function following surgery are complex and typically not predictable from preoperative pulmonary function testing. Other implications of age–related changes in pulmonary mechanics and respiratory control are that postoperative hypoxia is likely to occur and that the risk of aspiration
is significantly increased in the elderly patient. $^{24,30}$

Figure 2.2—Ventilatory response (VI) to isocapnic progressive hypoxia in eight young normal men (broken line) and eight elderly normal men aged 64 to 73 (solid line). Values are means ± SEM. BTPS = body temperature, ambient pressure, saturated with water vapor. (Reprinted with permission from Kronenberg RS, Drage CW. Attenuation of the ventilatory and heart rate responses to hypoxia and hypercapnia with aging in normal men. J. Clin Invest 1973;52:1812–1819, figure 1.)
NEUROLOGIC CHANGES

Pulmonary and cardiac complications, respectively, account for most morbidity and mortality in older surgical patients. However, neurologic morbidity affects a large number of patients, and age-related degenerative changes in the central and peripheral nervous systems contribute to a variety of other morbidities. In themselves, neurologic complications have a dramatic impact on length of stay and discharge disposition, translating directly into altered functional status and quality of life.

Independently of any comorbid process, both the central and peripheral nervous systems are affected by aging. There is a loss of cortical gray matter beginning in middle age, resulting in cerebral atrophy, although how much of this is attributable to aging itself or to degenerative diseases is a subject of ongoing investigation. At the level of the neuron, the complexity of neuronal connections decreases, the synthesis of neurotransmitters decreases, and the enzymes responsible for their postsynaptic degradation increase. While cerebral metabolism, blood flow, and autoregulation generally remain intact, neuronal loss and the deficiency of neurotransmitters limit the ability of the older brain to integrate multiple neural inputs. This has been described as a loss of “fluid” intelligence. Neuronal loss and demyelination also occur in the spinal cord. Functionally, spinal cord reflexes change
and proprioception is reduced. There are also important decreases in hypoxic and hypercarbic drive.\textsuperscript{22,37} Declines in visual and auditory function further complicate the ability of the nervous system to acquire and process information. This combination of changes can limit the ability of the older patient to understand and process information in the perioperative period. These changes are probably important contributors to postoperative delirium, drug toxicity, and falls.

Aging is also associated with neuronal loss in the autonomic nervous system. Both sympathetic and parasympathetic ganglia lose neurons, and fibrosis of peripheral sympathetic neurons occurs. This peripheral neuronal adrenergic loss is associated with impairment of cardiovascular reflexes. At the same time, decreases in adrenoceptor responsiveness result in increased adrenomedullary output and plasma catecholamine concentrations.\textsuperscript{11,13,36}

Skeletal muscle innervation decreases, translating into loss of motor units and a decrease in strength, coordination, and fine motor control.\textsuperscript{38} Joint position and vibration sense may be compromised, and the literature suggests some diminution in the processing of painful stimuli.\textsuperscript{39–42} However, this effect, if it exists, appears to be modest at best, and not affecting all nerve types equally.\textsuperscript{42–45} Furthermore, given huge inter–patient variability in nervous system function and in the experience of pain,
alterations in subtypes of pain perception do not translate into a decreased need for analgesia in the elderly patient. 44–48

RENEAL CHANGES

Aging is accompanied by a progressive decrease in renal blood flow and loss of renal parenchyma. 49,50 By age 80, half of all older persons may have reduced renal blood flow. This is accompanied by renal cortical atrophy, resulting in a 30% decrease in nephrons by the end of middle age. 49,51 Furthermore, aging is associated with sclerosis of remaining nephrons so that some of those remaining are dysfunctional. 50,52 Together, these processes result in a progressive decrease in glomerular capillary surface area and glomerular filtration rate. 50,52–54 However, because of loss of muscle mass, aging is not associated with an increase in serum creatinine. This physiologic, and often occult, aspect of senescence has practical implications in the perioperative period.

The old kidney has difficulty in maintaining circulating blood volume and sodium homeostasis in the perioperative period. 11,53–55 Sodium conservation and excretion are both impaired by aging. Fluid homeostasis is further complicated by alterations in thirst mechanisms and antidiuretic hormone release that frequently result in dehydration. 53–56 In the perioperative period, metabolic
acidosis is also relatively common, particularly in elderly patients who are less efficient in the renal excretion of acid. 57

Reductions in basal renal blood flow render the elderly kidney particularly susceptible to the deleterious effects of low cardiac output, hypotension, hypovolemia, and hemorrhage. Anesthetics, surgical stress, pain, sympathetic stimulation, and renal vasoconstrictive drugs may all compound subclinical renal insufficiency. The likelihood of acute renal insufficiency is especially great in intra-abdominal operations and following aortic surgery and is increased further by many drugs used in the perioperative period. Finally, age-related decreases in glomerular filtration rate reduce the clearance of a number of drugs given in the perioperative period.

PHARMACOKINETIC AND PHARMACODYNAMIC CHANGES

Aging is associated with multiple physiologic changes that may affect drug pharmacokinetics. 58 Decrease lean body mass and total body water and an increased proportion of body fat alter the volume of distribution of drugs, their redistribution among body compartments, and subsequently their rates of clearance and elimination. 59-61 The effect of changes in body composition on drug distribution and action varies, depending on the lipid or aqueous solubility
of the drug. Water-soluble drugs can have higher serum concentration and lower redistribution, whereas fat-soluble drugs tend to undergo wider distribution and accumulation, followed by delayed release.

Although age-related changes in the proportions of different plasma proteins make predictions about pharmacokinetics complex in the elderly person, for many drugs, decreased protein binding and increased free fraction have the potential to increase the pharmacologic effect of drugs administered in the perioperative period. $^{58}$ Furthermore, potential alterations in cardiac output and renal or hepatic clearance may change effective plasma concentrations and duration of action. $^{62}$ Neuronal loss and decreased levels of neurotransmitters in the central nervous system may increase sensitivity to anesthetic agents. The changes in pharmacokinetics that occur with aging make it difficult to identify an independent effect of aging on pharmacodynamics. $^{59,60}$ However, age-related changes in the central nervous system appear to increase the older person's sensitivity to a variety of anesthetic agents. $^{63-65}$

It has been known for decades that pharmacokinetic changes, particularly decreased metabolism, plus drug interactions coupled with polypharmacy conspire to make the elderly person prone to adverse drug effects. $^{66-68}$ There is an almost linear increase in adverse drug reactions with age, from below 10% at age 25 to above 20% at age $^{80,69,70}$ The likelihood of adverse drug reactions increases with the
number of drugs administered. As many elderly patients come to surgery on multiple medications, the addition of several, even short-acting drugs in the perioperative period makes adverse reactions likely.

**IMPLICATIONS FOR ELDERLY SURGICAL PATIENTS**

What is clear from a review of normal changes in physiologic function with aging is that even the fit elderly patient’s ability to compensate for perioperative stress is compromised. The cardiac, pulmonary, neurologic, and neuroendocrine changes that occur with aging make hypotension, low cardiac output, hypoxia, hypercarbia, and disordered fluid regulation more likely in the perioperative period. Furthermore, because baseline cardiac, pulmonary, renal, and neurologic function is typically adequate in the absence of acute challenges, it can be very difficult to predict the effect of perioperative stress on the older patient.
PREOPERATIVE ASSESSMENT OF THE ELDERLY PATIENT

The preoperative assessment of the elderly surgical patient is determined by the underlying health of the patient and influenced by the urgency of the procedure. That said, preoperative evaluation could serve several purposes in most patients. Historically, it has served two primary functions: One is to alert the surgical care providers to physiologic conditions that may alter perioperative management, and the other is to determine if medical intervention is indicated before proceeding. Two more contemporary uses of the preoperative assessment are to provide an index of risk and therefore contribute to decisions about the most appropriate intervention, and to provide baseline data on which the success of a surgical intervention might be judged.

Physiologic studies of aging and clinical experience with the elderly population yield three important conclusions that bear on preoperative assessment. First, the geriatric population is tremendously heterogeneous. This concept was superbly expressed by Muravchick, who noted that humans are never so similar as at birth, and never so dissimilar as in old age. The second conclusion is that basal function in most elderly patients is sufficient to meet daily needs, but that under conditions of physiologic stress,
impairment in functional reserve becomes evident. Third, it is evident that most older surgical patients have significant comorbidities. Up to 80% of elderly surgical patients have at least one comorbid condition, and one third have three or more pre-existing conditions.\textsuperscript{72,73} In spite of these limitations, even extreme age is not a contraindication to surgery. Acceptable outcomes are reported for operations even in very old patients.\textsuperscript{74–78} What is less clear is how to identify which patients will do well and which will do poorly. Even though this has been the subject of considerable research, no area of perioperative anesthetic care and management requires more investigation. The preoperative assessment of the individual patient is composed of four interrelated functions:

- risk assessment that is based on a stratification of risk derived from population-based studies,
- the history and physical examination to determine health and functional status,
- preoperative testing, and
- in some cases, preoperative optimization.

Each of these functions requires development and better definition for the geriatric surgical population.
RISK ASSESSMENT

Because age itself adds very little additional risk in the absence of comorbid disease, 79 most risk-factor identification and risk-predictive indices have been disease oriented. 80–84 Typically, these investigations have studied a broad age range of patients and in multivariate analyses identified the relative contribution of age and comorbid conditions to surgical morbidity and mortality. 81,82,85–88 Others have looked at the predictive value of the number of comorbid diseases independently of the operative condition or have evaluated the impact of ASA (American Society of Anesthesiologists) status, specific surgical factors, and intra-operative management. 82,88–93

The applicability of many existing risk indices to the geriatric population is unclear. Because of the prevalence of comorbid conditions, it becomes hard to stratify the older patient population into smaller subsets of more clearly defined risk. The scarcity of population studies of perioperative risk and outcomes specifically in geriatric populations can make choosing the most suitable course of care and providing good information more difficult. Furthermore, elderly patients have some unique risks. In addition to death, myocardial infarction, or congestive heart failure, older patients are particularly more prone than their younger counterparts to postoperative delirium, aspiration,
urosepsis, adverse drug interactions, pressure ulcers, malnutrition, falls, and failure to return to ambulation or to home. Therefore, preoperative assessment tools and the variables evaluated in outcomes trials require expansion for application to the geriatric surgical population.

Population studies need to examine not only mortality and major cardiopulmonary morbidity but also outcomes specific to the geriatric population. Once completed, epidemiologic studies that better stratify older patients would help define the preoperative assessment appropriate to older patients.

FUNCTIONAL ASSESSMENT

The efficacy of preoperative functional evaluation in elderly surgical patients requires investigation. This is important for several reasons. The evaluation of the “resting” patient does not indicate how the patient will respond to the cardiac, pulmonary, and metabolic demands of the perioperative period. This approach is emphasized in the guidelines of the American College of Cardiology and the American Heart Association for preoperative cardiac evaluation, in which the patient’s activity level, expressed in metabolic units, is a primary determinant of the need for subsequent evaluation. However, this concept must be expanded because the geriatric population has a unique need for functional evaluation in more areas than just...
cardiopulmonary capacity. Because of patient heterogeneity, functional assessments may be indicated to better characterize patient differences, whether it is for activities of daily living (ADLs), instrumental activities of daily living (IADLs), cognitive and emotional status, or urologic function.\textsuperscript{94,95} Scales like the Medical Outcomes Study Short Form–36 (SF–36)\textsuperscript{96} have multiple domains that are particularly useful in assessing older patients. Although these metrics have been applied successfully in orthopedic and thoracic surgery\textsuperscript{97–99} and can have predictive value for longer term outcomes,\textsuperscript{100–104} multidimensional assessment and perioperative functional assessment are largely absent from the surgical literature.\textsuperscript{98,105,106}

An example of their application is provided in the study of hip fracture patients by Keene and Anderson, who scored patients preoperatively on the basis of physical condition, ambulation, ADLs, preoperative living situation, and pre-existing disabilities.\textsuperscript{102} The scoring system was then used to predict which patients would be discharged to nursing homes following surgery. The actual outcome following surgery was observed for 1 year and compared with the models’ predictions (see Table 2.1). Though the study is small, it serves as an example of the type of research needed in geriatric surgery.

With regard to preoperative functional assessment, cognitive and psychologic evaluation of the elderly surgical patient deserve special comment. Although frank delirium
or dementia at admission clearly predicts poorer acute and long-term outcome. Subtle forms of cognitive impairment are infrequently diagnosed prior to surgery even though they are more common in elderly patients. In the absence of careful screening, preoperative cognitive deficits may not become evident until the postoperative period. Subtle forms of cognitive impairment can predict subsequent delirium in hospitalized medical patients and worsened cognitive outcome in cardiac, orthopedic, and gastrointestinal surgery patients. Preoperative mental status examination should be considered for all geriatric surgical patients. Preoperative depression and alcohol abuse are also relatively common and can affect postoperative outcomes in similar ways; a variety of assessment tools for depression are available. The impact of screening for mental status, depression, and

<table>
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<th>Patients (N)</th>
<th>Residence Before Fracture</th>
<th>Predicted Nursing Home Placement</th>
<th>Actual Nursing Home Placement</th>
<th>Functional Rating* (avg)</th>
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<td>Temporary</td>
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<td>Permanent</td>
<td>Permanent</td>
<td>30</td>
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</tbody>
</table>

*Functional rating was the composite score of five scales: physical condition (maximum 35 points), ambulation (maximum 30 points), activities of daily living (maximum 25 points), prefracture living situation (maximum 10 points), and prefracture disabilities (maximum points 0). maximum deduction for disabilities ~40.

alcohol abuse on perioperative management of elderly patients is a huge potential area of investigation.

Preoperative functional assessment is important because the goal should be to return the patient to at least his or her preoperative activity level. The success of surgery must be questioned if the procedure is technically adequate but the patient suffers loss of independence. Multidimensional assessment may help redefine standards for success of surgery and thus reset therapeutic priorities. Application of this type of assessment is exemplified by the work of Mangione et al, who longitudinally measured quality-of-life indicators in patients undergoing hip, thoracic, and aortic surgery. A variety of metrics, including the SF-36, were used to measure physical, psychologic, and social functions and health perceptions preoperatively as well as 1, 6 and 12 months after surgery. (See Figure 2.4 for examples.) Major morbidity and mortality aside, these types of measures address what is fundamentally most important in the medical management of older patients: whether the surgical intervention improves functional status and well-being. These measures are of particular importance to the elderly patient because, unlike the younger patient, the older one is at far greater risk for long-term functional compromise following the stress of surgery.
PREOPERATIVE TESTING

The third dimension of the preoperative evaluation of the elderly surgical patient is preoperative testing. Work in this area has been done for large populations of mixed-age groups. However, it is not clear whether selected
preoperative screening tests have a different yield in the elderly age group or, more likely, if specific testing is indicated for elderly patient populations undergoing certain types of surgical procedures.

In the general population there is agreement that most routine tests are not indicated. In an evaluation of preoperative screening in 1010 persons undergoing cholecystectomy, abnormal results were found in only 4.5% of tests. In another investigation of 3131 patients aged 0 to 98 years who underwent 38,286 tests, unexpected abnormal results were found in 15% of patients. However, only 3% had a change in their anesthetic or surgical plan that was based on those results. Unfortunately, in neither report was age-specific data provided, so it is unclear if the results can be applied to an elderly surgical population.

Smaller studies of elderly populations suggest that there is a higher yield for specific tests. Seymour et al examined the value of routine chest x-ray (CXR) in 223 patients aged 65 years and older undergoing general surgery. Of these, 40% had an abnormality regarded as clinically significant, although in only 5% of the patients did the CXR affect the course of treatment. Seymour et al also examined the value of an electrocardiogram (ECG) in routine screening in 222 patients aged 65 years and older, finding that only 21% of patients had a normal ECG and that 53% had a major abnormality. They reported
that although only 1% of patients had abnormalities that delayed surgery, 30% developed new ECG abnormalities postoperatively. The authors concluded that the screening ECG has little or no value for predicting cardiac complications but recommended preoperative ECG for all elderly patients to provide a basis for comparison and as a means of detecting patients for whom surgery should be deferred.

In a small study of acutely ill elderly (mean age 81 years) medical patients (50 admissions), Sewell et al examined the value of full blood cell count, sedimentation rate, urinalysis, electrolyte, liver, thyroid tests, and CXR. Six of 28 patients had abnormalities on CXR (21%), although management was influenced only in one. The most important finding in the screening battery was the frequency of unknown urinary tract infections (16 of 50 patients, 32%). A different retrospective analysis of 86 patients undergoing hip arthroplasty studied the impact of 24 laboratory tests on postoperative course. In four patients (4.6%) care was altered, three of whom had urinary tract infections. A cost–benefit analysis justified routine urinary analysis to reduce hip infections in elderly patients undergoing total hip arthroplasty.

Assessment of nutritional status can also be useful in subpopulations of surgical patients. A 44–center Veterans Administration study found that serum albumin concentration was a better predictor of surgical outcomes
than were many other patient characteristics. Though it can be difficult to separate the role of the disease process resulting in protein-calorie malnutrition from the effect of the malnutrition itself, a study of elderly hospitalized nonsurgical patients found that adverse outcomes could be attributed to malnutrition independently of greater acuity of illness or comorbidity. Because of wide confidence limits, laboratory assessment of nutritional status may make its application to individual patients less useful than to populations. It may prove useful to combine laboratory tests with anthropomorphic measurements, such as body mass index, limb circumferences, and weight loss. The latter assessments are simple and inexpensive, but their clinical yield has not been determined. Nutritional assessment may have implications for preoperative management and the timing of surgery as well as for risk stratification in certain types of surgery, but nutritional evaluation has not been adequately studied in elderly surgical patients.

A recent study on preoperative testing in 18,000 patients undergoing cataract procedures also deserves comment. Patients were randomly assigned to undergo or not undergo routine testing (ECG, complete blood cell count, electrolytes, blood urea nitrogen, creatinine, and glucose). The analysis was stratified by age and showed no benefit to routine testing for any group of patients. Similar conclusions were drawn in a study of 544 elderly
noncardiac surgical patients by Dzankic et al. 142

From these investigations and a body of work in younger subjects, three themes become evident. First, routine screening in a general population of elderly patients does not add significantly to information obtained in the clinical history. Second, in a general population, the positive predictive value of abnormal findings on routine screening is limited. Third, positive results on screening tests have relatively little impact on the course of patient care. In spite of those observations, further research is required.

Even though the yield for routine screening is very low, it can be clinically valuable and cost–effective to develop guidelines for preoperative testing that are based on the type of surgery. It is evident that different types of surgery impose different types and degrees of physiologic stress. The results of the cataract trial will not be applicable to patients undergoing vascular surgery. Preoperative tests such as echocardiography and thallium scanning can have predictive value and potentially alter the course of care and outcomes if applied to specific populations at higher risk. 80,143,144 Similarly, nutritional assessment 134,145 might be very useful prior to abdominal or major orthopedic surgery but would have a much lower impact for carotid endarterectomy. Screening for urinary tract infection prior to orthopedic surgery or pulmonary function testing prior to thoracic surgery are other examples. Because it is the interaction of the patient and the surgical stress that
determines outcome, specific testing might be equally indicated in a very physiologically challenged older patient undergoing minimally stressful surgery (hernia repair), and in the mildly compromised older patient undergoing surgery that imposes severe physiologic stress (eg, aortic aneurysm surgery). Future studies of older patients will need to stratify patients according to the severity of their pre-existing risk factors (low, intermediate, or high) and specifically examine the interaction of these factors with the specific surgical challenges most common in the elderly age group.

PREOPERATIVE OPTIMIZATION

The fourth dimension of preoperative evaluation determines whether medical intervention is indicated before proceeding with surgery. To some extent, this dimension has been lost with the foreshortening of the preoperative period, the “AM admit,” and a progressive elimination of preoperative testing.

If we are going to define research agendas for the care of elderly surgery patients, preoperative optimization of medical status must be revisited. This is an area where relatively little work has been done. Again, in specific populations undergoing high-risk surgery, the value of preoperative optimization, particularly of cardiac and pulmonary status, can be demonstrated. Examples where
the data are compelling include intervention for coronary disease before vascular surgery; pulmonary toilet, antibiotics, and corticosteroid therapy for some types of thoracic surgery; and preoperative β-blockade. Nevertheless, many areas have not been evaluated, particularly in the elderly population. Improving nutritional status before major elective surgery, preoperative hydration, and optimization of renal function in those with chronic or acute insufficiency could have broad impact. Preoperative management of antibiotic therapy, anticoagulation, antiplatelet therapy, and anemia are other obvious areas to examine. There are also suggestions that preoperative education, psychologic support, and physical therapy might facilitate pain management and rehabilitation following some types of surgery, but these have not been adequately assessed.

In today’s environment it will be difficult to conduct studies on preoperative optimization. It will be difficult to justify randomizing a patient to a control group when he or she is clearly malnourished and surgery can be delayed. Moreover, intervention and delay will add costs. However, limited studies in orthopedic and cardiac surgical patients suggest that appropriately applied preoperative care can be cost-effective in shortening hospital stays or improving functional status following discharge. Preoperative optimization will not be practical or necessary in many instances; however, much geriatric surgery is elective, so these studies can be conducted and, if positive, could affect large numbers of patients.
THE PREOPERATIVE RESEARCH AGENDA

The most pressing need for preoperative assessment is to develop better tools to predict which patients will do well and which will do poorly (see also Key Research Questions in Geriatric Anesthesia, end of chapter).

*Anes 1 (Level B):* Prospective epidemiologic studies are needed to describe the relative frequency of various outcomes characteristic of older surgical patients for the most common types of surgery.

*Anes 2 (Level B):* Once better understanding of characteristic outcomes of specific types of surgery for older patients is attained, patient and surgery-specific risk factors for geriatric complications should be identified by multivariate analysis that would stratify surgical risk as low, intermediate, or high, depending on type of surgery.

*Anes 3 (Level B):* The positive predictive value of preoperative assessment instruments should be determined in prospective nonrandomized or prospective cohort trials.

*Anes 4 (Level A):* Following evaluation of preoperative assessment instruments (Anes 3), prospective randomized trials should be performed to determine whether the application of these metrics could improve outcomes for elderly surgical patients by altering perioperative intervention, surgical timing, the type or extent of surgery,
or postoperative management.

*Anes 5 (Level B)*: Prospective cohort studies are needed to determine whether assessment of the older surgical patient’s preoperative functional status affects surgical decision making or perioperative care.

*Anes 6 (Level A)*: Depending on findings of prospective cohort studies (Anes 5), randomized trials should be performed to determine whether preoperative functional status assessment of elderly patients changes decisions about type or timing of surgery, or pre- or postoperative care strategies and outcomes.

*Anes 7 (Level B)*: Cross-sectional or prospective cohort studies are needed to determine by multivariate analysis whether there is an association between pre-existing cognitive impairment, depression, or alcohol abuse and adverse outcomes in geriatric patients.

*Anes 8 (Level A)*: For any association that is established by cross-sectional cohort studies between cognitive impairment, depression, or alcohol abuse and adverse outcomes in elderly surgical patients (Anes 7), prospective randomized trials should be performed to determine the effect of pre- or postoperative interventions on these adverse outcomes.
INTRAOPERATIVE MANAGEMENT

Anesthetic care is episodic, so most of the criteria to judge the success of anesthetic interventions are short-term. Studies of anesthetic drugs and techniques typically address hemodynamic stability, time to awakening, extubation time, postoperative nausea and vomiting, recovery room time, and length of stay. Awareness of the physiologic and pharmacokinetic changes characteristic of the elderly patient have led investigators to examine the effects of a host of anesthetic agents and adjuncts in this population. The effects on elderly patients of intravenous induction agents, narcotics, benzodiazepines, volatile anesthetics, neuromuscular blocking agents, and various types of local anesthetics have all been evaluated. Studies have included the use of these agents for inpatient surgical procedures, outpatient procedures, premedication, sedation, and their administration by bolus and infusion techniques. Because there is a theoretical advantage to shortening recovery time in patients for whom awakening, ambulation, and discharge might otherwise be delayed (ie, elderly patients), much of the more recent work focusing on elderly patients has been devoted to the ultra–short–acting agents.

Some of these studies have identified age–related alterations in the pharmacokinetics, induction, awakening, or recovery room stay. However, perspective is needed. Even though a drug may shorten extubation time by 10 minutes, recovery room time by 45 minutes, or total hospitalization
for an outpatient procedure by 90 minutes, the clinical impact of these changes on patient outcomes is probably minimal. There is a role for this type of research in geriatric anesthesia, but in an era of limited time and research dollars, research efforts should probably be directed elsewhere.

REGIONAL VERSUS GENERAL ANESTHESIA

Most general anesthetic agents depress cardiovascular and pulmonary function as well as alter consciousness, which is why it is often advocated that regional anesthesia be used for geriatric patients whenever possible. A major area of research has been to compare the risks and benefits of regional versus general anesthesia in elderly surgical patients. Elderly patients undergoing orthopedic procedures have been the focus of such research. These comparative studies have examined intraoperative cardiovascular stability; cardiac, pulmonary, and thrombotic complications; pain control; and cognitive outcomes. This subject was reviewed recently by Roy. 154

A few early studies reported that regional anesthesia for hip surgery was associated with better outcomes. Reduced mortality, higher postoperative Pao2, and fewer mental changes have been reported in patients receiving regional anesthesia. 155,156 However, these studies were very small, and their assessment of cognitive function would not
meet current standards for reliability or validity. 157

Subsequent investigations of elderly patients undergoing hip surgery found that intraoperative hypotension is more common with regional anesthesia, and although the incidence of deep-vein thrombosis (DVT) and blood loss were typically lower with regional techniques, no difference in major morbidity or mortality could be identified. 85,158–163 Because most of these studies are underpowered for rare events, meta-analysis has been used to help address statistical limitations.

The respective benefits of regional and general anesthesia were addressed in a 1992 meta-analysis. 164 Sorenson and Pace examined 13 randomized controlled trials conducted between 1966 and 1991 that reported follow-up to at least 1 month. Meta-analysis endpoints were mortality, DVT, and blood loss. Other complications or adverse events were not evaluated because of inconsistencies in definitions or “the absence of systematic and unbiased application of diagnostic tests to record these events.” Sorenson and Pace were unable to identify any statistically significant difference in mortality or blood loss by anesthetic technique, although the study found a clearly reduced incidence of DVT in regional anesthesia groups. Most of the data in the study were recently reanalyzed in another meta-analysis, along with some additional trials. 165 Like Sorenson and Pace’s, the analysis by Urwin et al identified reduced DVT and 1–month mortality in 2162
hip fracture patients receiving regional anesthesia, although no other outcome measure reached statistical significance. (See Figure 2.5.) The reduction in mortality, when that information was available, was not evident at 3, 6, or 12 months. Subsequent large, single-center observational studies involving 741, 166 1333, 167 and 9425 168 patients have also not identified meaningful differences in cardiopulmonary morbidity or mortality between regional and general anesthesia in hip-surgery patients.

### Figure 2.5—Comparison of outcome between regional and general anesthesia for dichotomous variables. All results were derived by the use of fixed-effects analysis except for those marked *, which were derived by the use of random-effects analysis. Statistically significant results are indicated by +. Results to the left of the vertical line indicate an advantage for regional anesthesia over general anesthesia. Results show the incidence of each outcome measure. T = number of trials; P = number of patients; OR = odds ratio; CI = confidence intervals. (Reprinted with permission from Urwin SC, Parker MJ, Griffiths R. General versus regional anesthesia for hip fracture surgery: a meta-analysis of randomized trials. Br J Anaesth 2000;84:450–455, table 2.)

#### Outcome Differences in Patients Undergoing Surgery with Regional or General Anesthesia

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Incidence (regional)</th>
<th>Incidence (general)</th>
<th>PETO OR (95% CI)</th>
<th>PETO OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mortality (1 mo)</strong></td>
<td>7/1,575</td>
<td>49/765</td>
<td>1.4 76/812</td>
<td>9.4</td>
</tr>
<tr>
<td><strong>Mortality (5 mo)</strong></td>
<td>6/1,491</td>
<td>88/726</td>
<td>12.1 90/705</td>
<td>12.8</td>
</tr>
<tr>
<td><strong>Mortality (8 mo)</strong></td>
<td>3/1,264</td>
<td>103/813</td>
<td>14.8 106/851</td>
<td>16.1</td>
</tr>
<tr>
<td><strong>Mortality (12 mo)</strong></td>
<td>2/726</td>
<td>80/304</td>
<td>22.0 36/372</td>
<td>21.0</td>
</tr>
<tr>
<td><strong>Operative hypotension</strong></td>
<td>7/873</td>
<td>146/426</td>
<td>34.3 116/447</td>
<td>26.0</td>
</tr>
<tr>
<td><strong>Patients receiving transfusion</strong></td>
<td>3/228</td>
<td>63/108</td>
<td>53.3 68/120</td>
<td>66.7</td>
</tr>
<tr>
<td><strong>Postoperative hypoxia</strong></td>
<td>1/67</td>
<td>10/20</td>
<td>35.7 14/29</td>
<td>48.3</td>
</tr>
<tr>
<td><strong>Pneumonia</strong></td>
<td>8/1,066</td>
<td>27/520</td>
<td>5.1 31/587</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>Myocardial infarction</strong></td>
<td>4/868</td>
<td>44/21</td>
<td>1.9 6/587</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Cerebrovascular accident</strong></td>
<td>7/1,055</td>
<td>10/229</td>
<td>1.9 6/590</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Congestive cardiac failure</strong></td>
<td>9/962</td>
<td>114/399</td>
<td>2.5 124/463</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Renal failure</strong></td>
<td>4/716</td>
<td>23/82</td>
<td>6.6 24/14</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Acute confusion state</strong></td>
<td>3/187</td>
<td>10/33</td>
<td>12.0 16/84</td>
<td>22.8</td>
</tr>
<tr>
<td><strong>Urinary retention</strong></td>
<td>2/97</td>
<td>10/46</td>
<td>23.6 10/49</td>
<td>20.4</td>
</tr>
<tr>
<td><strong>Nausea and vomiting</strong></td>
<td>2/96</td>
<td>23/41</td>
<td>4.7 24/19</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Deep vein thrombosis</strong></td>
<td>1/200</td>
<td>15/129</td>
<td>2.5 16/130</td>
<td>46.9</td>
</tr>
<tr>
<td><strong>Pulmonary embolism</strong></td>
<td>9/1,184</td>
<td>6/575</td>
<td>1.4 10/609</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Another meta-analysis was conducted by Rodgers et al.169 The authors examined the effects of regional anesthesia in 141 randomized trials involving 9559 patients. As in the report by Urwin et al, these researchers found a reduction in 30-day mortality and DVT in the regional group; the effect on mortality was not evident beyond 1 month. They also describe reductions in pulmonary embolism, transfusion, respiratory depression, myocardial infarction, and renal failure. Although the results are enticing, the reporting of many outcomes was incomplete across studies, so the analysis was based on smaller subsets of patients. Additionally, studies were not rated for quality, and data were used that were not reported in the published trial. Studies for general, obstetrical and gynecologic, urologic, orthopedic, and “other” surgeries were combined, and no information about age is provided. Finally, it is impossible to base practice on the results of this meta-analysis because all of the following groups of patients were combined in the regional anesthesia group: those receiving spinal anesthesia alone, those receiving epidural anesthesia alone, those receiving general anesthesia followed by postoperative regional anesthesia, those receiving general anesthesia combined with intraoperative spinal anesthesia, and those receiving general anesthesia combined with intraoperative epidural anesthesia. Additionally, in 22 studies where general anesthesia was combined with regional anesthesia, the
general anesthesia in the regional group differed from that in the general anesthesia alone group. From this, it is difficult to determine if the effects described in the meta-analysis are real and, if so, what their origin is, or which patients they would apply to. It is certainly not possible to recommend any practice on the basis of the results.

In addition to the more typical outcomes measures, several of the studies of orthopedic surgery patients have examined the effect of anesthetic technique on cognitive or functional outcome, often following patients for 3 months or longer. Each of the prospective studies is small, and only the study by Hole et al.\textsuperscript{156} showed regional anesthesia to be associated with better cognitive outcome in elderly patients undergoing hip or knee surgery. The bulk of investigations could identify no difference.\textsuperscript{117,157,170–172}

Even though not all the studies are in agreement,\textsuperscript{173,174} similar conclusions must be drawn for patients undergoing regional or general anesthesia for transurethral prostatectomy and peripheral vascular surgery.\textsuperscript{172,175–178} In carotid surgery there is a suggestion of a better outcome with a regional technique; however, most investigations are retrospective or nonrandomized, so the effect of patient selection cannot be eliminated.\textsuperscript{179–182} Additionally, in the multicenter North American Symptomatic Carotid Endarterectomy Trial, an independent effect of anesthetic technique (or intraoperative monitoring) on carotid surgical
outcome could not be found. The difficulty in identifying clear and meaningful differences between regional and general anesthesia has tremendous implications for the conduct of research in geriatric anesthesia. Probably the most substantive difference in the choice of anesthetic is whether the patient undergoes a regional or a general anesthetic. The pharmacologic difference with that choice is far greater than the difference between different induction agents, narcotics, local anesthetics, or muscle relaxants, or between different doses of those medications. If little or no difference in outcome can be identified for elderly patients undergoing major procedures with general or regional anesthesia, then the yield for similar outcome studies on differing anesthetic agents is likely to be low.

**PHYSIOLOGIC MANAGEMENT**

In addition to establishing a surgical plane of anesthesia, the anesthesiologist maintains physiologic stability. Although numerous studies have examined the relationship between intraoperative physiologic management and outcome, outside of relatively rare catastrophic events, such as loss of the airway or uncontrolled hemorrhage, it appears that physiologic management plays a modulatory rather than a primary role in outcomes. The best example is in cardiac surgery, where the acute changes
in blood pressure, hematocrit, and temperature typically exceed those seen with any other type of surgery. Additionally, most of the patients are older. In spite of that, it has been difficult to demonstrate a direct relationship between physiologic management and outcome. Rather, it appears that technical issues during surgery and the comorbidities that the patient brings to the operating room primarily determine outcome.

There is a role for specific studies of physiologic or pharmacologic management in elderly surgical patients, but those investigations are likely to have a smaller yield than risk stratification based on population studies and tailoring the surgical procedure to the patient on the basis of preoperative assessment.

It is important to note that these conclusions are not an indictment of anesthetic practice or the role of the anesthesiologist in the operating room. Just the opposite is true. Over the past three decades, anesthesiology has made tremendous strides in patient safety, monitoring, drugs, and education that have made the intraoperative period extraordinarily safe. Those advances will continue to expand what is possible surgically. At the same time, it is because the advances in intraoperative care have been so great that the greatest needs for research lie in the preoperative assessment and the postoperative management of patients.

There are also broad areas related to intraoperative management (rather than the specifics of anesthetic choice)
where research focused on the elderly patient would be productive. It is clear that anesthetics and alterations in autonomic function make it more difficult for older patients to maintain their body temperature, and postoperative hypothermia increases the risk of adverse outcomes.\textsuperscript{189-193} Studies of temperature control in older patients could be expanded. The appropriate place for prophylactic beta-blockade, antiplatelet agents, and H2 blockers in elderly surgical patients needs to be examined. Given that the immune response may be attenuated in elderly persons and that infectious complications are very common, the appropriate dosage and scheduling for perioperative antibiotics may be a useful area of research. Furthermore, elderly patients receive most of blood given in the perioperative period, so investigation of the immunosuppressive effects of homologous blood transfusion would be instructive. Elderly patients are also at increased risk for musculoskeletal and nerve injury, as well as thrombotic complications. Therefore, documenting the relationship between patient positioning, nerve and skin injury, and thrombotic complications is indicated. Similarly, the appropriateness of nothing-by-mouth (NPO) status, its relationship to hypovolemia, and aspiration risk in the elderly patient would be an area of research with a large potential impact on practice and patient satisfaction.

The fact that anesthetic choice or physiologic management has little independent effect on outcome is not
surprising. Very large studies of perioperative morbidity and mortality have found that, apart from catastrophic events, the anesthetic episode per se appears to have little or no impact on 30-day outcomes. Although certain pathophysiologic processes may be initiated during the intraoperative period, with few exceptions, major morbidity and mortality in the operating room are rare.
THE INTRAOPERATIVE RESEARCH AGENDA

Anes 9 (Level B): Cross-sectional or retrospective case-control studies are needed to identify the incidence of adverse cardiac or thrombotic-embolic complications in elderly patients undergoing surgery with and without preoperative β-blockade, antithrombotic or antiplatelet therapy, or with a hematocrit above a target value. These studies should be in surgeries identified as having an intermediate or high risk for related complications.

Anes 10 (Level A): For any association in elderly patients of cardiac thrombotic-embolic complications with a specific preoperative therapy or hematocrit level, prospective cohort or randomized studies are needed to determine if pre- or intraoperative therapies would reduce the complications.

Anes 11 (Level D): Prospective nonrandomized investigation of the effect of perioperative temperature management on surgical morbidity in the geriatric population is needed. These investigations should be conducted under conditions where either the surgery is physiologically very challenging or the older patient carries a high burden of comorbidity. Cardiac, respiratory, bleeding, and renal outcomes would be the primary focus of these investigations.

Anes 12 (Level D): Retrospective or cross-sectional research studies should be conducted to identify any relationship between the use or timing of perioperative antibiotic
therapy and postoperative pneumonia or wound infection. Differences, if any, between younger and older patients undergoing the same type of surgery should also be examined.

_Anes 13 (Level C)_: Depending on the findings in _Anes 12_, prospective randomized studies should be used to determine whether preoperative or postoperative antibiotic therapies reduce complications related to infections in elderly surgical patients.

_Anes 14 (Level D)_: Multicenter case–control or prospective cohort studies should be performed to determine whether receiving or not receiving blood in the perioperative period affects the incidence of perioperative infection and immunosuppression in elderly patients. Multivariate analysis would be required to separate the effect of homologous blood transfusion from the comorbid conditions making transfusion more likely.

_Anes 15 (Level C)_: If perioperative infection and immunosuppression in older surgical patients are shown to be associated with receiving blood in the preoperative period (Anes 14), alternative strategies such as delaying surgery or erythropoietin therapy should then be compared with blood transfusion in prospective cohort studies, because a randomized trial could not be justified.
Anes 16 (Level D): Cohort or case–control studies are needed to determine the relationship in older surgical patients between perioperative termination of anticoagulation and thromboembolic or bleeding risk.

Anes 17 (Level C): The effect of timing of termination and resumption as well as the temporizing use of antiplatelet agents in older surgical patients should be compared in case–control or prospective cohort studies.

Anes 18 (Level B): In prospective cohort studies the incidence of perioperative hypotension, aspiration, and renal insufficiency should be compared in elderly patients undergoing standard nothing–by–mouth orders before surgery and in elderly patients who would be allowed clear liquids closer to the time of surgery. This study would need to be conducted in:
- patients undergoing specific types of procedures where liberalization of fluid intake is not contraindicated for surgical reasons
- patients undergoing procedures that place them at greater risk for developing hypovolemia (bowel prep)
- instances where preoperative hypovolemia may contribute to complications (angiographic procedures).
Most surgical morbidity and mortality occurs in the postoperative period. Pedersen et al examined perioperative mortality in 7306 adult patients undergoing lower-risk surgery (no cardiac, thoracic, or neurosurgical procedures) and found that mortality during anesthesia was 0.05% (1:1800). In the first 24 hours the mortality was twice as high, 0.1%, and it rose fivefold over the next 6 days to 0.56%. Morbidity, including myocardial ischemia and infarction, stroke, renal insufficiency, pneumonia, and delirium, is also most common postoperatively.

POSTOPERATIVE RESPIRATORY INSUFFICIENCY

The most common morbidity following noncardiac surgery is respiratory. A Veterans Administration study of 84,000 patients (97% male, mean age of 60) found that 17% of patients experienced complications, with pneumonia in 3.6%, ventilatory failure in 3.2%, and unplanned intubation in 2.4%. In a study of 288 general surgical patients aged 65 and over, Seymour and Vaz reported that 17% of patients had atelectasis, 12% had acute bronchitis, and 10% developed pneumonia.

For many reasons, postoperative hypoxia may occur in 20% to 60% of elderly surgical patients. As highlighted previously, elderly patients have an increased

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alveolararterial gradient, reduced respiratory muscle strength, and hypoxic and hypercarbic drives at baseline. Additionally, there is a progressive loss of airway reflexes with age, and apnea and periodic breathing following administration of narcotics are more common. Postoperative pain, atelectasis, and fluid shifts further increase the likelihood of respiratory complications, as do reductions in cardiac output, hemoglobin concentration, and shivering. The supine position during recovery increases the transpulmonary shunt and makes hypoxia more likely. Finally, orthopedic and upper abdominal surgeries, which are common in elderly persons, have an independent effect in increasing postoperative hypoxia and respiratory complications.

In spite of the frequency of postoperative hypoxia and hypercarbia in elderly surgical patients, clear guidelines for oxygen therapy, pulse oximetry, and capnography in older patients have been poorly defined. This issue is of pressing importance, as “day surgery” has increased and continued efforts are made to abbreviate the time to discharge. Further, more and more patients, most of them elderly, undergo conscious sedation outside the operating room environment. Even though the study by Bailey et al is more than 10 years old, its implications are unchanged. In a study of hypoxemia and apnea after sedation with fentanyl and midazolam, they describe deaths associated with the use of these drugs. Of 86 reported U.S. deaths, “All
but three . . . occurred outside the operating room . . .
where patients are typically unattended by anesthesia personnel.” Determination of the requirements for oxygen therapy, pulse oximetry, and capnography in elderly patients undergoing inpatient and outpatient surgery, including procedures with conscious sedation, is indicated.

The risk of postoperative aspiration for the elderly surgical patient also requires attention. Because of alterations in pharyngeal function, diminished cough, and an increased incidence of gastroesophageal reflux, elderly patients are at increased risk of aspiration.23,24 This risk is accentuated by the effect of anesthesia, sedatives, and narcotics as well as by endotracheal intubation, nasogastric tube placement, and upper abdominal or neck surgery.30,203,204 Even though the incidence of aspiration in the operative period is low and is uncommonly associated with clinically important pneumonitis or pneumonia,205 the risk for aspiration extends well beyond the acute operative period.

It is likely that instrumentation of the pharynx, whether from an endotracheal tube,30 nasogastric tube,204 or a transesophageal echocardiography probe,203 alters sensation, motor function, and the protective reflexes preventing aspiration. For patients with prolonged endotracheal intubation (> 24 hours), this effect is persistent for at least 48 hours following extubation.30 Nasogastric tubes may also contribute to aspiration by
increasing the incompetence of the gastroesophageal junction. Pharyngeal dysfunction and aspiration may be related to a greater acuity of illness, but sufficient evidence suggests pharyngeal trespass itself has independent effects.

Given perioperative risk factors, the frequency of aspiration in the elderly population, and the incidence of postoperative respiratory morbidity, insufficient research has been directed to this issue in elderly surgical patients. Pharmacologic interventions to reduce gastric volume or increase pH have received attention in the anesthesia literature, but the investigation by Warner et al of aspiration occurring within 2 hours of surgery implies that research on aspiration and postoperative pneumonia must look beyond the immediate operative period. Additional important research will focus on establishing the appropriate use of nasogastric tubes, the restoration of pharyngeal and tracheal reflexes and gastrointestinal motility, and the advancement of feeding following surgery in the elderly patient. General studies as well as surgery-specific studies are needed.

**ACUTE PAIN MANAGEMENT**

The same questions that dominate research in pain management in the general population apply to the elderly age group. However, in many ways the questions for elderly
persons are more pressing because they might receive the most potential harm as well as the greatest potential benefit from improved treatment of postoperative pain. Because of ischemic heart disease, diminished pulmonary capacity, altered drug clearance, or increased drug sensitivity, the elderly patient is probably more vulnerable to the physiologic consequences of inadequate analgesia, as well as to the side effects of analgesic use. Additionally, there is evidence in the literature indicating that in certain circumstances the older person's pain may be less adequately treated. 48

PAIN AND ADVERSE OUTCOMES

The perioperative period results in stress and inflammatory responses that peak postoperatively when cardiopulmonary and neurologic complications occur. Therefore, efforts have been made to link the adequacy of analgesia with the magnitude of the stress response. In particular, it has been proposed that inadequate postoperative analgesia may be associated with myocardial ischemia and pulmonary failure. Researchers have examined the effect of the intraoperative anesthetic 173,207–210 and postoperative epidural analgesia on plasma levels of cortisol, epinephrine, norepinephrine, leucocyte counts, and acute phase proteins and have tried to relate these to cardiopulmonary outcomes. 173,207,211–215 Both negative and positive conclusions have
been reached.

When this subject was reviewed by Liu, Carpenter, and Neal, 216 they concluded that intensive analgesia using regional techniques has a limited impact on cardiopulmonary outcomes or the stress response in a general population of surgical patients. They also concluded that pain and the stress response are not directly coupled because the neuroendocrine response is still demonstrated (although blunted) in the presence of intense surgical analgesia with local anesthetics or opioids. However, studies in the groups with highest risk suggest a possible improvement in outcome with intense analgesia that uses regional techniques. 173,217 Intensive pain management strategies may be indicated in high-risk elderly patients or in low-risk elderly patients undergoing high-risk surgery. Defining the circumstances under which epidural analgesia or any other pain management strategy can improve outcomes is an important area for future research.

In addition to the stress response typically associated with the sympathetic–adrenal axis, most types of surgery initiate a significant catabolic state. An inhibitory effect of analgesia on protein wasting has been suggested, 218–220 but a more pressing area for research is to understand postsurgical catabolism in elderly patients. The relationship between preoperative nutritional status and postoperative catabolism must be better understood.
Experience with some critically ill patients suggests that catabolism may become dissociated from the initial surgical stress. Because elderly patients have decreased nutritional and metabolic reserve, they are most challenged by the postoperative catabolic state. Basic investigation into postoperative catabolism in the elderly person is important, as are investigations of interventions that might attenuate catabolism or facilitate the transition back to an anabolism.

The adequacy of postoperative analgesia does not appear to be an independent determinant of outcomes in the general population of surgical patients; however, a variety of other issues related to postoperative analgesia require attention. The relative benefit of patient-controlled analgesia (PCA) \(^{221}\) versus an as-needed or scheduled analgesic administration is of special importance for the elderly surgical patient. Because of the physiologic and psychologic heterogeneity in the geriatric population, it is unlikely that fixed formulae for age-appropriate drug dosing can be identified. Thus, the administration of narcotics on a set schedule in the elderly person is fraught with the potential for both overand underdosing. These considerations potentially make PCA analgesia an ideal choice. Nevertheless, the issue is complicated. The side-effect profile for PCA analgesics in elderly patients has not been established. \(^{222,223}\) It has also been suggested that many elderly patients may struggle with the technology. Similarly, the application of PCA for patients with altered
mental status is troubling. Outcomes with PCA in the elderly patient must be compared with fixed and as-needed dosing techniques, as well as with postoperative pain control by regional blockade.

The same is true regarding route of administration for analgesic agents. Is there a clear advantage or disadvantage to the use of the intravenous, epidural, or intrathecal routes for analgesic administration in the elderly patient? The elderly person is unusually susceptible to drug interactions and has an increased incidence of respiratory depression, urinary retention, ileus, constipation, and postoperative falls. These are influenced by choices in postoperative analgesia and may differ by route of administration.\textsuperscript{222-225} Investigations of analgesic strategies for elderly surgical patients will need to determine not only the quality of analgesia but also the risks and benefits specific to that population. Additionally, because narcotics are commonly associated with side effects in the elderly population, the use of analgesic adjuncts in postoperative pain management requires further investigation. Drugs like ketorolac, clonidine, dexmedetomidine, and COX-2 inhibitors have the potential to achieve adequate analgesia with lower doses of opioids, potentially reducing side effects.\textsuperscript{226-230}

A final reason why studies of acute pain management in the elderly person are required is that acute pain management may bear on rehabilitation and subsequently on functional status on discharge.\textsuperscript{231} This has
been shown with analgesic programs for continuous passive motion machines used following knee replacement. Research is required following other types of surgical procedures to determine whether facilitating rehabilitation by effectively managing acute pain can improve other functional outcomes.

Another opportunity for research in the postoperative care of hospitalized elderly patients is related to polypharmacy and adverse drug events. Elderly patients tend to accumulate drug prescriptions over time, and there is a clear relationship between the number of drugs taken and the incidence of adverse drug-related events. This problem will be compounded during the surgical period when even more medications are added. A study by Cullen et al prospectively compared adverse drug events among surgical and medical hospitalized patients in intensive care (ICU) and in general units. The researchers found that the rate of preventable and potential adverse drug events is related to the number of drugs administered rather than to the type of care delivered (ICU or non–ICU, surgical or medical). The earlier report of the same data on 4031 adult hospital admissions identified, among other things, the incidence of adverse drug events, their preventability, and the classes of drugs that caused most events. Those results have particular bearing on the perioperative care of the elderly person. In the investigation by Bates et al, analgesics were found to be the class of drug that is associated with the
highest number of adverse drug events. Antibiotics were found to cause the second greatest number of adverse reactions. Analgesics are also the leading class of drug associated with preventable adverse drug events, followed by sedatives and then antibiotics (see Table 2.2). In the 20 preventable adverse events related to analgesics, 40% were found to be caused by overmedication.

There is a pressing need for research in pain management of the elderly surgical patient. There is also a compelling need for research into the prevention of adverse drug events in elderly hospitalized patients. The intersection of pain management and preventable adverse events associated with analgesics and sedatives places anesthesiologists squarely in a leadership role for research into appropriate analgesic and sedative strategies for the elderly age group.

<table>
<thead>
<tr>
<th>Drug Class</th>
<th>Adverse Drug Events $N$ (%)</th>
<th>Preventable Adverse Drug Events $N$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N = 247$</td>
<td>$N = 70$</td>
</tr>
<tr>
<td>Analgesics</td>
<td>73 (30)</td>
<td>20 (29)</td>
</tr>
<tr>
<td>Antibiotics</td>
<td>59 (24)</td>
<td>6 (9)</td>
</tr>
<tr>
<td>Sedatives</td>
<td>20 (8)</td>
<td>7 (10)</td>
</tr>
<tr>
<td>Antineoplastics</td>
<td>18 (7) ,</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>9 (4)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Anticoagulants</td>
<td>8 (3)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Antipsychotics</td>
<td>6 (2)</td>
<td>5 (7)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>5 (2)</td>
<td>4 (6)</td>
</tr>
<tr>
<td>Electrolytes</td>
<td>3 (1)</td>
<td>3 (4)</td>
</tr>
<tr>
<td>Other</td>
<td>46 (19)</td>
<td>16 (23)</td>
</tr>
</tbody>
</table>

In patients who are hospitalized, there is also a window of opportunity to review patient medications, in particular to examine redundancy in therapeutic profile and to look for combinations that may make complications like respiratory depression, aspiration, confusion, postural hypotension, urinary retention, and falls more likely. The development of pharmacy and electronic drug databases for this work would be appropriate; hospitals are more likely than community practitioners to have the resources to support such database development. It would not be practical or appropriate to modify most patients’ chronic drug regimens in the postoperative period, but surgical hospitalization nonetheless provides an opportunity for a thorough drug review and recommendations to reduce iatrogenic complications in elderly patients.

DELIRIUM AND COGNITIVE DECLINE

Postoperative delirium or cognitive decline affect 5% to 50% of elderly patients; both disorders have similar predisposing factors, but the syndromes are not equivalent. Disordered thinking and confusion that waxes and wanes characterize postoperative delirium. The onset is typically on the first to third postoperative day, may be sustained for more than a week, and is associated with other medical complications, prolonged hospitalization, and decreased functional status on discharge. To date,
much of the research has centered on the impact of regional versus general anesthesia in orthopedic surgery. \textsuperscript{117,118,157,170–72,241} Cognitive dysfunction, a deterioration of such capacities as memory, central processing time, and acquisition of new information, has been well described in both cardiac and noncardiac surgical patients. \textsuperscript{242–245}

In anesthesia, the effect of differing anesthetics on postoperative delirium has been studied, \textsuperscript{118,157,172,246–249} and a leading hypothesis has been that offending agents aggravate an age–associated central cholinergic insufficiency. \textsuperscript{117,250,251} However, from review of the literature it becomes evident that delirium is a syndrome that can be triggered by many different perioperative events, so no single cause is identifiable and no single intervention is likely to be successful.

In addition to being linked to narcotics, sedatives, and anticholinergics, delirium has been associated with urinary tract infection, pneumonia, hypoxia or hypercarbia, fever, blood loss, and electrolyte disturbances. \textsuperscript{196,235,236,252–258} Chronic patient factors such as pre–existing frank or subclinical dementia, other organic brain disease, and vision and hearing loss are also predictors of postoperative delirium and cognitive decline. \textsuperscript{103,111,114,196,235,255,256} Finally, in the elderly patient it has been suggested that pain, sleep deprivation, sensory deprivation, and an unfamiliar environment may contribute to delirium. \textsuperscript{113,196,235,257,258}

Most of the research in the anesthesia literature has
focused on the effect of anesthetic and analgesic agents, but the literature in medical patients suggests that the yield for those studies will be low. Studies of the type conducted by Inouye might serve as a model for research in anesthesia. Inouye describes a multifactorial model for delirium involving the interrelationship between a vulnerable patient and acute insults. In a study of elderly medical patients, multivariate modeling identified four risk factors for developing hospitalization delirium: vision impairment, severe illness, pre-existing cognitive impairment, and a blood urea nitrogen–creatinine ratio > 18. Patients were then divided into low-, intermediate-, and high-risk groups, depending on the number of risk factors. In a subsequent validation cohort, the rates of delirium in the low-, intermediate-, and high-risk groups were 3%, 16%, and 32%, respectively. In those patients the rate of death or nursing-home placement was 3%, 14%, and 26%, respectively, an eightfold increase from the lowest to highest risk group. Precipitating factors for delirium in hospitalized medical patients have also been described by Inouye and Charpentier. Twenty-five factors occurring at least 24 hours before the onset of delirium were considered. Of those, a multivariate model identified five as predictive: use of physical restraints, malnutrition, more than three medications added, use of a bladder catheter, and any iatrogenic event (eg, volume overload, urinary tract
infection, pressure ulcer). Even though the precipitating factors were independent of each other, the authors note that “baseline and precipitating factors are highly interrelated and contribute to delirium in a cumulative fashion.”

In a subsequent publication, Inouye et al determined the effect of interventions that were based on their predictive model. Four hundred and twenty-six elderly medical patients in an intervention group were matched to an equal number in a usual care group. In the intervention group, six risk factors for delirium were targeted for intervention: cognitive impairment, sleep deprivation, immobility, visual and hearing impairment, and dehydration. The group receiving intervention by an interdisciplinary team had a 9.9% incidence of delirium versus 15% in the usual care group (a 34% difference). Subdivision of patients into intermediate- or high-risk groups demonstrated that intervention reduced delirium diagnosed by the Confusion Assessment Method (CAM) in intermediate-risk patients, but the tendency to reduce delirium in the high-risk group was not found to be statistically significant.

These studies indicate that presence and severity of cognitive deficit is a strong predictor of the likelihood of delirium during the hospitalization. The same effect has been identified in surgical patients. This brings us back to the recurring theme: Subclinical decrements in functional status may become evident during the
perioperative period. These findings are extended by the observation that postoperative delirium or cognitive decline may be a harbinger of a potentially permanent decrease in mental status.\textsuperscript{242,264}

Together, the data on the predictive value of preoperative cognitive status\textsuperscript{259} and the effect of that assessment on the success of intervention\textsuperscript{260} provide a compelling rationale to conduct a simple, short mental status examination as part of the preoperative interview. Short functional scales have been designed that might be applicable in the preoperative interview.\textsuperscript{116,265,266} The practicality of using such metrics in elderly surgical patients must be established. Following that, the incidence of preoperative cognitive impairment, and its severity, could be identified in populations of elderly patients undergoing different types of procedures. Research into the effectiveness of differing prevention strategies could follow. Those investigations could also examine whether reductions in delirium translate into reduced medical complications or improved functional status on discharge.
THE POSTOPERATIVE RESEARCH AGENDA

_Anes 19 (Level B):_ Prospective studies that better identify patient and procedural risk factors for respiratory failure, aspiration, and pneumonia in elderly surgical patients are needed.

_Anes 20 (Level A):_ Randomized trials are needed to determine if respiratory monitoring or O2 therapy can reduce the incidence of respiratory failure in elderly surgical patients.

_Anes 21 (Level A):_ Randomized studies of prophylactic antibiotics, changes in pharyngeal instrumentation, or the way feeding is advanced are needed to determine whether practice changes reduce aspiration and postoperative pneumonia in elderly surgical patients.

_Anes 22 (Level B):_ Cross-sectional studies capable of identifying any relationship in elderly surgical patients between intensive nutritional support in high-risk surgery and functional status on discharge (eg, chronic respiratory failure, ambulation, independent living) are needed.

_Anes 23 (Level A):_ Data from studies of associations between nutritional support and postoperative functional status after high-risk surgery in elderly patients (Ane 22) should be used to design prospective cohort or randomized controlled trials comparing feeding strategies in elderly
patients at risk for malnutrition and muscle wasting following major surgery.

_Anes 24 (Level C):_ Randomized trials of interventions that might attenuate postoperative catabolism or facilitate the transition to anabolism in the elderly patient are needed.

_Anes 25 (Level D):_ Large cross-sectional studies describing analgesic practice and its complications in the elderly surgical patient are needed.

_Anes 26 (Level B):_ Depending in part on findings of large, descriptive studies of analgesia in elderly patients (Anes 25), prospective cohort studies are needed to determine the effect of analgesic modes (patient-controlled versus as-needed versus scheduled dosing), route of administration, the role of nonopioid adjunctive drugs, and nonpharmacologic interventions. These investigations must define a balance between adequate analgesia and reduction of the incidence of adverse drug events in the elderly patient.

_Anes 27 (Level A):_ Prospective randomized controlled trials comparing outcomes with analgesic programs specific to types of surgery are needed to determine whether analgesic regimes designed for the elderly patient reduce in-hospital morbidity or improve functional status on discharge.
Anes 28 (Level D): Improved tools for the assessment of pain in the cognitively impaired elderly patient should be developed.

Anes 29 (Level C): Improved tools for assessing pain in cognitively impaired elderly patients (Anes 28) should be used to determine the adequacy of pain management strategies in this group of patients.

Anes 30 (Level D): A retrospective review is needed to determine the incidence of polypharmacy with combinations of drugs that might contribute to complications (hypotension, bradycardia, falls, confusion, bleeding diathesis, constipation, and urinary retention) in geriatric surgical patients.

Anes 31 (Level A): The effect on outcomes for elderly surgical patients of simplifying drug regimens in hospital or of communicating that information to primary care physicians should be examined in a randomized controlled trial.

Anes 32 (Level B): Cross-sectional studies, with multivariate analysis, are needed to determine whether the risk factors for delirium in elderly surgical patients are the same as those for elderly medical patients.
Anes 33 (Level B): Studies are needed on the utility of the Confusion Assessment Method (CAM) for serial testing of elderly patients before and after surgery to facilitate the diagnosis of postoperative delirium. The CAM should be compared with other tests of cognitive function and with the clinical diagnosis for delirium. At the same time, since dementia is the leading predisposing factor for delirium, the utility of short mental status tests to make the preoperative diagnosis of early dementia should be tested, using a full psychiatric examination as the gold standard.

Anes 34 (Level A): Prospective controlled (nonrandomized; ie, by ward or unit) trials in patients at moderate to high risk for delirium should be performed to determine the effect of preoperative or postoperative interventions on the incidence of delirium.
A significant proportion of the geriatric population suffers from chronic pain conditions. Much of this is related to osteoarthritis; other neuropathic pain disorders that afflict older patients include postherpetic neuralgia (PHN), diabetic neuropathies, and causalgias. Care of these patients is complex, and for many of these painful conditions, therapy is inadequate.

A number of factors limit success in treating chronic pain in elderly persons. First, unlike acute postoperative pain, chronic pain is caused by conditions that typically are not reversible. Second, pain conditions in the elderly person may have a central nervous system component. Third, effective treatment of chronic pain is hampered by the side effects of medications and complications from polypharmacy. Fourth, depression and behavioral changes commonly complicate therapy. Fifth, assessment of pain in older patients can be difficult, and, finally, chronic pain in the elderly person is often associated with unrelated comorbid conditions that may alter treatment plans. In spite of these limitations, geriatric patients benefit, as do younger patients, from chronic pain therapy.

As described by the American Geriatric Society Panel on Persistent Pain in Older Persons, most pain syndromes can be classified into one of four types: nociceptive, neuropathic, mixed or unspecified, and psychogenic. The usefulness of different classes of analgesic agents in these
types of syndromes is reasonably well described. Nociceptive pain includes the pain typically associated with arthropathies, myalgias, and ischemic disorders; the mainstays of analgesia are initially acetaminophen and nonsteroidal anti-inflammatory drugs, followed later by narcotics.\textsuperscript{46,47,267} In contrast, narcotics are thought to have a lesser place in the treatment of neuropathies such as diabetic neuropathy, PHN, and complex regional pain syndromes.\textsuperscript{267,272,273} Instead, the primary pharmacologic therapies are tricyclic antidepressants and anticonvulsant agents.\textsuperscript{46,267,274–276} Antiarrhythmic drugs are second–tier agents for neuropathic conditions. Treatment of mixed or unspecified pain syndromes is challenging, as the mechanisms are unknown and treatment may require trials of differing analgesic approaches.\textsuperscript{47} For patients whose pain has been classified as psychogenic, psychiatric intervention rather than analgesic agents is indicated.\textsuperscript{47}

In addition to familiar analgesics and adjuncts, there is a need for a multidimensional approach to chronic pain in elderly persons. Neuraxial opioids, local anesthetics, and corticosteroids have a role for some patients, as do peripheral or central neuromodulatory techniques and a host of physical, physiatric, and cognitive–behavioral strategies.\textsuperscript{43,46,47}

Defining research priorities for anesthesiologists in such a broad and complex area is difficult. The first priority is that chronic pain trials must have sufficient control
groups and statistical power. As pointed out by Stanton-Hicks et al regarding neuropathic pain conditions, studies are typically small and anecdotal with few experimental findings, and “without adequate predictors for the choice of therapy, current practice is chaotic, and continues to use the trial-and-error approach.”

After design issues are addressed, probably the most basic research recommendation for any of these types of pain conditions is that outcomes should emphasize functional status rather than a change in a pain score per se. This is superbly outlined in the consensus report on complex regional pain syndromes. Though quantifying pain is relevant, ultimately the determination of which interventions facilitate rehabilitation, maintain or increase mobility, and support ADLs is a priority.

The second broad area requiring further investigation relates to prevention. One of the best examples is in PHN. The rash of acute herpes zoster is very common in elderly persons; a lesser but significant percentage of those affected develop the chronic debilitating pain condition of PHN. Because zoster is chronic and recurring, the percentage of the population affected with PHN increases with age. Although PHN may develop in less than 5% of younger patients with zoster, it may develop in half of patients aged 60 and over. Once established, PHN is difficult to treat. Further research is indicated to determine whether antiviral, analgesic, or anti-
inflammatory therapies during acute zoster can prevent the
development of chronic PHN. 280–283 A better understanding
of precipitating events for other chronic pain conditions, as
in PHN, 284 might allow the introduction of preventive
measures. In addition to directing research efforts toward
functional effects and trying to define opportunities for
prevention of chronic pain conditions, for any strategy it is
important to examine the risk–benefit ratio, emphasizing
adverse outcomes that are more likely to occur in a geriatric
population. As in acute pain management, the effect of
chronic therapy on the incidence of complications like
confusion, postural hypotension, falls, urinary retention,
and constipation must be reported.

Finally, cognitive impairment is a continuum and in
milder forms is very common. There is a two–way
relationship between pain and cognitive impairment: pain
may impair cognition and cognitive impairment can interfere
with the communication of pain. 46,285 Therefore, a further
area of investigation relevant to the care of patients with
chronic pain is its assessment in the cognitively impaired.
RESEARCH AGENDA IN CHRONIC PAIN

Anes 35 (Level B): The first priority in chronic pain trials is large cross-sectional studies that are powered to identify any relationship between pain intervention and functional outcomes.

Anes 36 (Level A): With the establishment of any relationship between intervention for chronic pain and functional outcomes in elderly patients (Anes 35), it must be determined prospectively if specific chronic pain therapies can improve functional outcomes in treatment groups relative to a historical or concurrent, nonrandomized control.

Anes 37 (Level C): Given the high incidence rate of herpes zoster in the geriatric population, further prospective studies are needed to determine if antiviral, analgesic, or anti-inflammatory therapies during acute zoster can reduce, relative to standard care, the development of chronic post-herpetic neuralgia.

Anes 38 (Level D): Cross-sectional studies documenting the association of chronic pain therapy with the incidence of complications like confusion, postural hypotension, falls, urinary retention, and constipation in the elderly population are needed.

Anes 39 (Level D): Cross-sectional studies that describe
pain management in cognitively impaired patients, relative to a nonimpaired population, are needed.

*Anes 40 (Level D)*: Pain assessment tools for chronic pain in the cognitively impaired elderly patient must be compared prospectively with standard assessment methods.

*Anes 41 (Level C)*: Prospective trials comparing different analgesic strategies with regard to clinical and functional outcomes are needed.
SUMMARY

The perioperative care of the geriatric patient is complex. Older patients are at increased risk for a host of complications, and it is probably easier to precipitate these complications than to directly prevent them. This precarious state is a function of decreased functional reserve, variable response to stress, and the number of comorbidities in older patients.

Nevertheless, we have learned a great deal that can guide future research. Rather than continuing to focus attention on the choice of anesthetic technique or on short-term outcomes, such as time to extubation or recovery room stay, we should focus attention on better risk stratification of elderly patients in order to better serve the goal of improving patient outcomes. If identified risk factors are amenable to therapy, it should be determined whether improvement in patient status leads to improved outcome. An essential element of both types of investigations will be a focus on preoperative functional status and outcomes appropriate to the geriatric population, rather than just major cardiopulmonary morbidity and mortality.

Outcome is determined by the interaction of patient factors and the challenges introduced by surgery. Surgical impact varies widely by type, so the development of comprehensive care strategies for specific types of surgery common in the elderly age group is indicated. Such an approach is more likely to generate positive results and
practical guidelines than pooling elderly patients undergoing differing types of surgery. Developing comprehensive clinical pathways specific to the care of the elderly patient undergoing specific types of surgeries is indicated because these would bring together preoperative, intraoperative, and postoperative management. This approach could improve outcomes and would serve as a foundation for assessing alternative strategies. These might have particular value in postoperative care, particularly with regard to the prevention of delirium, respiratory monitoring, and pain management. In these investigations the anesthesiologist has a unique role, as the clinician responsible for preoperative assessment as well as intraoperative and postoperative management for every elderly patient undergoing every type of surgery.
KEY RESEARCH QUESTIONS IN GERIATRIC ANESTHESIA

Anes KQ1: What preoperative assessments are useful in developing patient management plans for surgeries common in the elderly population?

Hypothesis-generating: Large observational studies are needed to identify preoperative risk factors for adverse geriatric outcomes following common surgeries. These will identify both patient- and surgery-dependent factors. Assessment tools for mental status, nutrition, hydration, thrombotic risk, and ADLs must be applied or developed when necessary. It then should be determined which risk factors are potentially modifiable.

Hypothesis-testing: Randomized controlled trials are needed to determine if preoperative or postoperative intervention against modifiable risk factors will decrease perioperative geriatric complications. The adverse effects of such interventions, such as delay of surgery or postoperative bleeding, must be examined along with the potential benefits of interventions. Examples of interventions that could reasonably be attempted include intensive nourishment for malnutrition and precise management of hydration, multifactorial interventions to prevent postoperative delirium, pre- or postoperative rehabilitation programs to maintain or improve functional status (ADLs, exercise capacity), and antiplatelet therapy for thrombotic and embolic complications.
**Anes KQ2:** Can proper choice of postoperative analgesic techniques reduce postoperative morbidity or improve functional status at discharge?

Hypothesis-generating: Large prospective studies describing analgesic practice and its complications in the elderly patient are needed. The efficacy and complications of regional analgesic techniques, nonopioid adjunctive drugs, and physiatric interventions must be investigated. These investigations must emphasize the type and incidence of adverse drug events in the elderly population.

Hypothesis-testing: Prospective randomized trials are needed to determine if perioperative intensive analgesic techniques (including traditional narcotic, regional, nonopioid adjunctive drugs and physiatric interventions) designed for the elderly patient reduce in-hospital morbidity or improve functional status on discharge.
**Anes KQ3**: How can postoperative pulmonary complications in the elderly patient be reduced?

Hypothesis-generating: Cross-sectional or cohort studies that better identify high-risk procedures or perioperative periods of vulnerability for postoperative hypoxia, respiratory failure, and pneumonia in the elderly surgical patient are needed. These investigations should identify both patient and procedure risk factors, as well as their interaction, for these complications.

Hypothesis-testing: Randomized trials are needed to determine if respiratory monitoring, prophylactic antibiotics, changes in pharyngeal instrumentation, or the way feeding is advanced will reduce respiratory failure, aspiration, and postoperative pneumonia among elderly patients.
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Postoperative Cognitive Dysfunction: The Next Challenge in Geriatric Anesthesia

Terri G. Monk, MD

Adapted from the 2003 Rovenstein Memorial Lecture
The population of the United States is aging, and is projected to do so into the foreseeable future:

At the present time, the US population aged 65 years and older is approximately 35 million. Within the next 50 years, that number will double to nearly 75 million and those 85 years and older will increase more than four-fold to 18 million.

The Reality for the practicing anesthesiologist:

- Half of all individuals age 65 and greater will have a surgery in the remainder of their lifetime.
- Over 7,000,000 surgeries per year (and rising) in people over 65 years of age.
- Most anesthesiologists will be geriatric anesthesiologists!
So what about the cerebral effects of anesthesia in the elderly?

In 1955, a review of records of 1200 patients aged 50 years or older who had an operation under GA showed mental deterioration in 10% of the patients. The conclusion: "operations on elderly people should be confined to unequivocally necessary cases" (Bedford, The Lancet, 1955; 2:259)

In the past, there was a hesitancy to perform surgery on elderly patients and a time when patients were told that they were too old to have elective surgery. This is no longer the case, and on the whole, the risks and recovery from surgery in healthy elderly patients is not much different from younger patients.

The biggest exception is cognitive function following surgery.

We have all observed older patients who develop delirium after surgery. Delirium is reported to occur in 10-15% of elderly patients who receive general anesthesia. Dementia is extremely rare following surgery and presents with cognitive deficits in multiple domains and severe impairment in occupational and social function. The third type, and the focus of this review, is post-operative cognitive dysfunction (POCD). It is not known if these disorders are different points on a spectrum, or if they represent unique conditions.
What is POCD?

Postoperative cognitive dysfunction is defined as a “deterioration of intellectual function presenting as impaired memory or concentration.” This disorder is usually mild and may not be detected until days to weeks after surgery.

It is only recently that publications about POCD in non-cardiac surgery have become commonplace because the diagnosis must be corroborated with neuropsychological testing and can only be made if there is evidence of greater memory loss than one would expect due to normal aging. This means the patient has to be tested prior to surgery and at least several weeks after surgery to determine if cognitive decline has occurred. This is not a part of normal clinical care and is a very expensive and time-consuming effort when included in research protocols.

Little is known about the medical, social and economic implications of cognitive decline, but longitudinal studies of normal aging without surgery suggest that any abrupt decline in cognitive function heralds a loss of independence, withdrawal from society and death.
Mechanisms of POCD—High Risk Patients

The mechanisms responsible for postoperative cognitive decline after surgery are unknown, but potential risk factors can be classified into patient, surgical and anesthetic categories. There are some elderly patients who may be moving towards dementia and any stress such as surgery can push them over their “functional cliff” into impaired cognitive function. There are also high-risk surgical procedures such as cardiac or orthopedic surgery and, quite possibly, high-risk anesthetic techniques.

Threshold Theory

In the past decade, neuropsychologists have used the concept of a threshold theory to explain why some elderly people are vulnerable to cognitive deterioration while others remain cognitively intact their entire lives.

The basis of the threshold theory is that an individual’s brain
reserve capacity determines cognitive changes during aging. In the image above, you can see two hypothetical cases. In case A, the individual has greater reserve capacity and presumably redundant neural networks. In this case, a lesion occurs but remains subthreshold and the patient continues to function normally. In case B, a similar brain lesion occurs, but the individual has less brain reserve and can no longer function normally after the insult.

In recent years, neurologists have described a transitional state between normal aging and dementia called mild cognitive impairment or MCI. While all elderly individuals experience some gradual cognitive decline with normal aging, there are certain elders who experience greater memory loss than one would expect for their age but do not meet the criteria for dementia. When these people are observed longitudinally, they progress to dementia at an accelerated rate compared with healthy, age-matched individuals. It is possible that the elderly patients who experience postoperative cognitive problems have mild cognitive impairment prior to surgery and the stress of the perioperative period pushes them over their “functional cliff.”
Mechanisms of POCD—High Risk Surgical Procedures

- Cardiac Surgery
- Orthopedic Surgery

Cardiac surgery is a well-known risk factor for cognitive dysfunction. However, cerebral microemboli also occur during orthopedic surgery. The University of Florida published this study entitled “Cerebral Microembolism Diagnosed by Transcranial Doppler during Total Knee Arthroplasty.” In this study, they placed transcranial Doppler monitors on 22 patients undergoing total knee replacement surgery. They detected cerebral emboli in 60% of the patients undergoing knee replacement surgery despite the fact that only 9% of the patients had a patent foramen ovale on transesophageal echocardiography examination. None of the patients had gross neurologic deficits, but neuropsychological testing was not done to determine if mild cognitive decline had occurred.
Mechanisms of POCD — Anesthetic Risk Factors

Exposure to anesthesia has been suggested as a possible cause of postoperative cognitive decline. Evidence suggests that cholinergic neurons in the basal forebrain regulate normal memory function. Choline reserves decrease with aging and this is felt to be the primary reason that the elderly are more prone to delirium following surgery. Anesthetic agents affecting the release of central nervous system transmitters such as acetylcholine, dopamine, and norepinephrine could potentially impair memory, especially in elderly patients. However, the mechanisms of general anesthesia are poorly understood making it difficult to postulate the effects of anesthesia on memory.

It is now accepted that cognitive deterioration following coronary artery bypass surgery is common and this information has made its way into the lay press.

The most comprehensive longitudinal study of cognitive function after coronary artery surgery was published by Dr. Mark Newman and his colleagues at Duke in February 2001. These investigators followed 261 patients for 5 years after their bypass surgery. At hospital discharge, 53% of the patients had cognitive decline, which was a predictor of worse long-term cognitive outcome.

The largest prospective study evaluating cognitive dysfunction after non-cardiac surgery was published in The Lancet in March of 1998. This study was a collaborative research effort from 13 hospitals in 8 different European countries and the United States. It was conducted from 1994 through 1996 and the senior author on this manuscript was Dr. J. S. Gravenstein at the University of Florida.

The hypothesis for this study was that anesthesia and surgery in elderly patients caused prolonged postoperative cognitive dysfunction and the incidence of this problem increased with aging. The investigators postulated that POCD was secondary to hypoxemia and hypotension.
In addition to neuropsychological testing, patients had extensive physiological monitoring in the perioperative period. Oxygen saturation was measured by continuous pulse oximetry on the night prior to surgery, in the operating room, and for the first 24 hours after surgery as well as the nights of postoperative days 2 and 3. This information was collected in a blinded fashion and was not available to the staff caring for the patients. Noninvasive blood pressure was also frequently measured during the perioperative period.

These investigators found that postoperative cognitive dysfunction occurred in 26% of patients at one week after surgery and in 10% of patients at three months after surgery, which was significantly higher than the 3% of control patients at each time point.

The authors of this study concluded that anesthesia and surgery did indeed cause long-term postoperative cognitive problems. Extreme hypotension occurred in 23% and extreme hypoxemia 11% of the patients. Although common, there was no correlation between postoperative cognitive dysfunction and either low blood pressure or low oxygen saturation. One of the limitations
the study was that there were differences in the rates of POCD at the various centers, making it difficult to generalize the results of the study to a single institution.

When I moved to the University of Florida in 1998, I was intrigued by the findings of the first international study and Dr. Gravenstein encouraged me to continue this research. We decided to perform a single-site study evaluating the relationship between age and Postoperative Cognitive Dysfunction. From February 1999 to September 2002, we enrolled nearly 1200 patients undergoing elective non-cardiac surgery. These patients were classified as young (being 18 to 39 years of age), middle-aged (being 40 to 59 years) and elderly (being 60 years or older) which was the same definition of elderly used in the first international study. In order to evaluate the impact of the passing of time without surgery on memory, we also enrolled family members in the same age groups. The study design was identical to the first international study and included the same psychometric test batteries and the same statistical analyses. The primary endpoint was cognitive decline at 3 months after surgery and the secondary endpoint was death with the first year after surgery.

All adult patients undergoing major, non-cardiac surgery as inpatients were eligible for the study. All patients received general anesthesia and the procedures were expected to last 2 hours or longer. We included patients with a preoperative Mini-Mental Status Exam score 24 or great in an attempt to include only patients who were cognitively intact prior to surgery. We also excluded any patient undergoing cardiac or neurosurgical procedures (because these procedures are known to cause cognitive problems), any patient with pre-existing neurological problems, drug dependence, major depression, or those who were not expected to live 3 months or longer to complete the study protocol.
At hospital discharge the incidence of cognitive decline varied between 33-40%. Cognitive decline was common in all age groups and there were no differences among patients in any of the age groups. At three months after surgery, the incidence of cognitive dysfunction ranged between 4-5% in young and middle-aged patients. However, patients aged 60 years or greater had a 13% incidence of cognitive decline. This was significantly higher than the incidence in young and middle-aged patients.

Univariate predictors of POCD at 3 months included:
- Lower educational level
- Older age
- History of stroke
- Higher ASA class
- Higher NYHA class
- History of previous MI
- When logistic regression was performed using the significant univariate indicators for cognitive decline, only lower educational level and older age remained significant.
One year after their surgical procedure, we contacted all patients to determine survival status. Patients who had cognitive decline at hospital discharge had a 6.5% incidence of death in the first year and those who exhibited cognitive problems at 3 months after surgery had a 8.1% incidence. As mentioned earlier, longitudinal studies of aging without surgery have found that abrupt changes in cognition are associated with an early death. After we found the relationship between cognitive decline and early death, we felt it was important to further evaluate predictors of mortality in this population.

As many other studies have shown, baseline co-morbidity was the most significant predictor of death in the first year. We also found that the use of major inhalational techniques compared to total intravenous anesthesia increased the risk of death by nearly 3 times. Other significant predictors of one-year mortality included intraoperative beta-blocker use, chronic beta blocker use, deep anesthesia as indicated by a BIS < 45, and systolic blood pressure less than 80. Beta-blocker use was not protective in this patient.
population because they were not used prophylactically. Intraoperative beta blockers were employed to improve hemodynamic stability and chronic beta blocker use was probably a marker of higher comorbidity.

The findings of this study can be summarized as follows. First, postoperative cognitive dysfunction is common in all adults, regardless of age, at hospital discharge. At three months after surgery, cognitive problems are significantly higher in those patients aged 60 years or older. Patients with less than a high school education were at higher risk of postoperative cognitive problems, which is probably related to less preoperative cognitive reserve. Long-term cognitive decline is also associated with a higher mortality rate in the first year after surgery.

In addition to co-morbidity, anesthetic management also appears to exert a significant effect on mortality in the first year. Our results found an association between the use of volatile anesthetic agents, cumulative deep anesthesia time, and systolic hypotension and death within the first year after surgery.
There is obviously quite a bit of research yet to be done in geriatric anesthesia to determine which of these correlated risk factors are modifiable.

It is hard to imagine that the type of anesthesia or the depth of anesthesia during surgery really effects long-term outcomes. But I think it is possible that intraoperative management may lead to events in the immediate postoperative period such as delirium or respiratory problems. These events may predispose patients to worse long-term outcomes. If this is true, practicing anesthesiologists may be able to influence long-term outcomes by adjusting anesthetic regimens. If as a specialty we made an effort to reduce one-year mortality by just 5%, this would result in 40 to 50,000 lives saved each year.
Selected Topics in Geriatric Anesthesiology

From the Syllabus on Geriatric Anesthesiology
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AGING AND THE RESPIRATORY SYSTEM

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Because many of the intraoperative manipulations performed by anesthesiologists in the conduct of an anesthetic focus on the respiratory system (e.g., assessing adequacy of patient ventilation, gas exchange, acid-base balance, delivery of volatile and inhalational agents), it is important for anesthesia providers to understand how aging affects the respiratory system. Such knowledge is becoming increasingly important as the U.S. population ages and this aged population presents more often for surgery. Knowledge of the age-related decrease in pulmonary capacity, combined with an understanding of the effects of the anesthetic process, will aid the practitioner in selecting appropriate supportive and prophylactic measures before and after surgery in the aged patient. With such information in hand, nonagenarians and even centenarians should not be denied either elective or emergency surgery for fear of respiratory limitations.

Characterizing the affect of the normal aging process on the respiratory system is a complex concept as it is difficult to separate the changes associated with age from those attributable to diseases of the aged. In fact, age-related disease has far more impact on the respiratory system and the conduct of an anesthetic than do age-related respiratory changes. This discussion will focus on those respiratory changes that can be attributable to age alone.

The respiratory system can provide a young adult with adequate gas exchange at many times beyond resting requirements even in the face of both major reductions in pulmonary function (i.e., a 40 – 50 percent loss of maximal ventilation), as well as a significant increases in metabolic rate (e.g., a doubling of metabolic rate, as in
severe fever). The magnitude of this reserve will easily see an otherwise physically fit patient through the convalescence of a major procedure even if complicated by major pulmonary morbidity without pulmonary mortality. However, aging inexorably reduces the capacity of all pulmonary functions.

Complicating our understanding of this process is the fact that the rate of loss of function is extremely variable among persons of the same chronological age. However, there are four hallmarks of the aging process: 1) a decline in elasticity of the bony thorax, 2) a loss of muscle mass with weakening of the muscles of respiration and reduced mechanical advantage, 3) a decrease in alveolar gas exchange surface and 4) a decrease in central nervous system responsiveness, which have anatomical, mechanical and functional consequences. There is very little information in the literature as to whether pulmonary mechanics under anesthesia are influenced by age.

There are a number of striking anatomic changes which occur in the respiratory system with age. As a consequence of a generalized loss of all muscular and neural elements (muscle fibers, mucosal receptors, nerve fibers, etc.), laryngeal structures undergo a slow but continual decline in function. Protective reflexes involved in the regulation of coughing and swallowing are diminished. The end result is chronic pulmonary inflammation from repeated aspirations with frequent contamination of the lower airway with oral and gastric organisms.

With aging, the larger and more central airways increase in diameter, as noted by an increase in anatomic and physiologic dead space. The trachea and large bronchi increase in size about 10 percent from youth to old age. However, expiratory flow and resistance to gas flow in the large airways changes with little or no physiological consequence. Beyond age 40, the diameter of the small airways, not privileged to have cartilaginous support, decreases significantly. Despite the decrease, overall airway resistance does not appear to increase significantly. There is a small but measurable increase in dead space. Further out in the lung
there are more functional changes. Elastic elements of the lung parenchyma are lost with age. The distal orders of respiratory bronchioles dilate as do alveolar ducts. The alveoli become dilated, Kohn’s pores become more numerous and larger, and fine parenchymal tissue is lost with a loss of tethering support. The end result is the smaller distal airways with a tendency to early collapse, dilated alveolar ducts and fewer gas exchange surfaces. These changes are manifest functionally by air trapping, increased closing capacity, frequency-dependent compliance and gas exchange problems.

A combination of factors alters the mechanical function of the lung with age. These include: 1) a decrease in motor power as a consequence of fewer muscle fibers and a decrease mechanical advantage, 2) an increase in parenchymal compliance decreasing elastic recoil of the lungs and ultimately a change in structure and function of the chest wall due to a loss of intervertebral spaces, and 3) a stiffening of the chest wall from changes in ribs, sternum and articular cartilages making the chest less expansible.

The tendency of the lung to assume a larger resting volume and the limitations imposed by a stiffer chest wall plus a decrease in motor power result in a change in the components of the total lung capacity. Vital capacity declines progressively with age. As a rough rule of thumb, there is a linear loss of 5 to 20 percent of functional ability per decade, which may be helpful in comparing an elderly patient’s current capacity against normal values. From age 20, vital capacity (VC) decreases progressively (-20 to -30 ml/yr) whereas residual volume (RV) increases (+10 to +20 ml/yr). In fact, the ratio of RV to TLC increases from 25 percent at 20 years of age to about 40 percent in a 70-year-old man, which gives the chest wall a somewhat barrel-like appearance. It is interesting that the decrease in elastic recoil of the lungs and progressive stiffening of the chest wall serendipitously counteract each other with no net significant change in absolute FRC. The total lung capacity (TLC) grows with age until puberty, where it reaches an average value of 6 to 7 liters, after which a slow loss of volume begins. With the age-related loss in total lung capacity (TLC), plus the very
modest increase in FRC, the ratio of FRC to TLC tends to increase with age.

The reduction in motor power of the accessory muscles of breathing as well as the decreased expansion of the chest wall cause the dynamic lung volumes and capacities to decrease progressively with age (e.g., FEV\(_1\)). The FEV\(_1\) decreases with age by about 27 ml/yr in men but by only 22 ml/yr in women. However, the percent change in the two sexes is similar because men start off with higher absolute values of these measurements.

There is a clear age-related increase in the closing volume (CV) and closing capacity (CC). In childhood and youth, the closing capacity remains well within the expiratory reserve volume. Over time it progressively enlarges, encroaching on the tidal volume in the 60-year-old. Both the CV and CC also increase with recumbency, a common position perioperatively. During active breathing, closing pressure in young subjects is about -1.25 cm H\(_2\)O pressure, and opening pressure is +2.5 cm H\(_2\)O, the difference being attributable to hysteresis. The values for closing pressure (CP) and opening pressure (OP) in subjects aged 65-75 years are 0 and 4.5 cm H\(_2\)O, respectively. The higher values for both CP and OP will decrease the elderly patient's ability to keep some ventilated areas open and to re-open those areas that have collapsed.

The pressure-volume curve of an older lung is similar in shape, but shifted upward and to the left; in other words, the aged lung possesses less elastic recoil. This change in compliance is quite regional rather than being evenly distributed across the lung. The effect is to slow passive exhalation in some lung areas while other lung areas empty normally. The dynamic lung compliance (compliance measured during active breathing) becomes more frequency dependent with age. Thus as breathing rate increases, lung expansion becomes less effective particularly in some areas, thereby increasing the maldistribution of ventilation to perfusion.

Also, in older subjects the pressure across basal lung units may be
positive rather than subatmospheric. During quiet breathing, inspired gases will preferentially go to the more distensible upper lung units leading to an uneven distribution of gases. However, these variably compliant lung areas are surrounded by a thoracic cage that has become stiffer; the stiffness of the older chest wall overshadows the lesser elastic recoil of the lung and the anesthesiologist may perceive a less compliant respiratory system. The functional, or gas exchange capability, of the aged lung is affected by the anatomical and mechanical changes of age. The efficiency of alveolar gas exchange decreases progressively with age for a number of reasons. Alveolar surface area decreases with age from about 75 m$^2$ at age 20 years to about 60 m$^2$ at age 70 years.

Although blood volume does not change with age, the quantity of blood present in the pulmonary circulation at any given instant does decrease with age. There is also evidence that the distribution of pulmonary blood flow changes with aging. The change in blood flow, combined with the altered distribution of inspired gas, promotes even more V/Q mismatching. Alveolar dead space, which is a good index of the distribution of pulmonary blood flow, increases with age. The increased V/Q mismatch plus the increased alveolar dead space adversely affect the aged patient's blood gas values.

Arterial blood gases become integral components in the interpretation of lung function during anesthesia. There are reference values available to aid in the interpretation of arterial blood gases in middle-aged and elderly persons (40-70 yr). The normal alveolar oxygen tension PaO$_2$ is fairly constant from infancy to senescence. A number of studies have demonstrated the mean PaO$_2$ declines from 95 ± 2 mmHg at age 20 to 73 ± 5 at age 75 years. This decline in arterial oxygen tension is modest: approximately 0.4 mmHg/year. After age 75, however, PaO$_2$ stays relatively constant at approximately 73 mmHg.

In humans there is a normal amount of relative hypoxemia due to shunt, diffusion block and ventilation/perfusion mismatch. Age
and anesthesia worsens hypoxia mostly by increasing ventilation/perfusion maldistribution. We also know this can be made more prominent by pulmonary disease, the effects of aging and the application of mechanical ventilation. The efficiency of vascular distensibility and recruitment decreases with age. The increasingly rigid pulmonary vasculature probably blunts the hypoxic pulmonary vasoconstrictor (HPV) reflex. The loss of physical support of surrounding pulmonary elastic tissue surrounding both the small airways and pulmonary vessels may be a contributing factor. Thus the ability of the aged lung to respond to altered ventilation/perfusion matching is compromised.

Finally, it is important to recognize that the ventilatory response to hypercapnia and hypoxia is blunted in the elderly patient. The ventilatory response (change in minute ventilation) in the healthy aged patient (70-year-old) to either a hypercapnic or hypoxic stimulus is half that seen in the 25-year-old.

In summary, the aged lungs have some but certainly not all of the features of chronic obstructive lung disease, e.g., increased RV and RV/TLC, reduced VC and FEV₁ plus a compliance that worsens as breathing rate increases. The fact that older patients have some of the features of chronic obstructive pulmonary disease (COPD) should not imply that they should be considered as having COPD, however.

What does all of this mean to the clinician expected to provide anesthesia for the aged patient? An increase in ventilation during hypoxia and hypercapnia is a useful clinical sign and also a homeostatic response. The fact that these responses are blunted in older subjects indicates that simple clinical observation of ventilatory frequency and chest movement with breathing may not be an accurate manifestation of the ventilatory stimulus to an aged patient. The clinician should also realize that, together with these age-related decreases in reserve in the awake state, the ventilatory responses to hypercapnea are reduced by narcotic premedication and by thiopentone and narcotic and inhalational anesthetics in a dose-related manner.
Aged patients may be hypoxemic during normal spontaneous ventilation postoperatively because of the mechanical changes of the aged lung and chest wall. The risk is increased by the supine position and by the use of narcotic analgesics in an age group that already has blunted ventilatory reflexes to hypoxia and hypercapnia. Any residual anesthetic will also exert an additive effect. The elimination of narcotics and muscle relaxants may be delayed due to the impaired renal function in older patients. The effects of large volumes of crystalloid infusion may manifest in the recovery room.

Older subjects are less able to increase and maintain ventilation at high levels than young adults during periods of increased demand for oxygen. Ventilatory muscle fatigue is quite likely to occur early due to the altered physiology of voluntary muscle. It seems reasonable to assume that older patients will develop ventilatory inadequacy earlier for any given ventilatory load. The subjective feature of ventilatory inadequacy is dyspnea.

The anesthetic technique and agents are of less importance than the degree of preparedness and the acumen of the anesthesiologist. In the aged the strategies are the same: increasing FIO2 as necessary while remembering that oxygen toxicity is a concern. Large tidal volumes are useful until circulatory impediment and barotrauma become a concern. Aging limits the effectiveness of each of these therapeutic interventions.

Finally, one should remember that, overall, the age-related changes of the respiratory system essentially consists of a mix of restrictive and obstructive lung disease. The whole picture and how these changes impact the aged patient may not be apparent immediately after surgery, but the changes may become maximally manifest any time during the first 2 to 3 days after the operation.
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Thermoregulation in the Elderly

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Normal autonomic responses to decreases in core body temperature include vasoconstriction and shivering. Of the two defense mechanisms, shunt vasoconstriction is the more efficient. Restriction of blood flow, especially to the fingers, toes, and nose, reduces heat loss to the environment. Shivering occurs at core body temperatures that are about 1°C lower than those required for activation of vasoconstriction. Although shivering can double metabolic rate, most of it occurs in the extremities. As heat is generated in the extremities, peripheral blood flow will increase due to local heating as well as to meet the increased muscle metabolic demand. The end result is that much of the heat produced by shivering is lost to the environment.

Elderly patients are unable to regulate their body temperature to the same degree as young adults because their responses to changes in body temperature are altered. They do not respond normally to hypothermic challenges. In general, geriatric patients neither vasoconstrict nor shiver in response to cold until their temperature has fallen to levels below that required for activation of these defense mechanisms in young adults. The relationship between impairment of thermoregulation and age is not linear and it does not occur in all aged patients. Rather, it is most common in patients over the age of 80. While younger patients will shiver at a temperature of 36.1°C, most patients over the age of 80 will not shiver until their core body temperature falls to 35.2°C, on average. Furthermore, the ability to vasoconstrict and reduce skin blood flow is reduced with age, making obligatory heat loss in a cold environment greater than in young adults. These alterations in the elderly patient’s ability to regulate body temperature result in more frequent and severe hypothermia in this patient group.
Anesthetics alter thermoregulatory responses in all patients. In clinically useful doses, sedatives and general anesthetics impair thermoregulatory responses by preventing vasoconstriction or shivering until more extreme decreases in body temperature are achieved in comparison to the absence of the anesthetic agents. Consequently, the immobile, vasodilated patient in a cold operating room will lose heat unless active measures are taken.

Geriatric patients are even more prone to intraoperative hypothermia, not only for the reasons cited in the previous paragraph, but also because the inhibition of thermoregulatory responses by anesthetics is greatly exaggerated in elderly patients. Body temperature must decrease to a lower level in the elderly before vasoconstriction or shivering is triggered. Because clearance of anesthetic agents tends to be reduced in the elderly, their effects in this patient population are prolonged. This renders the geriatric patient more susceptible to postoperative hypothermia as well.

Hypothermia, in addition to being more pronounced, lasts longer in geriatric patients than it does in young patients. Recovery from mild hypothermia is accompanied by shivering in elderly patients. The shivering that does occur, though, is milder than it is in young patients. In elderly patients who shiver, body oxygen consumption only increases approximately 38% over nonshivering levels. Whether or not patients are shivering, there is an increase in their oxygen consumption that is proportional to the degree of hypothermia. Recovery from even mild hypothermia is prolonged in the elderly because their lower metabolic rate produces less heat.

Elderly patients are not immune to the adverse effects of hypothermia, which include bleeding, decreased immune function, and decreased wound strength. Bleeding is increased due to impaired platelet function and inhibition of the enzymes in the coagulation cascade. Decreases in temperature as little as 2°C will increase blood loss and transfusions. The vasoconstriction that
accompanies hypothermia causes relative tissue hypoxia as less oxygen rich blood is brought to the vasoconstricted areas and the hypoxia results in decreased wound strength.

Hypothermia may exacerbate the decreased clearance of drugs in the elderly. This diminished clearance, accompanied by a decreased MAC in the elderly, means that anesthetic effects may be both pronounced and prolonged.

Elderly patients are more prone to have coronary disease than are younger adults. Hypothermia causes an increased incidence of myocardial ischemia in geriatric patients that is not related to shivering. Instead, ischemia is likely due to hypertension and increased plasma concentrations of norepinephrine. Consequently, it is not too surprising to note that hypothermia is associated with an increased risk of perioperative myocardial infarction.

The last major complication of hypothermia is an increased risk of infection. In a randomized study of colorectal surgery, patients assigned to routine care were almost 2°C colder at the end of surgery than patients who received aggressive intraoperative warming. Despite achieving normothermia in both groups by 6 hours postoperatively, the subjects receiving routine care suffered three times as many wound infections (19% vs. 6%) and remained hospitalized an average of two days longer than the patients who were more aggressively warmed.

As temperature regulation is altered in elderly patients, extra care must be taken to maintain their body temperature. This can be done by several consecutive measures, which include: warming the operating room until the patient is covered with drapes and warming blankets, prepping preoperatively and cleaning postoperatively with warmed solutions, not infusing cold intravenous fluids, and covering the patient with warm blankets at the end of a surgical procedure for transport to the post anesthesia care unit. Maintenance of temperature is extremely important as the elderly are susceptible to all of the adverse effects
of hypothermia, which may be more prolonged in this patient population.

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Safe Sedation of the Elderly Outside the Operating Room

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Within the next decade, it is estimated that 20-40 percent of anesthetic cases may be performed outside the operating room. Patient demand has also influenced this trend, with surveys showing the elderly preferring more ambulatory settings. In addition, Medicare also favors outpatient protocols for certain procedures.

This expansion of outpatient procedures for the elderly must be viewed with caution because perioperative complications increase with age. The etiology of this observation is controversial but is probably more a function of associated concurrent diseases than age in and of itself. In addition, liability claims for adverse events associated with sedation have substantially increased. Levels of injury are comparable with general anesthetics, with those injured tending to be older, more debilitated and performed on an outpatient basis.

One must appreciate that geriatric patients have limited physiologic reserves. There is less heart rate responsiveness in response to hypotension. Ventilatory responses to hypoxia and hypercarbia are reduced, with greater risks for apnea. Impairments in thermoregulation and water balance increase vulnerability for hypovolemia and hypothermia. Changes in volume of distribution, bioavailability and receptor sensitivity lead to alterations in pharmacodynamics for most drugs. Limitations in renal clearance and hepatic function require attenuation of dosage. Since many elderly have prolonged circulation time, longer periods are
required for interval dosing. Thus, titration to effect is an important principle in applying clinical judgment to the geriatric patient. Delirium may occur in a high percentage of elderly surgical patients. This should give rise to caution for similar potential in the sedated geriatric patient. Procedures in remote locations often have anesthetic requirements that rival many operating room procedures. The risk of delirium may be increased with agents such as midazolam, meperidine and anticholinergics. Immobilization and prolonged nothing by mouth (NPO) status are prominent contributing factors for periprocedure delirium.

Because of increased sensitivity to medications, patients with any baseline disorientation should be insured of overnight observation. There is evidence that interventions such as repeated orientation, maintaining sensory aids and familiar family contacts are key factors in delirium prevention.

When sedating the geriatric patient, the agent of choice should have a short half-life, with minimal active metabolites and limited side effects. One should avoid using standard dosages calculated on a mg/kg basis. These boluses frequently produce unwanted respiratory depression and hypotension. Likewise, slower administration of an agent and allowing more time for peak effects often achieves the desired goals with less overall dose.

Midazolam and fentanyl are a common combination used for conscious sedation. Due to increased sensitivity in the elderly and decreased clearance of these agents, smaller doses and more delayed increments must be used. Propofol also has a reduced clearance in the elderly. Older patients require lower doses for any given effect, in many cases as little as 50 percent of the expected "standard" dose.

Remifentanil is the newest ultra short-acting agent on the market and its use is currently being explored. It offers potent, rapid analgesia, but its rapid offset may be a double-edged sword in cases involving prolonged discomfort. In the elderly, its use
appears to be associated with an increased incidence of hypoventilation. While clearance is quite rapid and independent of age, the dosage required for clinical effect in the elderly is at most 50 percent of package insert guidelines. Its utility as a sedative needs to be more thoroughly evaluated, but at this time there appears to be only modest enthusiasm compared to other currently available agents.

Safe sedation of elderly patients also includes maintaining appropriate practice standards in all areas where these agents are administered. The Joint Commission on Accreditation of Healthcare Organizations addressed this issue by mandating that institutions develop protocols for conscious sedation. While they do not set specific standards for practice, they state that institutions should have policies dealing with evaluation, personnel, equipment, monitoring, and recovery. They also require evidence of monitoring for compliance. Anesthesiologists should be involved in the establishment of these protocols because they optimize patient safety through identification of patients who require care beyond the scope of conscious sedation.

Among various logistic considerations, geriatric patients take longer to accomplish many tasks. Thus, more time must be allowed for preprocedure preparation. Also, older patients’ skin may be fragile, so adhesive tape should be used with caution to avoid torn skin. Extra padding should be used on procedure tables to prevent compression sores. The elderly are less agile and may require equipment aids (e.g., chair raisers or footstools). Many elderly are hearing impaired, so verbal and written post-procedure instructions may foster comprehension.

Several novel approaches to sedation have recently evolved, and a few may prove useful in enhancing the care of geriatric patients undergoing procedures in remote locations. Similar to patient controlled analgesia, the concept of patient controlled sedation is now being explored. Several studies have demonstrated its safe and efficacious use for conscious sedation in the operating room. However, one study, which used Propofol in the
treatment of the elderly, found an increased incidence of profound sedation. The boundaries of this technique have yet to be defined. Bispectral index monitoring (BIS) is currently being evaluated as a level of consciousness monitoring. The processed EEG signal is quantitated and used as an indicator of sedation level. It may permit more effective titration of drug administration, thus speeding up recovery time.

For anesthesia departments noting increased usage of conscious and deep sedation outside their operating rooms, we may see the advent of formal anesthesia sedation services available throughout a hospital community. Advantages of such a service include providing a hospital with timely, reliable, high-quality service with an optimization of recovery and turnaround time. In summary, sedation of the geriatric patient in remote locations requires appreciation of their physiologic limitations and underlying co-morbid conditions. The clinician must pay attention to periprocedural care, including use of short acting agents, in conjunction with a judicious dosing strategy.

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Perioperative Complications in Elderly Patients

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Introduction

By the year 2030, it is estimated that 20 percent of Americans will be older than 65, while one out of four elderly individuals will be older than 85 years of age. Twenty-one percent of those over age 60 will undergo surgery and anesthesia as compared with only 12 percent of those aged 45 to 60 years. Despite the higher numbers of elderly patients having surgery, mortality and morbidity rates have been declining. Old age appears to have assumed less influence as a determinant of adverse outcome as perioperative care has improved. A better understanding of the associated risk factors leading to perioperative complications may help anesthesia providers to further lower the risk. This chapter will review recent studies examining common perioperative adverse events in elderly patients and their associated risk factors.

Mortality

Recent studies have shown a decline in the perioperative mortality rates from 20 percent in the 1960s to 10 percent in the 1970s, and
to 5-6 percent in the 1980s. This trend of declining mortality rates even extends to those on the extreme end of the age spectrum. For example, a study by Warner from 1998 reported on 31 patients over 100 years of age. The patients had postoperative mortality rates of 0 percent, 16.1 percent and 35.5 percent on 48 hours, 30 days and one-year follow-up, respectively. The survival rate was the same for the patients who underwent surgery as for controls who did not have surgery.

Several risk factors for perioperative mortality have been identified. Emergency procedures are associated with a higher mortality rate regardless of the age group. In 795 patients above 90 years of age, the 48-hour mortality rate for patients undergoing emergency surgery was 7.8 percent versus .6 percent in those who were age matched but undergoing elective surgery. The location of the surgical site also has an important impact on mortality rate.

Procedures involving the thorax or abdomen have been shown by multiple studies to have higher complication and mortality rates. In addition, coexisting diseases have been found to be important risk predictors of perioperative mortality. Current data support the view that the effects from coexisting disease outweigh the effects of age alone on anesthetic outcome. When age and severity of illness are compared, the number of coexisting diseases is more significant. Recently, several studies have identified albumin level to be a good predictor of postoperative mortality. Albumin, a marker of nutritional status, may serve as a surrogate marker for the preoperative health status of the surgical geriatric patient. Since emergency procedures increase perioperative risk, early surgical treatment should be considered whenever possible.

Delaying surgery just because of the patient’s age is not supported by the literature. Every effort should be made to perform a thorough preoperative evaluation, including nutritional assessment, and to optimize the status of the patient’s chronic medical diseases as much as possible before surgery. That assessment and care should continue postoperatively, especially after emergency surgery where there may be insufficient time for
Cardiovascular Morbidities

The elderly are more prone to develop cardiovascular complications. A study by Pedersen et al. in 1990 examined patients over 80 years of age who were undergoing anesthesia. He reported a 16.7 percent cardiovascular complication rate compared to 2.6 percent in those less than 50 years of age. A high rate of cardiovascular complications (40 percent) was found in patients with preoperative heart disease, especially those with clinical signs of congestive heart failure, prior history of ischemic heart disease or previous myocardial infarction. Our recent study also found a similar cardiovascular complication rate of 12.5 percent in 367 patients over 80 years of age undergoing noncardiac surgery. Our results, along with those from previous studies, suggest that the type of anesthesia does not appear to influence perioperative cardiovascular morbidity. Rather, hemodynamic control may be more important.

While some of the risks associated with adverse cardiovascular outcomes have been identified, randomized studies are lacking in determining whether modifying risks may improve outcomes. Some risk factors such as a history of congestive heart failure may be difficult to diagnose preoperatively. In fact, one-third of geriatric patients with heart failure may have diastolic dysfunction despite having normal systolic function. In the absence of specialized tests for estimating preoperative heart function, the goal should be to optimize symptomatic complaints as much as possible prior to surgery.

Pulmonary Morbidities

In a study of 7,306 anesthetics administered to patients over 80 years of age by Pedersen et al., 10.2 percent developed pulmonary complications, similar to a rate of 7 percent found in our recent study of patients 80 years or older. In our study, we further demonstrated that a prior history of congestive heart failure and
prior neurologic history increased the odds of an adverse postoperative pulmonary event by multivariate analysis.

Preoperative optimization of respiratory function is important in decreasing adverse pulmonary events. Cessation of smoking is associated with better outcomes even immediately prior to surgery since carbon monoxide levels have been shown to decrease soon after cessation. Good exercise capacity may also impact perioperative outcome. In a study investigating patients scheduled for abdominal and noncardiac thoracic surgery, patients who were unable to raise their heart rate above 99 beats per minute or perform two minutes of supine bicycle exercise had a higher cardiopulmonary complication rate (42 percent versus 9.3 percent).7

Neurologic Morbidities

There is a wide variation in the reported incidence of postoperative cognitive deficit (POCD) in the literature. One of the largest studies of elderly surgical patients was conducted by Moller et al.8 The authors found that POCD was present in 25.8 percent of patients one week after surgery and in 9.9 percent of patients three months after surgery. This was compared to a control group of hospitalized patients not undergoing surgery who had a POCD rate of 3.4 percent one week after hospitalization and 2.8 percent three months after hospitalization. Increasing age, duration of anesthesia, lack of education, a second operation, postoperative infections and respiratory complications were identified as risk factors for early cognitive dysfunction.

Several studies have looked at general versus regional anesthesia, since general anesthesia may lead to changes in cerebral blood flow and cerebral metabolic oxygen consumption. The evidence to date suggests that although cognitive deficits may occur postoperatively, no particular anesthetic technique appears to be implicated.9 Furthermore, a history of preoperative neurologic disease has been demonstrated by our study to also increase the rate of POCD.6 Until more definitive clinical studies become available, minimizing the number of medications used, avoiding
hypoxemia and hypercarbia, providing adequate postoperative pain control and involvement of geriatricians in postoperative care appear to be the best approach in minimizing the occurrence of POCD in the geriatric surgical patient.

Conclusion

Surgery in the geriatric population is not without risk, but the mortality rate has markedly decreased. Chronological age is much less important as an independent risk factor. A more important predictor is the presence of coexisting disease. Although prospective trials involving risk modification are lacking, medical optimization, adequate planning preoperatively, including scheduling surgery electively as opposed to emergently, and improving nutritional status may be helpful. Anesthetic technique is probably not as important as meticulous control of hemodynamics perioperatively. Opportunity to improve perioperative outcomes in the elderly will be possible when risk factors for these adverse events can be modified and outcomes evaluated in prospective trials.

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Preanesthetic Evaluation for the Elderly Patient

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Fifty percent of all Americans over 65 will undergo a surgery prior to death; thus it is important to understand the basic physiological changes that occur during aging. The elderly are a heterogeneous group and aging is not always a predictable process. Although the preoperative assessment must be tailored to the individual, some basic guidelines for elderly patients are discussed in this section.

The preoperative evaluation of an elderly patient is best accomplished several days before the surgery and ideally not before medical information has been obtained from the surgeon or primary care physician. An evaluation in a preanesthetic clinic is advantageous and provides the patient with the additional opportunity to meet with nursing and social work staff.

The anesthesiologist’s assessment includes a history, physical examination and review of the medical chart. Laboratory testing is indicated by comorbid conditions and the type of surgery contemplated; tests should not be performed solely because of advanced age. A discussion about anesthetic techniques and risks can reduce patient anxiety. The visit also provides the opportunity to refute preconceived negative beliefs about the safety of anesthetic techniques such as spinal and regional anesthesia.
Some specific areas and questions to be addressed during the visit might include:

- **What is the patient’s mental status?** Is the patient able to answer coherently, or is the family answering for him or her? Will regional techniques and outpatient surgery be feasible?
- **Does the patient have cardiac disease?** Coronary artery disease is prevalent in elderly patients, and it may be unrecognized due to limited function prior to surgery. Is a prior cardiac work-up available? Why was it performed? Is more needed?
- **Assessing functional capacity** - this may provide an excellent estimate of reserve. For instance, can the patient walk up and down stairs with and without groceries?
- **Does the patient have pulmonary disease?** Is he or she short of breath in the clinic or lying flat? Document room air oxygen saturation.
- **Is the patient hypertensive?** This may alter cerebral autoregulation and require higher systemic pressure intraoperatively. Make sure to document baseline blood pressure.
- **Is the patient markedly anorexic, dehydrated or very frail** (e.g., in a wheelchair)? Or does the patient appear young and vigorous for his or her age?
- **Does the patient have an understanding of their medications?**
- **Has the patient had a prior surgery?** How did he or she tolerate the anesthesia? Were there complications that may influence the choice of the next anesthetic, such as confusion or congestive heart failure?
Guidelines for Elderly Patients:

1. Expect interindividual variability
2. Advanced chronological age is not a contraindication to surgery
3. Clinical presentation of disease is frequently atypical, leading to delays and errors in diagnosis
4. Most older patients are on multiple medications and have multiple illnesses (individuals older than 65 have on average 3.5 medical diseases)
5. Diminished organ reserve can be unpredictable - limitations may only become apparent during the surgery
6. A disproportionate increase in perioperative risk may occur without adequate preoperative optimization - adverse events are more frequent with emergency cases
7. Meticulous attention to detail can help avoid minor complications that can rapidly escalate into major adverse events in elderly patients
8. Impact of extrinsic factors - smoking, environment, socioeconomic, etc. - is difficult to quantify

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Ethical Challenges in the Anesthetic Care of the Geriatric Patient

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Introduction

Geriatric patients face special medical, economic and social challenges that affect the ethical and legal issues in their medical care. Ethical principles guiding the care of elderly patients are no different from those involved in the care of other adult patient populations. Common ethical challenges include conflicts over patient autonomy and choice, surrogate decision-making and do-not-resuscitate (DNR) order in the operating room.

Respecting Patient Autonomy

The ethical principle of respect for patient autonomy requires that medical decisions be made by the patient, whose life is directly and most affected by the consequences of the decision. Physicians can provide information, recommendations and rational argument to convince a patient to agree to medical therapies, but the ultimate decision of what will be done to them rests with the patient. The legal doctrine embodying this principle is that of informed consent and has been upheld in U.S. courts since 1914.

Informed Consent

Informed consent requires several elements. First, consent must be voluntary and free of undue influence or coercion. Second, consent must be made based on sufficient information. Finally, the decision-maker must be able to understand the information given
to them, apply it in some rational way to the medical issue at hand and arrive at a decision based in part on the information given to them. Patients have the right to refuse medical therapy, even if the decision is at odds with what the physician feels “is best” for them.

Voluntary decisions, by definition, must be free of force, intimidation, duress or coercion. Social and economic pressures affecting elderly patients may hinder the ability of elderly patients to make truly voluntary choices. Pressures from family members to undertake, or not undertake medically onerous treatments can cause an elderly patient considerable duress. Economic pressures on patients with limited monetary resources may play a hidden albeit significant role in the patient’s decisions. Fears of dependency or of burdening the family may encourage some patients to forgo treatment that might otherwise be beneficial. These influences affect any patient population, but geriatric patients are particularly likely to face such pressures while suffering from medical conditions that require difficult treatment decisions.

A patient must have sufficient information to give informed consent. In the “reasonable person” standard, used in about half of the United States, the physician must provide information that any “reasonable person” would need. About half of the United States apply an “individual” standard, recognizing that some individuals may have special informational requirements. In general, patients should be told in lay terms the diagnosis to be treated, the proposed treatment, the foreseeable risks and benefits of the procedure and the viable alternatives to the procedure, including no treatment. Anesthesiologists should pay particular attention to explaining the risks of common problems that generally do not have significant long-term impact (e.g., nausea, sore throat, delirium) as well as rare problems that have significant long-term impact (e.g., death, neurologic injury, myocardial ischemia or infarction).

“Competency,” is a legal term describing a patient’s ability to
perform certain functions. Medical authors often refer to the ability of a patient to make medical decisions as "capacity" to distinguish it from the related legal term. Capacity is a relative, not an all-or-none, phenomenon. Incapacity to handle finances, for example, does not preclude capacity to make personal decisions about medical care. Capacity can wax and wane with environmental factors, such as time of day, familiarity of surroundings, the presence of distractions and reactions to medications. Decision-making capacity can be impaired by medical conditions that afflict elderly patients, such as dementia, cerebrovascular accidents and depression. Physical impediments to communication that are more common in elderly patients, such as aphasia and hearing loss, can give the false appearance of impaired capacity when no impairment exists.

Determining that an elderly patient has the capacity to make medical decisions can be a challenge for the anesthesiologist, who is often a stranger to the patient, and has limited time and resources for making what can sometimes be complex determinations. Many patients who carry the diagnosis of dementia have sufficient abilities to make medical decisions, yet studies demonstrate that patients with dementia are likely to be referred for competency evaluations when they disagree with their physician, and are unlikely to be referred if they agree. When decisions are required regarding resuscitation in ICU patients, there is evidence that many physicians will not have discussed DNR decisions with competent patients either before or during the ICU stay.

Assumptions about patient capacity based on diagnosis categories or age is not consistent with ethical medical care. Determination of decision-making capacity should focus on the patient's functional capacity. Basic questions to ask include:
1. Can the patient receive and understand information relevant to the decision at hand?
2. Can the patient understand possible consequences of their choice and alternatives, including risks and benefits?
3. Can the patient make and express a decision and discuss his/her
values and desires in relationship to the medical advice provided?

Some patients are clearly too impaired to make medical decisions, but when questions arise, expert consultation can be helpful, both in determining a patient’s capacity to make decisions and in overcoming physical barriers to communication. Consent in impaired patients may require extra time, patience, and effort, but anesthesiologists are ethically obliged to promote and respect the autonomy of patients in making medical choices.

Surrogate Decision-Making

When patients are too impaired to make medical choices, a surrogate decision-maker may be involved. Proxy decision-making is based on three assumptions:

1. That a competent patient’s decisions can be implemented by proxy.
2. That the proxy will make the same decision that the patient themselves would make if they were competent (the proxy would “don the mantle” of the patient).
3. That, in the absence of proxies, doctors might act less out of interest for the patient than out of fear of litigation.

Usually doctors turn to family members, assuming that families have the patient’s best interests at heart and, by virtue of coming from a common cultural background, are more likely to actually know what the patient would decide. But studies have shown that family proxy decision makers often come no closer than chance alone at predicting what a family member would want under hypothetical circumstances, and that proxies and patients infrequently discuss issues and values surrounding the use and withdrawal of life-sustaining technologies. Moreover, it has been demonstrated that physicians are incorrect in predicting resuscitation preferences in 25 percent of their patients. Proxy decision-making is a poor substitute for patient decision-making and should be avoided unless the patient is truly unable to participate in decisions.
Mechanisms for proxy decision-making include living wills, durable power of attorney or legal hierarchies. Living wills (advanced directives) are documents of a competent patient’s wishes, executed in front of qualified witness, which can then be used on occasions when a patient is no longer competent to guide medical decision-making. A durable power of attorney is a mechanism for the competent patient to designate a specific person as their proxy for medical decision-making should they later become incompetent. Each state has a legal hierarchy through which a medical decision-maker is appointed if the patient has not executed a living will or durable power of attorney. Sometimes the court may appoint a legal guardian apart from family or other surrogate decision-makers who is legally responsible for health care decisions for the patient.

Do Not Attempt Resuscitation Orders (DNR)

Any adult with decision-making capacity has the right to refuse specific medical interventions, including cardiopulmonary resuscitation, even in the operating room.

Studies have shown that DNR orders are frequently entered in patient charts without a discussion with the patient and informed consent, even if the patient is competent to participate in such a discussion. Physicians often turn to surrogate decision-makers and leave competent patients out of the decision-making process if the patient is elderly or carries the diagnosis of dementia. Paternalism (the doctor “knows” what is best), a desire to promote good and do no harm (the discussion might stress, and therefore harm, the patient) or more selfish motivations (the doctors wants to avoid a discussion that may be distressing to them) have been used as rationale to avoid having difficult conversations that are nevertheless ethically required.

The implications of cardiac arrest under anesthesia differ from those for arrest in other areas of the hospital; over 60 percent of patients resuscitated in the OR survive to discharge versus 7-17...
percent of patients on the ward. This is probably because OR arrests are witnessed, receive immediate intervention, and usually occur from reversible causes—medication effects and hemorrhage, while arrests on the ward may go unwitnessed for varying lengths of time and are often related to the severity of the underlying disease process.

Cardiac arrests, resuscitations and outcomes are different between the ward and the operating room, but the moral principles governing conduct with respect to patient autonomy are the same. As with other medical interventions, patients must be given appropriate information and provide informed consent (or “informed refusal”) for cardiopulmonary resuscitation in the operating room. Because some procedures commonly thought of as resuscitation (e.g., mechanical ventilation) may be required for the anesthetic care of the patient, the anesthesiologist should discuss the ways in which resuscitation can practically be limited in the OR and still permit reasonable anesthetic care to proceed.

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Postoperative Pain Control in the Elderly Patient

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Introduction:

Poorly controlled pain in the postoperative period can lead to slow recovery and life threatening complications. Meeting the needs of an elderly patient can be especially challenging. Elderly patients often have multi-system disease in conjunction with physiologic changes associated with aging. Not infrequently, mental impairment and polypharmacy render these patients susceptible to adverse effects of analgesic medications used in pain control.

Some of the problems encountered in caring for the elderly include:
1. Misconceptions - pain perception decreases with age elderly cannot tolerate opioids
2. Inadequate assessment - difficult in patients with cognitive impairment, dementia, aphasia
3. Lack of education - fear of addiction (patient, health care giver)
4. patient expects to have pain
5. patient unfamiliar/unwilling to use equipment, e.g., PCA
Ways to Optimize Pain Control:

ASSESSMENT
Frequent assessment, especially after interventions for pain control.

Questions: What is the level of pain?
How much relief from previous dose?
What activities? Able to deep breathe?
Any side effects?

Frail, debilitated patients and cognitively impaired patients benefit from frequent assessments. Enlist the help of a family member in order to try to “understand” the patient. It may be helpful to note the patient’s posture (rigid, not moving, etc.), facial expressions, verbal cues such as moaning. In a confused patient (who is previously not confused), rule out hypoxia, drug interaction, nighttime confusion and pain. A history of alcohol abuse warrants preventive measures against withdrawal.

EDUCATION
Educate the patient and the patient’s family on commonly held misconceptions such as addiction to opioids used in acute pain. Patients should be encouraged and instructed to use equipment, e.g., epidural or intravenous PCA.

What Are the Analgesic Options for Pain Control?

Pharmacologic options
In the elderly patient, changes in drug absorption, distribution, metabolism and elimination may affect the eventual plasma level and effect of a given analgesic drug. Drug absorption may be altered as a result of increased gastric pH and decreased gastric motility. Distribution of drugs may change due to a decrease in lean body mass or to a decrease in plasma proteins and albumin from chronic illness and poor nutrition. Hepatic blood flow, renal blood flow and glomerular filtration rate are decreased in the elderly. Consequently, hepatic drug metabolism may be
decreased, and elimination of drugs may change as renal and hepatic clearance decreases.

The oral route of analgesic drug administration is simple and cost-effective. Nonsteroidal anti-inflammatory agents and opioid analgesics are prescribed for patients who experience mild to moderate pain and can take oral medications postoperatively.

**Acetaminophen:**
- oral analgesic, antipyretic
- dose around the clock
- do not exceed total daily dose of 4 grams
- hepatotoxicity a concern
- opioid sparing

**NSAIDS:**
- use those with short half-lives (e.g., ibuprofen, ketoprofen, diclofenac - oral route)
- parenteral NSAID Ketorolac (use 15mg IV q6 hr, not to exceed 5 days)
- dose around the clock
- opioid sparing effect
- beware of gastrointestinal, renal and platelet effects

**NSAID Toxicity:**

**Gastrointestinal:**
- risk of bleeding with high dose, long duration, concurrent steroid use, prior ulcer
- least risk with ibuprofen, diclofenac
- intermediate risk with indomethacin, naproxen, piroxicam
- highest risk with ketoprofen, azapropazone
- nonacetylated salicylates well tolerated

Renal:
- avoid NSAID in patients with renal failure, insufficiency, CHF,
shock
• chronic progressive renal failure with long-term use, high dose

Platelets:
• NSAIDs inhibit platelet aggregation (reversible) nonacetylated salicylates less of an effect

Opioids:
• use those with short half-lives (morphine, hydromorphone, oxymorphone, oxycodone)
• do not use meperidine as first line opioid. Nor meperidine metabolite relies on renal elimination, accumulation is CNS toxic.
• avoid IM administration (painful, unpredictable absorption due to less muscle, more fat)
• side effects, decrease dose if adequate analgesia
• patient monitoring for sedation, respiratory depression
• use around-the-clock dosing
• start with low dose (25 percent to 50 percent of usual adult dose), titrate up slowly
• use adjuncts (acetaminophen or NSAID) for opioid-sparing effect
• patient monitoring for sedation, respiratory depression

Other routes of administration of analgesics include parenteral, epidural or intrathecal. Transderm opioid (fentanyl) is not easily titratable and is not appropriate (contraindicated in elderly) for use in acute postoperative pain. Local anesthetics are useful in wound infiltration, regional blocks (e.g., brachial plexus block) for prolonged postoperative analgesia, and in low concentrations in epidural analgesia.

Intramuscular injections are suboptimal; muscle wasting may be present in the elderly patient and may contribute to unpredictable levels of analgesic drug.

IV PCA Opioid Use:
• instruct patient on concept and use of machine
patient should be physically able to push the button

designate family member or nurse to activate button if patient unable

use basal rate with caution

Epidural Analgesia with Opioids:
- decrease dose of opioid, especially morphine sulphate
- decrease concomitant parenteral opioid administration
- patient monitoring for sedation, respiratory depression

Common Side Effects of Opioids:
- respiratory depression, sedation
- nausea, vomiting
- ileus
- pruritus
- urinary retention

Less Common Side Effects:
- confusion, psychosis
- dizziness, orthostatic hypotension

Nonpharmacologic options

These can be helpful to patients with anticipated prolonged postoperative recovery, a high level of anxiety or fear, who have to undergo treatments during their recovery (i.e., cancer patients) and who continue to have discomfort despite pharmacological interventions and wish to avoid adverse effects of increasing doses of analgesic drugs.

Physical agents include heat or cold, massage or exercise and transcutaneous electrical nerve stimulation (TENS). Cognitive-behavioral techniques include education/instruction, relaxation, imagery, music and biofeedback.
Conclusion:

The elderly patient often presents with multisystem disease and changes in drug metabolism and elimination leading to increased sensitivity to analgesic medications. Even so, it is possible to provide these patients with good pain control by selecting the analgesic modality and drugs best suited to each individual patient. Using careful titration of analgesic doses, and by assessing patients frequently for inadequate pain control and for adverse side effects, elderly patients need not be denied the benefits of modern technology in the management of acute pain.

Goals of optimized pain management in the postoperative period are to provide patient comfort and satisfaction, to restore function and to decrease perioperative morbidity, thereby decreasing hospital stay and health care costs.

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