



Physician Series

FREQUENTLY ASKED QUESTIONS

**About Anesthetic Considerations
for Elderly Patients**



American Society of
Anesthesiologists 

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American Society of Anesthesiologists
Committee on Geriatric Anesthesia

Sheila Ryan Barnett, M.D., Chair

Shamsuddin Akhtar, M.D.
Steven J. Barker, Ph.D., M.D.
Ruma Bose, M.D.
Angela Botts, M.D.
Ruth E. Burstrom, M.D.
Deborah J. Culley, M.D.
Christopher Jankowski, M.D.
Jacqueline Leung, M.D.
Michael C. Lewis, M.D.
Alec Rooke, M.D.
Raymond C. Roy, M.D., Ph.D.
Frederick E. Sieber, M.D.
Jeffrey H. Silverstein, M.D.
Zhongcong Xie, M.D., Ph.D.
Khwaja Zakriya, M.D.

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Recommended reading

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INTRODUCTION

The oldest segment of our population is rapidly expanding. This will lead to an inevitable shift in the mean age of patients cared for by most practicing anesthesiologists. The following booklet has been composed by the ASA Geriatric Committee to address some of the common geriatric questions facing the anesthesiologist on a daily basis. The booklet has been organized into sections, each one includes a few questions about the topics. This is not meant to replace any of the excellent texts or reviews available but instead to supplement the reading for ASA members.

DEMOGRAPHICS

How have the demographics in the US of the elderly population changed over the last 100 years?

The entire US population almost tripled during the 20th century and the geriatric segment of the population alone grew tenfold. Whereas only 4% of the population; less than 5 million individuals, was over 65 years old at the turn of the century, the number of people age 65 and older now constitutes 12% of the population. It is estimated that the number of elderly will double again by 2040. The oldest old, those greater than 85 years of age, represent the fastest growing segment of the population. Although octogenarians account for only 12% of all elderly now; they are predicted to constitute almost 20% of the elderly population by 2040. The number of centenarians is increasing even faster - from only 57,000 in 1996 to a predicted 447,000 persons by 2040.

Thus, not only is the absolute number of older Americans increasing but the overall US population is also becoming older with proportionally fewer individuals under 65 years of age.

What impact has the change in elderly demographics had on perioperative services?

The growth in the geriatric population impacts perioperative services through an increase in the number of surgical procedures and utilization of perioperative services. Patients over age 65 years represent approximately 12% of the population but account for 33% of health care costs, 38% of hospital bed stays, and 21% of inpatient surgical procedures. Forty percent of Medicare inpatients suffer a minor or major medical, surgical, or anesthesia-related complications during hospitalization for non-cardiac surgery; 8% experience a “failure to rescue” event; and 4% die in the perioperative period.

What percentage of the surgical patient base will be made up of elderly patients over the next 20 years?

The expected growth of surgical procedures performed in older Americans in future years will not be uniform across surgical specialties. Those specialties in which elderly patients are already well represented are projected to have greater increases in workloads. The estimated surgical work load for the elderly strongly parallels the number of procedures performed by each specialty currently. Ophthalmology has the largest forecasted increase - 15% by 2010, and 47% by 2020. These projections reflect that older patients are the predominant consumers of cataract surgery which make up 55% of the overall procedure-based workload of ophthalmologists. The incidence of cataracts in individuals 65 years or older is over 8 times the incidence in patients 45 to 64 years of age, thus the projected increase in numbers are not surprising.

Currently 70% of cardiothoracic surgery procedure-based work is derived from patients 65 years old or older. In the absence of a paradigm shift in indications, funding mechanisms for heart surgery and no change in what can be accomplished by interventional cardiologists, the growth in surgical work over the next 20 years for cardiothoracic surgeons could be as high as 42%. Similarly, the profile of age-specific use of neurosurgical procedures is estimated to grow by 15% by 2010 and 28% by 2020.

How do demographic changes in the elderly population affect the health care budgets?

As the number of geriatric Americans increase and the US population becomes older, there will be proportionally fewer individuals under 65 years to fund the retirement and health care of those older than 65 years. At the same time the aging of the baby boomers is increasing the cost of health care dramatically. This perfect storm is likely to force a revamping of how health care is funded in the United States in the very near future.

Table 1.

	Early 1980's	2005
U.S. Population	231.7 million	281.4 million
Americans over 65	25.6 million	34.7 million
Life Expectancy of Americans	74.5 years	77.4.years* (*2002)
Americans 85 or Older	2.2 million	9.2 million
National Health Expenditures	247 billion	\$1,542 billion

PREOPERATIVE ASSESSMENT

Does age in itself increase the risk of anesthesia?

Advanced age is a consistent risk factor for increased morbidity and mortality after anesthesia, however this is most likely due to coexisting diseases. There is no evidence that age by itself increases perioperative risk in the absence of co-morbid conditions. The incidence of chronic disease increases steadily with advancing age and it is the severity of acquired chronic disease that is the primary contributor to the risk of anesthesia and elective surgery in the older surgical patient.

Technically the ASA status, an assessment of the severity of preoperative co-morbid illnesses, does not include age as a criterion. However some anesthesiologists routinely assign an ASA II classification to otherwise healthy patients over 65 years old. This practice should probably be re-examined, since as stated, age by itself does not necessarily increase perioperative risk.

What are some of the common complications which should be discussed with older patients?

Postoperative complications depend on the type of surgery and the preoperative co-morbidities. Overall complications occur more frequently in the elderly because older patients are more likely to have co-morbid conditions than their younger counterparts. The most frequently occurring postoperative complications in older patients involve the heart, brain, lungs and the kidneys. Avoiding complications is important, as the occurrence of a complication postoperatively, has been shown to be associated with increased morbidity and mortality.

The likelihood of a complication will depend most on the patient's underlying functional reserve and co-morbidities. Both age and co-morbid disease contribute to the loss of functional reserve of all organs and most importantly, the heart, lungs, brain, and kidneys. Decreased functional organ reserve diminishes the ability of older patients to restore homeostasis that is distorted by the physiologic changes caused by disease, surgery, and anesthesia and increases perioperative risk. For the older patient a discussion regarding potential complications should include what might be expected for any adult for example in the patient with underlying cardiac or pulmonary disease and so on. In the older patient however, the risk of cognitive issues post surgery are more significant. These may manifest as delirium or the more subtle changes of post operative cognitive dysfunction, both discussed in greater detail below.

What questions pertinent to the elderly should be asked during a preoperative interview?

The preoperative interview provides the opportunity to assess organ reserve capacity by evaluating the mental and physical status of the patient. Diseases involving the cardiovascular, pulmonary, renal, and central nervous system occur with increasing frequency in the elderly and the symptoms may be atypical.

During the preoperative interview questions should be focused on assessing the functional state of the older patient, this may provide an estimate of the patient's reserve and ability to tolerate a significant surgery. Simple questions about how far the patient can walk, and what are their daily activities may reveal significant limitations that otherwise may not have been apparent.

In contrast to most younger patients, cognitive impairment is more likely to be present in older patients, reflecting the increasing incidence of dementia and central neurologic disease found in the geriatric age group. Cognitive impairment increases the risk of developing postoperative cognitive dysfunction and delirium following surgery. Thus a simple test of the patient mental status can be very valuable to establish a baseline. A mini-mental state exam which evaluates consciousness, perception, cognition, and memory may be useful to determine the degree of pre-existent cognitive impairment. Preexisting depression, low education level, prior history of stroke, alcohol abuse, are additional factors that may contribute to post operative cognitive dysfunction (POCD) and delirium.

Since a history of congestive heart failure is a major predictor for perioperative cardiac morbidities, excluding symptoms of heart failure (such as pedal edema, rales, or S3 gallop) are critical during preoperative evaluation. If present, questions should be raised as to whether the patient has been optimized prior to the elective surgery. Specialized tests such as the level of plasma B-type natriuretic peptide may be helpful but are not routinely available in patients with compensated heart failure. Abnormalities on preoperative chest X-ray such as cardiomegaly, and abnormalities on electrocardiogram such as left atrial enlargement, left ventricular hypertrophy, Q waves provide additional baseline information of the patient, but have limited value in predicting perioperative cardiac risk.

Polypharmacy is a common occurrence in the elderly and a detailed history of all medications, including over the counter medications and herbal remedies, should be obtained. Herbal medications may have interactions with anesthetic agents and can lead to unexpected side effects, including bleeding.

Are there recommended preoperative tests for elderly by virtue of age?

There are no preoperative tests that are absolutely required based solely on the age of a patient. An 80-year-old man who steps in a pothole at the beginning of a ten kilometer race is unlikely to require any preoperative laboratory tests prior to an open reduction and internal fixation of his ankle fracture. Preoperative testing is indicated for three primary reasons in the elderly: 1) risk assessment and treatment planning, e.g., a stress echocardiogram to assess inducible ischemia or serum albumin in cachectic or bedridden patient; 2) provide baseline information, e.g., the ECG in a patient with coronary heart disease, hematocrit in patient scheduled to undergo a high blood loss procedure, or creatinine in patient who is to receive a radiographic dye injection; and 3) perioperative management decisions, such as rescheduling surgery for risk adjustment, for example waiting for elevated creatinine to recover after arteriography,

controlling severe hyperglycemia or diabetic ketoacidosis, or cardioversion if newly recognized fibrillation, performing a less extensive surgical procedure, or adjusting the anesthetic and analgesic approaches and intensity of perioperative care.

The typical older patient with several co-morbidities commonly requires an electrocardiogram, a basic electrolyte profile that includes sodium, potassium, chloride, bicarbonate, glucose, creatinine, and blood urea nitrogen, and a hematocrit. Chest radiographs are rarely obtained in the absence of positive findings in the history or on physical examination. Renal function can be compromised in the elderly due to co-morbidities and aging. Serum creatinine is the most commonly used laboratory test to evaluate renal function. However, a normal serum creatinine in the elderly does not exclude renal insufficiency. Total muscle mass generally decreases with advancing age, a decrease in production of creatinine and a lower than normal serum creatinine should be observed in healthier older patients.

Who determines if an older patient is capable of caring for him/herself after day surgery?

With an increasing number of surgical procedures being done as day procedures, it is important to determine if the older patient has a caregiver to assist them after surgery. Although anesthesiologists typically focus on assessing the functional status of the patient, other functional status assessments widely used in the geriatric community should be considered. These include whether the patient can independently perform Activities of Daily Living (ADL), and Instrumental Activities of Daily Living (IADL) without assistance. The five activities in ADL include eating, dressing, using the toilets, transferring and walking, and bathing. The seven activities in IADL include telephoning, shopping, using transportation, preparing meals, doing housework, taking medications, and managing finances. Since independence in performing IADL is dependent on the cognitive status, the older patients at risk for POCD likely will require assistance in self-help, and taking medications postoperatively.

What about Informed Consent in an Elderly Patient?

During the course of the preoperative evaluation it may become obvious that a patient may not be able to provide operative consent for a variety of reasons. In that case a health care proxy should be contacted.

Paternalism, when the physician makes decisions about the patient's health care even though the patient is capable of doing so himself, is commonly experienced by elderly patients and should be avoided. It is often difficult to determine during a short preoperative visit if the patient is mentally capable of making health care decisions on his own and does indeed understand all the risks and benefits of the anesthetic and surgical procedure. The patient's primary care physician may be able to provide more information regarding the baseline cognitive status and the patient's living situation. It is important for the anesthesia, medical, and surgery providers to communicate among themselves and establish a consensus approach in this setting.

Why is an older person's blood pressure so labile during anesthesia?

Aging leads to major changes in the cardiovascular system. The sympathetic nervous system activity tends to have a baseline increase with age, and reacts more dramatically to events that alter sympathetic activity, such as a painful stimulus. In consequence, changes in sympathetic tone due to varying depths of anesthesia and surgical stimulation create greater swings in systemic vascular resistance (and perhaps venous tone as well) that lead to hypertension when resistance is high (and blood return to the heart is enhanced by venoconstriction), or the reverse when sympathetic tone decreases. Blood pressure stability also depends on the efficacy of the baroreflex and maintenance of adequate cardiac filling. Although the vasoconstrictor component of the baroreflex remains basically intact, the magnitude of the heart rate response to the baroreflex decreases with age. Changes in contractility may also decrease due to the decrease in the response to beta receptor stimulation. Cardiac preload becomes problematic for two reasons. First, the veins stiffen with age, and therefore do not buffer changes in blood volume as effectively as in a young adult. Second, the myocardium stiffens with age, and requires a higher filling pressure to maintain an adequate end-diastolic volume. Modest changes in filling pressure may result in large changes in stroke volume. Coupled with the ineffective maintenance of preload by the veins, stroke volume may be prone to greater variation than seen in a young adult.

Is the marked hypotension or hypertension dangerous to the patient?

Within reason, probably not. There is little evidence that brief hypotension leads to complications such as myocardial ischemia, stroke or even transient cognitive dysfunction. Defining what is a reasonable blood pressure is not clear-cut, however. Some advocate maintaining blood pressure within 20% of the patient's normal baseline. Although such a strategy cannot be faulted, many would consider it too stringent and could lead to overtreatment. Another strategy is to keep blood pressure within the autoregulatory zone, usually defined as a mean pressure between 50 and 150 mmHg. If used, some caveats apply. First, the zone refers to pressure at the arterioles, where autoregulation occurs. Thus, patients with large artery atherosclerosis may have arteriolar pressure below what is measured by BP cuff or arterial line. Second, organs that are positioned above the point of BP measurement will be at a lower pressure by approximately 2 mmHg per inch of height. It is difficult to imagine any patient requiring a mean pressure much above 100 mmHg, so there is little reason to allow a patient to remain at the upper end of the autoregulatory zone. Lastly, because coronary perfusion occurs primarily during diastole it is important to maintain diastolic pressure above 60 mm Hg in patients with significant coronary heart disease.

If blood pressure aberrations need to be treated, should it be managed differently in older patients?

All blood pressure changes occur from a change in vascular resistance, heart rate, preload (end-diastolic volume), contractility, or a combination thereof. Treating hypotension with fluid administration, as is commonly done, is a rational strategy if the cause of the hypotension is primarily hypovolemia and/or venous pooling, both of which decrease cardiac preload. Given that blood pressure changes in the elderly appear to be more the result of changes in vascular resistance than preload, it makes sense to treat hypotension with an alpha-agonist and hypertension by deepening the anesthetic. Alpha-agonists have the added benefit of venoconstriction, thereby shifting blood from the peripheral veins back to the heart and supporting cardiac output. This strategy does not imply that overt hypovolemia should be ignored; volume administration will be a component of good anesthetic management. Nevertheless, volume administration is more problematic in the elderly, and is discussed below. As for heart rate, it should be remembered that patients with left ventricular hypertrophy have a relatively fixed stroke volume and cardiac output will be compromised if the heart rate decreases low enough. Coronary perfusion, which occurs primarily during diastole, will be compromised if the heart rate is too fast. Clearly, the appropriate range will vary among individuals depending on many factors including their overall level of fitness, but older patients are more likely to experience compromises in cardiac output with heart rates much below 60 beats per minute and more likely to experience myocardial ischemia with heart rates much above 80 beats per minute. Contractility should never require active support in an elderly patient with a healthy heart.

Why should one be more careful with fluid administration to an older patient?

Because of the venous stiffening with age, excess volume is not well tolerated and will lead to an exaggerated increase in central filling pressures; pressures that are relatively high to begin with in elderly patients due to myocardial stiffening and diastolic dysfunction. Indeed, with age, heart failure is increasingly due to diastolic dysfunction, not systolic dysfunction. Hypovolemia is also not well tolerated by older patients because of the need for high filling pressures to maintain cardiac filling. Thus, it is much more of a fine line between too much and too little volume than would be the case with young adults. How an older patient is managed during surgery may profoundly influence the postoperative course as well. Excessive fluid administration can lead to increased third space fluid accumulation intraoperatively and immediately postoperatively in such organs as the heart, which will decrease contractility, and the lungs, which decrease oxygenation. Eventually that fluid will mobilize – typically on post-op day two or three. That excess fluid may markedly increase the venous pressures in the stiff cardiovascular system and potentially lead to pulmonary congestion or even pulmonary edema. The fact that the elderly kidney will remove excess volume less effectively than in a young adult only exacerbates the situation. Thus, it is reasonable to give volume in the OR based on clear evidence of hypovolemia such as volume loss and not just as a reflex response to any decrease in blood pressure. A decrease in urine output is not as reliable an indicator for fluid administration in older patients as it is

in younger ones, especially in the presence of chronic medications such as diuretics. Finally the rate of fluid administration must be reduced in older patients with diastolic dysfunction to avoid flash pulmonary edema.

Should cardiovascular medications be held prior to surgery?

Without question, chronic beta-blocker therapy should be maintained. Angiotension receptor blockers (ARBs) and angiotensin converting enzyme inhibitors (ACEIs) are usually not administered the morning of surgery (and some withhold these medications night before) in hypertensive patients without congestive heart failure who are to receive general, spinal, or epidural anesthesia. But in patients with congestive heart failure it is reasonable to continue the ACEIs and ARBs and be prepared to treat hypotension during induction of anesthesia. Some anesthesiologists recommend holding diuretics the morning of surgery in the absence of congestive heart failure. This is reasonable, but sometimes the kidneys become dependent on the diuretic and urine output may be limited during surgery if the diuretic is not given even if the patient is well hydrated.

PHARMACOLOGY

By how much should drug dosages be reduced when caring for older patients?

In general, drug dosages should be reduced and the interval between dosing increased for elderly patients. The degree of reduction varies broadly with the class of drug. For induction agents, doses should be reduced by at least 20% (based on lean body mass). For propofol and etomidate, the reduction may be as much as 50%. Higher doses of propofol generally result in significant and potentially prolonged hypotension, and any repeat bolus doses should be delayed. In the case of etomidate, although unconsciousness is easily achieved with a lower dose, blockade of the sympathetic nervous system response to intubation may require adjunct medication such as a large dose of opioid or small boluses of propofol. Older patients' exhibit increased sensitivity to benzodiazepines and the dose of midazolam should be markedly reduced in the very old. The initial doses of opioids should be reduced by approximately 50%. However, postoperative analgesia especially in the initial period in the recovery room, may ultimately require almost as much opioid as in a young adult. Muscle relaxants and reversal agents are dosed similarly in young and old alike, although relaxant onset may be delayed in elderly patients.

Why change the dose in older patients?

Multiple mechanisms are responsible for greater peak drug effects in the elderly. Often times the initial volume of distribution is smaller for older patients and the rapidity of redistribution into non-target tissue is slowed, making the initial drug plasma concentration higher for a longer period of time (encourages greater transfer of drug into the target tissue). For many drugs, such as the benzodiazepines and

some opioids, the brain is actually more sensitive to the drug. Any drug whose effect must be terminated by metabolism (as opposed to redistribution) will invariably last longer in an older patient. The longer metabolic half-life can be attributed to slower metabolism by the liver and/or kidney, and an increased steady-state volume of distribution, both of which decrease drug clearance. With respect to inhalational agents, MAC decreases by approximately 6% per decade after age 40. Thus, MAC in an 80 year old would be roughly 25% lower than in a young adult.

What problems might be caused by the preoperative medications?

Fortunately, the days of scopolamine premedication are behind us, but scopolamine has reappeared in a patch for PONV. Scopolamine has strong anticholinergic properties that can lead to confusion and it is not recommended in elderly patients. Diphenhydramine (Benadryl) also has significant anti cholinergic side effects. Although popular as a pre-medication for radiologic studies involving contrast, it should be avoided in the older patient due to the risk of delirium and sedation.

Even a relatively short acting drug such as midazolam can cause problems with memory and cognition postoperatively, perhaps because the clinical half-life is approximately four hours in older patients. The elderly are often less anxious than young adults before surgery, so the routine use of anxiolytic premedications is discouraged.

Are there some drugs that should be avoided altogether in the elderly?

Yes, but only a few. Repeated or a large dose of meperidine should be avoided because of the CNS side effects of its metabolite normeperidine and anticholinergic properties. As mentioned above, anticholinergic drugs (including drugs with anticholinergic effects such as diphenhydramine and scopolamine) should be avoided because of the CNS effects and predisposition to delirium. One exception is glycopyrrolate, a quaternary amine that does not cross the blood brain barrier. Given the improved safety profile of the modern neuromuscular blocking agents, it is reasonable to avoid using pancuronium the long acting muscle relaxant. The older patient is more susceptible to the adverse consequences of residual neuromuscular blockade and this is most likely to occur with pancuronium.

Are there over the counter medications that elderly patients may take that may influence the administration of anesthesia?

Many older patients supplement their myriad of chronic prescription drugs with over the counter medications that even the primary care physician may not be aware. Drug-drug interactions such as synergistic side effects or inhibition of metabolism of one drug by another drug contribute to the high incidence of adverse drug reactions caused by polypharmacy in older patients. Chronic medications can also increase the risk of adverse perioperative complications. A prime example is the increased risk of delirium from any drug with anticholinergic effects, such as the diphenhydramine.

A few comments on herbal medicines. Ephedra/Ma Huang stimulates the cardiovascular system and may cause untoward vasoconstriction leading to stroke or myocardial infarction, in addition they deplete catecholamine stores and can lead to negative interactions with MAOIs. Yohimbe depletes catecholamine stores as well. Echinacea is associated with allergic reactions. Garlic, ginkgo and ginseng can increase bleeding from platelet inhibition and/or inhibition of coagulation. Kava may enhance the sedative effects of anesthetic drugs. St. John's wort may increase cytochrome P450A4 drug metabolism, affecting many IV anesthetic drugs and coumadin. Ginseng and Valerian may cause CNS stimulation. Most herbal medicines should be stopped before surgery, preferably for several days. Valerian is a possible exception because its sedative effect can lead to withdrawal symptoms on abrupt discontinuation. In short, herbal medicines containing active ingredients can cause problems, and the elderly are at particular risk.

POSTOPERATIVE COGNITIVE CHANGES

What is Postoperative Cognitive Dysfunction?

Postoperative cognitive dysfunction (POCD) describes a deterioration of cognition function after surgery and anesthesia. POCD is a developing concept characterized by persistent deterioration of mental performance. In contrast to classic delirium, or postoperative confusion, that is diagnosed clinically at the bedside, POCD is defined by neuropsychological cognitive tests. Definitions are still evolutionary with respect to which is the best diagnostic test, what is a significant amount of decline and when is the most appropriate time to administer tests postoperatively.

What are the risk factors of postoperative cognitive dysfunction?

This is an active area of ongoing research and a major concern for the future. Some population studies have shown that the risk factors for early POCD include: advancing age, longer duration of operation, limited formal education; second operation, postoperative infections, respiratory complications, cardiopulmonary bypass, on-pump cardiac surgery, major surgery, severe illness, orthopedic surgery, acute postoperative pain, and preoperative cognitive impairment. It is important to note that age is the strongest predictor of POCD 3 months postoperatively.

What is postoperative delirium?

Postoperative delirium is an acute mental state characterized by transient and fluctuating disturbance of consciousness and cognitive dysfunction after anesthesia and surgery. Although delirium can last beyond the acute hospitalization, it is transient and fluctuating in contrast to POCD that is characterized by a relatively persistent change in cognitive functioning.

Delirium in the postoperative period can be divided into emergence delirium and postoperative delirium, based on the time of onset. Emergence delirium is seen during or immediately after emergence from general anesthesia and usually resolves within

minutes or hours. Postoperative delirium tends to occur between postoperative day 1 and 3, and usually resolves within hours to days, although symptoms may fluctuate and persist for weeks to months. Delirium commonly occurs in hospitalized elderly patients postoperatively and frequently manifests as agitation, the classic ‘sundowning’ patient. However patients with hypoactive delirium may be very withdrawn and the delirium may not be as readily recognized. All elderly patients with delirium are at increased risk of increased morbidity, length of hospital stay, transfer to nursing faculties instead of home and mortality. (see below)

What are the risk factors of postoperative delirium?

The risk factors for postoperative delirium are numerous and include advanced age, preoperative cognitive impairment, tobacco use, depression, abnormal serum levels of sodium, potassium, and glucose, preoperative albumin level ≤ 4.0 g/dl, preoperative serum urea nitrogen:creatinine ratio of 18 or greater, intraoperative blood loss, vascular surgery, multiple blood transfusions, surgery for hip fracture, and cardiopulmonary bypass.

Can anesthetics cause postoperative cognitive dysfunction and postoperative delirium?

There have been studies suggesting that some anesthetics may cause neurotoxicity and learning/memory deficits in animals. However, to date, clinical studies comparing regional and general anesthesia have not shown a difference in the incidence of POCD or delirium. This suggests that general anesthesia may not cause clinically significant postoperative central nervous system dysfunction or that drugs used for sedation offset any brain-sparing effects of the regional anesthetic. There is insufficient evidence on the exact etiology of delirium and POCD at this point, and future research is needed.

What are the sequelae of delirium and POCD?

Delirium is associated with increased morbidity (including risk of injury), mortality, duration of hospital stay, nursing home placement, consultant and nursing costs. Long-term POCD correlates significantly with decreasing activity of daily living.

FLUIDS MANAGEMENT AND TRAUMA

Do elderly trauma patients have the same morbidity/mortality as younger patients?

Elderly patients have increased mortality compared to younger patients in all categories – immediate (at the scene), early (24 – 48 hours after trauma) and delayed (48 – 72 hours). Aggressive resuscitation, extensive radiographic diagnostic imaging, and early intensive monitoring or operative intervention can help reduce early mortality rates in elderly trauma patients. It is critical to prevent delayed complications of trauma including cardiovascular compromise, pneumonia, sepsis and

multi-system organ failure. In hospital complication rates for elderly trauma patients are 33%, compared to 19% in younger patients.

Several authors recommend using TEE (transesophageal echocardiography) or PACs (pulmonary artery catheters) to guide treatment in elderly trauma patients with hypotension, Injury Severity Score (ISS) >15, or with uncertain cardiovascular and/or fluid status.

Are crystalloids indicated in resuscitation of elderly trauma patients?

Although significant controversy exists, there are no studies that support the superiority of crystalloids over colloids. When considering appropriate fluid management a primary concern is the assessment of the patient's volume status. Determination of volume status is complicated in the elderly patient by the frequent occurrence of multiple co-morbidities and medications, which are often unknown in trauma victims. Beta-blockers, calcium channel blockers, and opioids slow the heart rate and over-ride the tachycardic response to hypotension while inhaled agents blunt the baroreceptor response to hypotension. It is therefore important to determine if shock is present and differentiate the type of shock. How a given practitioner determines where the patient is on the Starling curve and what the appropriate treatment should be is best left to the judgment of the individual practitioner.

On a practical basis, one can provide a crystalloid or colloid challenge and then monitor its effect on the respiratory variability of the arterial wave form, urine output, acid-base status, lactate levels, CVP, pulmonary artery pressures, cardiac output, mixed venous oxygen saturation, or echocardiographic measures.

What is an acceptable transfusion threshold for elderly trauma patients?

Many elderly patients have chronic anemia and may present with low hemoglobin. There have been no large randomized controlled trials in elderly patients that demonstrate a benefit of a particular transfusion threshold. Though erythropoiesis is affected after trauma, red blood cell (RBC) transfusion therapy has not always been associated with improved outcomes and may even cause harm. Thus, current guidelines based on recent meta-analyses are all that is available to guide RBC transfusion. In general, elderly patients with hemoglobin value of 7 g/dl should be considered for RBC transfusion. There is no proven value in transfusing to beyond 10 g/dL even in patients with ischemic heart disease. Between a hemoglobin of 7 and 10 g/dL the need for transfusion should be individualized based on a variety of clinical variables including evidence of organ ischemia, potential or ongoing bleeding and patient's intravascular volume status.

How is fluid and electrolyte homeostasis affected by aging?

Fluid and electrolyte homeostasis is closely linked to renal function and body composition, and both change with aging. Kidneys atrophy with age and cortical thickness decreases by 10% per decade after the age of 30. Renal plasma flow also decreases. There is progressive loss of renal function and by some estimates the

estimated GFR (glomerular filtration rate) decreases by 1 ml/year after the age of 50. However, there is significant variability and a third of elderly patients do not show any changes in GFR. Though serum electrolytes and extra-cellular fluid volume are not affected by aging, homeostatic mechanisms to conserve electrolytes and water are impacted by the aging process. The ability to dilute and concentrate urine in response to water loading (intravenous fluids) or water restriction (NPO status) is limited. Elderly patients are not able to excrete or conserve sodium as effectively as younger individuals and have a higher threshold to develop thirst compared to young patients. This may predispose geriatric ambulatory patients to hypernatremia due to inadequate hydration if they are not prompted to drink adequate fluids postoperatively. Conversely, dilutional hyponatremia can develop insidiously and present as confusion, anorexia, lethargy, nausea or weakness.

Clinically, in conjunction with changes in cardiovascular system, older patients are predisposed to heart failure, volume overload and pulmonary edema with volume loading and to hypotension with mild dehydration. Elderly patients also have decreased ability to excrete acid and the response to metabolic acidosis may be muted. In view of decreased renin and aldosterone levels and decreased renal function, elderly patients are also prone to hyperkalemia, which may be exacerbated by potassium loading events such as gastrointestinal bleeding, blood transfusion and exogenous potassium administration.

REGIONAL AND GENERAL ANESTHETICS

Is regional superior to general anesthesia regarding post operative care of the elderly for pain control, early ambulation, or risk of DVT?

Regional anesthesia with epidural or peripheral nerve block (single shot or continuous catheter infusions) with local anesthetics provide excellent analgesia, good functional outcome, reduced length of hospitalization and improved patient satisfaction. Although not specific to the elderly, evidence suggests that regional anesthesia and postoperative analgesia improves postoperative functional outcome and achieves rehabilitation goals earlier when compared with general anesthesia followed by intravenous patient controlled analgesia with opioids.

In addition to analgesia, antithrombotic effects of regional anesthesia may be beneficial. It is well established that a hypercoagulable state occurs following anesthesia and surgery and the risk of venous thromboembolism following major orthopedic surgery in elderly patients in particular is substantial. Incidence of deep venous thrombosis is reported as 45-57% following total hip arthroplasty, 40-84% following total knee arthroplasty and 36-60% following hip fracture repair in clinical trials where patients received no postoperative anticoagulant. The risk of fatal pulmonary embolism following hip fracture repair may be as high as 7.5%. Several studies demonstrate that neuraxial anesthesia reduces the incidence of thromboembolic complications, the exact mechanism remains unclear.

Does a combined general and neuraxial technique vs. general alone in thoracic or upper abdominal cases result in decreased risk for pneumonia, atelectasis, and a better respiratory function post operatively?

There is a decreased incidence of atelectasis and pulmonary infections, and earlier extubation in patients receiving post operative analgesia via continuous neuraxial block as compared to patients receiving postoperative analgesia with intravenous patient controlled anesthesia.

Are peripheral nerve blocks in geriatric patients associated with less hemodynamic changes during the perioperative period in orthopedic procedures? Can peripheral nerve blocks be used safely in elderly patients with severe cardiac conditions?

There are definitive advantages to using peripheral nerve block techniques in the geriatric population during orthopedic procedures. These include anesthetizing a single extremity such that the hemodynamic changes are minimized. Peripheral nerve blocks may include either single shot or continuous catheter infusion techniques such that the length of surgery is a mute issue. Patients with severe cardiac disease on anticoagulants can often undergo nerve blocks in circumstances when one can not administer an epidural or spinal anesthetic.

It is unclear whether regional anesthesia is associated with better cardiac outcomes in comparison to general anesthesia. Evidence is scant comparing cardiac outcomes between peripheral nerve blocks and general anesthesia or other regional techniques.

SEDATION

Are there particular drug regimens that are better tolerated in the elderly patient?

In general when sedating older frail patients it is best to limit the number of medications – to avoid polypharmacy - and to reduce the initial dose and extend the interval between repeat doses.

The most popular drugs are propofol, midazolam and fentanyl; there is less literature on dexmetomidine, ketamine, or remifentanyl. There is no single regimen that can be recommended for ‘the elderly’; the choice will depend on the case and the requirements e.g. does the patient need to be absolutely still, what is the anticipated length and the patient and their co-morbidities. In a sedation case communication is important and the options for sedation may be limited in the demented or deaf patient.

Propofol is the most popular agent for sedation, however its administration can be associated with significant hypotension, especially if the older patient is dehydrated. To reduce the hypotension initial bolus doses should be either reduced or avoided. A continuous propofol infusion may result in more stable hemodynamics compared to multiple boluses. If boluses are needed the interval between the doses should be extended to allow for the full hemodynamic impact of the dose to manifest. Older patients in general are more sensitive to narcotic induced apnea and the older, frail patients may

develop significant hypercarbia with repeated doses. Fentanyl and remifentanyl doses should be reduced by at least 50%. The short action of remifentanyl offers significant advantages, but the administration can be associated with bradycardia that may limit its use in geriatric patients that are beta blocked or have significant AV node dysfunction.

Ketamine in low doses is well tolerated by the elderly patient and avoids the risk of respiratory depression. It may result in hypertension and the addition of labetalol or other antihypertensive agent can be needed.

Midazolam is the most popular perioperative benzodiazepine, older patients exhibit increased sensitivity to its effects and the initial dose should be reduced by 50%. Long acting benzodiazepines such as lorazepam and diazepam and their metabolites may accumulate in the older patient resulting in significant sedation and delirium. In general they should be avoided. Meperidine is not recommended in patients over the age of 65 years as it has been associated with delirium and seizures. However the low dose used to treat shivering in the PACU is acceptable.

What monitors are needed for a sedation case?

Standard monitors; ECG, pulse oximetry, and BP are required for any monitored anesthesia case. In the older patients it is also useful to monitor ventilation –respiratory rate or ET CO₂; as significant hypercarbia can occur before desaturation becomes evident. It should be assumed that any sedative case in an older patient could unintentionally become a general anesthetic if the patient is particularly sensitive to the drug or drug combination that is administered.

ACUTE POSTOPERATIVE PAIN

Do older patients need less analgesic medication postoperatively?

Although lower doses of analgesics are recommended in general for older frail patients, it is important to recognize that acutely they do not appear to have less pain than younger patients. Frequent pain assessment and titration of analgesics as needed for optimal pain control is essential. In studies concentrating on the initial recovery phase the older patient needed an equal amount of morphine for pain, but the subsequent maintenance dose was lower.

In general post operative analgesic medications should be adjusted for geriatric patients to allow for the effects of aging on pharmacokinetics and pharmacodynamic sensitivity to opioids. Drug distribution is altered with normal aging due to a decrease in total body water and increase in adipose tissue. These changes result in a smaller volume of distribution and increased plasma concentration of water-soluble drugs such as morphine. In contrast, there is an increased volume of distribution with possible delay in the onset of action and accumulation of more lipid soluble drugs such as fentanyl. Phase I metabolism through the liver is also impacted by normal aging secondary to decreased enzymatic activity and number of hepatocytes. This may result in an increased half-life for several drugs including morphine.

Perhaps most importantly, excretion is significantly impacted by aging secondary to a decrease in the number and size of nephrons; overall kidney mass; renal blood flow; glomerular filtration rate; and active renal tubular secretion. Creatinine clearance may decrease up to 40% by age 80 and analgesic doses should be adjusted accordingly. Secondary to these changes in distribution, metabolism, and clearance in elders, it is recommended to “Start low, go slow” when initiating an analgesic regimen. Initially, short acting opioids should be utilized to minimize the risk of accumulation. After a stable analgesic regimen is determined, medications can be converted to long acting formulations for ease of administration.

Aside from regional anesthesia, what are some suggestions for opioid sparing in the elderly?

Opioid analgesics are associated with adverse effects including respiratory depression, nausea and vomiting, constipation, and delirium. Fortunately there are several effective opioid sparing medications that should be considered in postoperative elders.

The World Health Organization (WHO) analgesic ladder, provides a step wise approach to pain treatment, and recommends non-opioid analgesics as the first step in pain management. Scheduled acetaminophen is the first line, non-opioid analgesic of choice for elders. In the postoperative setting, it has been associated with reduced opioid requirements and improved pain scores. Doses of 650 to 1000 mg orally or per rectum every six hours are recommended unless contraindicated due to hepatic dysfunction. In geriatric patients, non steroidal anti-inflammatory drugs (NSAIDS) are relatively contraindicated due to a two fold increased risk of gastrointestinal bleeding and association with acute renal dysfunction. Indomethacin is also associated with delirium. Preemptive premedication with gabapentin is another important option for opioid sparing in geriatric patients. Single preoperative doses of gabapentin ranging from 300 to 1200 mg have been found to reduce pain intensity and opioid use for 24 hours postoperatively. There was also a reduced incidence of nausea and vomiting, constipation, and urinary retention. Of note, gabapentin is renally cleared so the dose should be adjusted in elders with renal dysfunction. Further study will be needed to determine the optimal dosage for preemptive premedication in the elderly.

How can one assess pain in the demented elderly patient?

Accurate pain assessment in older patients with dementia is vital. Dementia currently affects 1 in 5 patients over 80 years and it is projected that there will be 13 million elders with Alzheimer’s disease by 2050. Pain among this population has traditionally been poorly assessed and undertreated. When assessing pain in elders with dementia, the patient is always the best source of information despite cognitive impairment. Patients with mild cognitive impairment and early dementia are usually able to utilize a traditional unidimensional pain assessment scale such as the visual analogue scale, numerical rating scale, verbal rating scale, or faces pain

rating scale. In general, they do best with verbal descriptors of pain (i.e. verbal rating scale) or visual scales (i.e. visual analogue scale and face pain rating scale). It may be necessary to present multiple scales or ask about pain using a variety of terms to ensure accurate assessment.

Pain assessment in nonverbal elders with advanced dementia is particularly challenging. Health care provider proxy reports have been utilized to assess pain in this population but tend to underestimate pain. Studies have found that physicians identified pain in 43% of communicative elders but only in 17% of nonverbal elders. Observational assessment methods are preferable and the Pain Assessment in Advanced Dementia (PAINAD) is a brief, easy-to-administer assessment designed for use in nonverbal elders with advanced dementia. The PAINAD includes assessment of breathing, negative vocalization, facial expression, body language, and consolability to determine an overall pain score ranging from 0 to 10. This tool is sufficiently sensitive to detect changes in pain over time and is appropriate for use during the postoperative period.

What are some of the consequences for the elderly patient with poor pain control?

Optimal postoperative pain control for geriatric patients is particularly important given that patients over age 65 now account for 35% of all surgeries in the United States. Inadequate pain management in this population can hinder recovery and lead to significant complications. Some of the unwanted consequences of poor pain control include direct suffering, decreased physical function, decreased socialization, depression, sleep disturbances, increased health utilization costs, increased postoperative pulmonary and cardiac morbidity, and increased length of hospitalization. Decreased physical functioning is of particular concern in elderly patients postoperatively as this can dramatically impact their ability to participate with rehabilitation and return to their preoperative level of function.

Aggressive treatment of predictable breakthrough pain, such as occurs with physical therapy and wound care, should be pursued using a low dose, short acting opioid analgesic dosed 30 to 45 minutes prior to the activity. Under treated pain is an important – and potentially modifiable - risk factor for delirium. As discussed in an earlier question, delirium affects 13 to 61% of elders undergoing elective surgery. In postoperative elders, low doses (<10 mg of morphine sulfate equivalents per day) or no opioid analgesics are associated with an increased risk of delirium. This can lead to significant associated adverse outcomes including hospital mortality rates of 22 to 76%, increased length of hospitalization, increased institutionalization following discharge, and increased re-hospitalization within 30 days.

TABLE 1

GUIDELINES FOR TREATING GERIATRIC 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 > 65 y have on average 3.5 medical diseases)
5. Diminished organ reserve can be unpredictable - limitations may only become apparent during severe stress
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 - which in elderly patients can rapidly escalate into major adverse events
8. Impact of extrinsic factors - smoking, environment, socioeconomic - is difficult to quantify

TABLE 2

THE AIRWAY

Establishment of an airway can be difficult in the elderly patients. The factors that can increase the airway difficulty include:

- Decreased cervical neck extension, and increased vertebrobasilar insufficiency with extension
- Reduced mouth opening
- Difficult mask fit in edentulous patients
- Cardiac effects during laryngoscopy may be less well tolerated
- Probable exaggerated increase in norepinephrine in response to intubation
- Loss of protective reflexes (increased passive aspiration)
- Presence of end-stage diseases such as rheumatoid arthritis

TABLE 3

NEURAXIAL BLOCKS

a. Spinals

- May be more difficult to place secondary to arthritis and calcification of ligaments
- Paramedian approach may be more useful than midline
- More rapid onset and higher spread with most local anesthetics
- More dramatic decreases in blood pressure
- Reduce dose of local anesthetics
- Increased risk delayed apnea with intrathecal narcotics

b. Epidurals

- Osteoarthritic changes of the vertebra occur with narrowing of the intervertebral foramina, changes may result in greater local anesthetic spread within the epidural space
- Reduce the dosage for a given level, and anticipate a less predictable response
- Initial epidural dose may be reduced only minimally, however due to the reduction in clearance of amides subsequent doses need to be reduced and spaced
- Postoperative spinal headaches after dural puncture are less common in elderly patients - 5% vs. 15% in young patients

TABLE 4

PHARMACOTHERAPY

- Water soluble drugs: higher initial bolus plasma concentrations
- Lipophilic drugs: prolonged half life secondary increase in adipose
- Kinetics: reduced excretion and clearance
- Dynamics: increased target organ sensitivity eg benzodiazepines and opioids
- Decreased MAC of inhalational agents

TABLE 5
DRUG DOSING FOR THE ELDERLY

DRUG CLASS	Dose Adjustment	Comments
Induction Agents <ul style="list-style-type: none"> • Propofol • Thiopental • Etomidate 	20-60% reduction, dose on lean body mass	Thiopental requires only about a 20% reduction; propofol more so (only 1 mg/kg for the very old). Primary cause for reduction is from a decreased initial volume of distribution and slowed redistribution, although increased brain sensitivity may be present with propofol.
Benzodiazepines <ul style="list-style-type: none"> • Midazolam • Diazepam 	After age 60, dose reduction progresses rapidly to 75% reduction by age 90	↑↑ brain sensitivity seems to be main reason to reduce dose. Midazolam metabolic half-life roughly doubles with age, but diazepam half-life is markedly prolonged.
Narcotics* <ul style="list-style-type: none"> • Morphine • Fentanyl • Alfentanil • Sufentanil • Remifentanil 	50% reduction. (hydromorphone and methadone not studied, but assume 50% reduction).	↑↑ brain sensitivity seems to be main reason to reduce dose. With morphine, remember time to peak effect is long, and the long-acting active metabolite morphine-6- β -glucuronide becomes important with large doses.
Muscle relaxants <ul style="list-style-type: none"> • Vecuronium • Mivacurium • Cisatracurium • Rocuronium • Pancuronium 	Slightly slower onset of action.	Metabolism not greatly prolonged except for vecuronium and pancuronium.

*Do not use meperidine in the elderly except in small doses for the treatment of shivering.

