Section Editor: **Peter S. A. Glass**

REVIEW ARTICLE

CME

Perioperative Care for the Older Outpatient Undergoing Ambulatory Surgery

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As the number of ambulatory surgery procedures continues to grow in an aging global society, the implementation of evidence-based perioperative care programs for the elderly will assume increased importance. Given the recent advances in anesthesia, surgery, and monitoring technology, the ambulatory setting offers potential advantages for elderly patients undergoing elective surgery. In this review article we summarize the physiologic and pharmacologic effects of aging and their influence on anesthetic drugs, the important considerations in the preoperative evaluation of elderly outpatients with coexisting diseases, the advantages and disadvantages of different anesthetic techniques on a procedural-specific basis, and offer recommendations regarding the management of common postoperative side effects (including delirium and cognitive dysfunction, fatigue, dizziness, pain, and gastrointestinal dysfunction) after ambulatory surgery. We conclude with a discussion of future challenges related to the growth of ambulatory surgery practice in this segment of our surgical population. When information specifically for the elderly population was not available in the peer-reviewed literature, we drew from relevant information in other ambulatory surgery populations. (Anesth Analg 2012;114:1190–1215)

Global population aging is a result of the parallel decline in mortality and fertility rates.[1] Public health initiatives have also directly contributed to population aging. While the United States (US) population <65 years of age is increasing by 1% per year, the population from ages 65 to 79 years is increasing by >2% per year, and the population 80 years or older is increasing by 3% per year.[2] The number of "elderly" persons (>65 years) has tripled over the last 50 years and will more than triple again over the next 50 years (Fig. 1). On a global level, the most rapidly growing age group is that aged 80 years and over (i.e., "oldest-old" or geriatric).

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Accepted for publication January 6, 2012.

Funding: White Mountain Institute.

The authors declare no conflict of interest.

Reprints will not be available from the authors.

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DOI: 10.1213/ANE.0b013e31824f19b8

According to the US Census Bureau, the older population (i.e., individuals >65 years of age) numbered 39.6 million in 2009, or 12.9% of the population. By 2030, there will be approximately 72 million older persons, representing 19% of the US population.[3] The US National Hospital Discharge Survey reported in 1999 that the 12% of US citizens ages 65 years or older constituted 40% of all hospital discharges and 48% of inpatient care days.[3] Thus, the number of surgical and other procedures performed on the elderly has increased dramatically in absolute terms, per hospital discharge, and per capita.

Of the 70+ million operations and diagnostic procedures performed annually in the US, >30% occur at freestanding ambulatory surgical centers not attached to a hospital or emergency department. In these facilities, patients are expected to go home the day of surgery.[4] The most common ambulatory surgery procedures on patients >65 years of age are listed in Table 1.

THE RATIONALE FOR AMBULATORY SURGERY IN THE ELDERLY

It is important to consider the potential benefits for this patient population beyond the expected monetary savings to the health care system and reduced risk of nosocomial infections.[5] Because it is widely acknowledged that older patients are less able to adapt to unfamiliar environments, allowing elderly patients the opportunity to recover in the comfort of their familiar "home" environment with minimal disruption to their daily routine may actually facilitate the healing process and reduce postoperative discomfort. A study by Canet et al.[6] suggested that the avoidance of

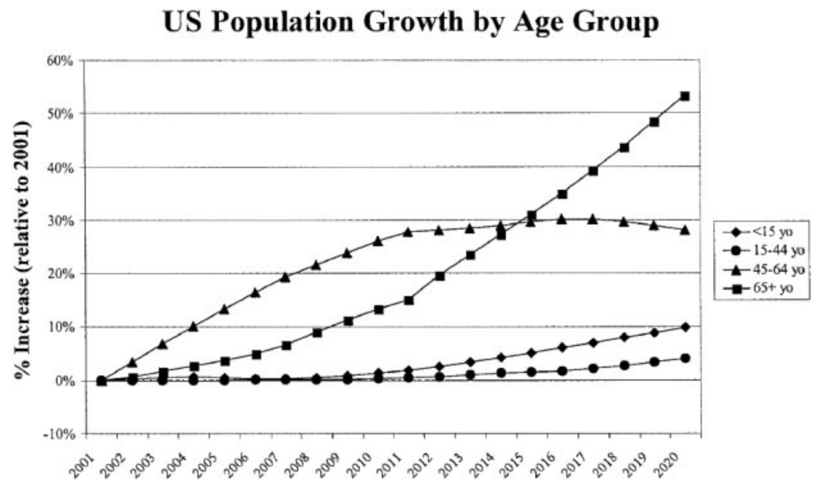

Figure 1. Actual and projected percentage increase in the United States population by age group, 2001 through 2020 (from Etzioni et al.,[337] reproduced with permission).

Table 1. Top 10 Ambulatory Surgery Procedures in Patients Older than 65 Years

	Number of surgical procedures in thousands (Medicare's percentage)
Inguinal and femoral hernia repair	38 (23)
Therapeutic procedures on muscles and tendons	44 (19)
Therapeutic procedures on joints	19 (13)
Cholecystectomy and common duct exploration	21 (16)
Excision of semilunar cartilage of knee	23 (15)
Lumpectomy, quadrantectomy of breast	33 (23)
Lens and cataract procedures	342 (75)
Decompression of the peripheral nerve (e.g., carpal tunnel release)	27 (24)
Partial excision of the bone (e.g., bunionectomy)	15 (17)
Transurethral excision, drainage, or removal of a urinary obstruction	33 (40)

From U.S. Department of Health & Human Services, Agency for Healthcare Research & Quality (2003).

hospitalization in elderly patients undergoing minor surgery resulted in less cognitive dysfunction in the first postoperative week because of the less stressful conditions associated with the ambulatory (vs. hospital) surgery setting. A study by Castells et al.[7] compared clinical and perceived health outcomes (and cost) between ambulatory and inpatient cataract surgery in the elderly. Although the "expected" economic benefits were noted in the ambulatory surgery group, no statistically significant differences were observed between the 2 groups with respect to visual acuity or other clinical and health outcome measures. However, outpatients more frequently reported at least 1 complication in the first 24 hours after surgery than did inpatients (64% vs. 43%). Importantly, there were no differences in complication rates between the 2 groups at later follow-up intervals. These investigators concluded that ambulatory cataract surgery was more cost effective despite the higher risk of early complications in the outpatient group.

In addition to the aforementioned cost savings in comparison with hospital-based care and elimination of the need to adapt to an unfamiliar inpatient routine, other benefits of ambulatory surgery for the elderly surgical population include a reduction in respiratory and intubation-related events and the relative reduction of postoperative complications (e.g., pain, postoperative nausea and vomiting [PONV], nosocomial infection).[6] A lower incidence of adverse events in the postanesthesia care unit (PACU) could result in a shorter PACU stay and fewer unanticipated hospital admissions after ambulatory surgery.

PHYSIOLOGIC AND PHARMACOLOGIC EFFECTS OF AGING

Even in the absence of any discernible disease, the aging process results in a progressive functional decline in all major organ systems. Table 2 summarizes how these physiologic changes affect both the pharmacokinetics and pharmacodynamics of commonly used anesthetic and analgesic drugs.[8] Organ function peaks in the fourth decade of life, and the functional reserve (the difference between basal and maximal organ function) is well maintained in most individuals until age 60 years.[9] However, after age 60, individuals exhibit a wide variation in their functional reserve, as is seen in Figure 2. As part of the preoperative assessment of older patients, it is useful to determine whether a patient is physiologically "young" (i.e., exhibiting only changes associated with normal aging) or "old" (i.e., exhibiting aging effects due to comorbidities in addition to normal aging).

Basal Metabolic Rate (BMR) and Temperature Regulation with Aging

The BMR declines 1%–2% per decade from age 20 to 80 years.[10] Aging combined with a decreased level of physical activity contributes to this decrease in BMR. Shivering is less common in older patients because a lower core temperature must be reached to trigger a response,[11] placing the elderly at greater risk of perioperative hypothermia.

Cardiovascular Effects of Aging

Advancing age is associated with loss of arterial elasticity and reduced arterial compliance as elastin production declines and collagen is damaged over time, leading to an overall "stiffening" of the heart and vascular system.[12] The

Table 2. Age-Related Changes in Organ System Function and Effect on Pharmacokinetic (PK) and Phamacodynamic (PD) Changes in the Elderly and Implications on Anesthetic Management

PK and PD changes	Organ system changes	Implications for anesthetic dosing	Effect on anesthetic medications
Drug absorption	↑ gastric emptying time	Minimal as most anesthetic drugs are given IV	None for anesthetic drugs administered via the parenteral route
	↓ in intestinal motility		
	↓ gastric acid production	Medications given via the oral route may be poorly absorbed	↓ absorption of oral digoxin or analgesic medications
	↓ intestinal blood flow		
	↓ absorption capacity		
Drug distribution	Body composition changes: ↓ total body water	↑ peak drug concentrations after IV bolus doses	↑ initial blood concentration → ↑ potency of hydrophilic drugs after a standard IV bolus dose (e.g., propofol, opioids, midazolam)
	↑ body fat	↑ volume of distribution → prolonged effect for lipophililc drugs	Prolonged duration (↑ half-life) for lipophilic drugs (e.g., benzodiazepines, inhaled anesthetic agents especially isoflurane)
	↓ cardiac output	↑ circulation time	↑ time to onset of hypnosis during induction of anesthesia
Plasma protein binding	↓ plasma proteins	↓ binding of anesthetic medications by proteins (e.g., albumin) → ↑ free (active) drug	↑ free-drug concentrations of highly protein bound drugs (e.g., propofol) → ↑ potency after a standard IV bolus dose
Drug metabolism	↓ liver function secondary to ↓ hepatic blood flow	↓ clearance of many anesthetic medications	↑ duration of anesthetic drugs "cleared" as they pass through the liver (e.g., opioids, lidocaine, ketamine)
	↓ Phase 1 metabolism (e.g., drug oxidation, reduction, and hydrolysis)		Slightly ↑ duration of anesthetic drugs metabolized by the liver (i.e., diazepam, lidocaine)
Drug elimination	↓ renal blood flow → ↓ GFR ↓ renal function	↓ clearance of drugs eliminated by the kidney	↑ duration of anesthetic drugs primarily eliminated by the kidney (i.e., muscle relaxants, opioids)
CNS drug sensitivity	Cerebral atrophy → ↓ white matter and neurons in the brain	↑ sensitivity to anesthetic drugs	↑ sensitivity to propofol → ↓ dose by 40% to 50% in patients ≥65 years
	↓ receptor sites (e.g., GABA, NMDA, β adrenergic, muscarinic)	Anesthetic agents exert their effects at lower blood and effect-site concentrations	↑ sensitivity to sedatives and opioids, especially remifentanil
			↓ MAC for inhalational anesthetic agents
	↓ neurons spinal cord and deterioration in myelin sheaths of nerves		↑ sensitivity to local anesthetics
	Progressive closure of the intervertebral foramina ↓ volume of CSF	↓ area of the epidural space	↑ spread of local anesthetic and ↑ levels of analgesia after spinal or epidural block → ↓ dose

GFR = glomerular filtration rate; MAC = minimal alveolar concentration; CSF = cerebral spinal fluid; CNS = central nervous system; GABA = gamma-aminobutyric acid; NMDA = N-methyl-D-aspartate.

progressive reduction in nitric oxide production with aging also contributes to vascular stiffening.[13] As the aging heart pumps against an increased afterload, the left ventricular wall thickens, leading to ventricular hypertrophy.[14] Although these age-related changes in cardiac function preserve systolic function, the decrease in left ventricular compliance impairs early diastolic filling, making the aging heart dependent on late diastolic filling.[15] Because late diastolic filling is a function of atrial function, hemodynamic instability can result from the presence of supraventricular arrhythmias.[16] Impairment in the ventricular relaxation phase, termed *diastolic dysfunction*, also predisposes the elderly patient to fluid overload and "flash" pulmonary edema.[17]

Autonomic Changes with Aging

Autonomic nervous system (ANS) function progresses from parasympathetic predominance at birth to gradually increasing sympathetic activity in early adulthood. Sympathetic activity predominates in later life as parasympathetic activity progressively declines. A concomitant decrease in β-adrenoreceptor responsiveness renders the elderly patient's ANS less capable of responding to stressful stimuli.[14] The baroreflex likewise suffers from the age-related decrease in vagal activity, resulting in a reduced capacity to maintain a stable arterial blood pressure in response to acute physiologic changes during the perioperative period.[18] The combination of ANS changes and structural changes in the cardiovascular system can increase blood pressure variability.[16] The clinical consequences of autonomic aging include increased blood pressure lability, reduced responsiveness to inotropic and chronotropic drugs, and an increased dependence on preload to maintain cardiac output.

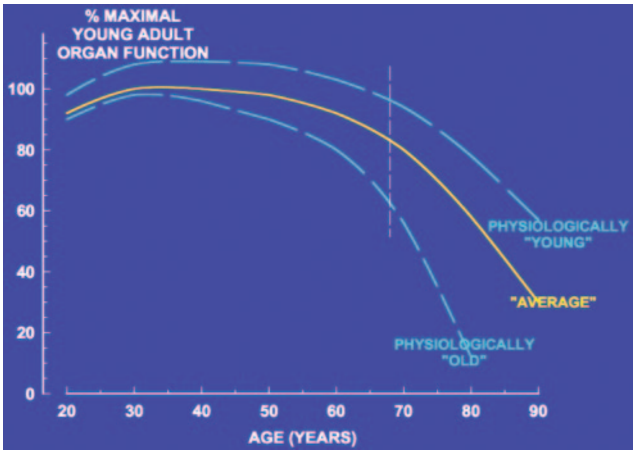

Figure 2. Theoretical changes in organ function over time as a percentage of maximal (optimal) young adult function for those who are considered "normal," as well as those considered physiologically "young" or physiologically "old" (from Murvchick, 2001,[340] reproduced with permission).

Pulmonary Changes with Aging

After the age of 50 years, lung compliance decreases secondary to loss of parenchymal elasticity, loss of chest wall compliance due to calcification of the costo-chondral joints, and decrease in alveolar surface area.[19] These changes result in a decrease in vital capacity, expiratory flow, and diffusion capacity, and an increase in residual volume, closing capacity, dead space, and ventilation–perfusion heterogeneity.[19] Clinically, elderly patients experience gas exchange abnormalities that require progressively increasing inspired oxygen concentrations.[9] Older patients also have impaired respiratory responses to hypoxia and hypercapnia, and an increased sensitivity to the respiratory-depressant effects of opioid analgesics and benzodiazepines.[19] Advanced age is an important predictor of postoperative pulmonary complications, including aspiration, pulmonary edema, atelectasis, and pneumonia.[20]

Renal and Hepatic Effects of Aging

The kidneys lose approximately 10% of parenchymal thickness per decade of life,[21] accompanied by a 10% decline in renal blood flow per decade, contributing to a 30%–50% decrease in creatinine clearance between the ages of 20 and 90 years.[22] Despite this decline in renal function, serum creatinine levels remain in the normal range because the production of creatinine decreases as a result of the loss of muscle mass, which occurs at a rate similar to the decline in glomerular filtration rate. Liver mass also decreases by 20%–40% during the typical human lifespan, with a concomitant decline in hepatic bloodflow.[23] Impaired hepatic and renal function in elderly patients affects the metabolism and excretion of many different anesthetic, analgesic, and muscle-relaxant drugs (Table 2).

Cerebral Effects of Aging

Cerebral atrophy increases and cerebral perfusion decreases after age 60 years, but there is marked heterogeneity in the magnitude of these changes.[24] On average, there is a 15% decrease in white matter by the age of 90 years,[25] which may predispose the elderly to postoperative cognitive disorders[26–28] and increase their sensitivity to the central depressant effects of anesthetic medications. Aging results in an overall loss of neurons in both the cerebral cortex and the spinal cord, and slows conduction velocity in peripheral nerves, resulting in an increased sensitivity to the local anesthetics used in neuraxial and peripheral nerve blocks (PNBs).[29] However, a cause-and-effect relationship has not been firmly established between neurodegenerative disorders and anesthesia in the elderly.[30]

Effects of Aging on Pharmacologic Effects of Anesthetic Drugs

As individuals age, there is a progressive loss of skeletal muscle mass and total body water as muscle is replaced with adipose tissue, especially in women. An increase in adipose tissue leads to an expansion of the "lipid (deep) reservoir" for centrally active anesthetic drugs (e.g., benzodiazepines, volatile agents, opioid analgesics, and sedative-hypnotics [IV anesthetics]), contributing to prolonged elimination half-life values and an increased duration of action of these drugs in the elderly.[31] In addition, the reduction in total body water decreases the central volume of distribution for water-soluble drugs, resulting in higher average and peak plasma drug concentrations and an enhanced peak (maximal) effect.[22] Older patients with poor nutrition can have a 20% or more decrease in albumin levels. Because many anesthetic drugs are highly bound to albumin (e.g., propofol, diazepam), even modest decreases in albumin levels can increase free-drug concentrations, contributing to increased sensitivity to these drugs in the elderly.

Although oral drug absorption from the gastrointestinal tract is often delayed in the elderly, these changes are of minimal importance in the perioperative setting because the majority of anesthetic and analgesic medications are administered IV. Age-related pharmacokinetic changes in drug distribution, metabolism, and elimination have a significant impact on drug dosing in geriatric patients (Table 2).[8,29,31] The mechanisms responsible for the pharmacodynamic changes associated with aging are less well understood. However, the aging of the central nervous system results in neuronal loss and a decline in cognitive reserve, contributing to the enhanced sensitivity of the elderly to centrally active anesthetic drugs. As a result of these age-related changes, the central nervous system–depressant effects of anesthetic drugs (e.g., sedation, hypnosis, cardiorespiratory depression) occur at lower blood and effect-site concentrations in older patients.[30] The old adage to "start low and go slow" applies when administering potent anesthetic and analgesic drugs to elderly patients in the ambulatory setting.

Drug Interactions in the Perioperative Period

Polypharmacy, the term used to describe the use of multiple chronic medications, is common among elderly patients undergoing ambulatory surgery procedures. It is estimated that 40% of geriatric patients take 5 or more different drugs per week and 12%–19% use 10 or more drugs in a week.[32] An expert panel found that polypharmacy (defined as 5 or more chronic medications) was the only patient characteristic associated with adverse drug reactions in patients over the age of 65 years.[33] Combinations of analgesic medications (e.g., opioids, local anesthetics, and anti-inflammatory drugs) can produce enhanced postoperative analgesia as part of a multimodal regimen, but their interactions may contribute to delayed wound healing in the elderly.[34,35] Anesthesia providers should be aware of all prescription, "over-the-counter," and herbal medications taken by elderly outpatients to minimize adverse events from drug interactions in this high-risk surgical population.

PREOPERATIVE PREPARATION AND RISKS OF COEXISTING DISEASES

Strategies for ambulatory surgery in the elderly[36] must assess the risks of the proposed operative procedure, the planned anesthesia and analgesia regimen, and the patient's underlying medical condition.[37] Risk reduction strategies for the elderly outpatient involve optimization of coexisting diseases.[38–40] To minimize perioperative adverse events in the elderly,[41] an accurate preoperative assessment of the patient's physical and functional status[42,43] allows anesthesiologists an opportunity to implement an appropriate perioperative care plan, including preoperative interventions (e.g., prehabilitation)[44–46] and/or prophylactic therapies (e.g., antiemetic prophylaxis of "at-risk" patients).[47] Earlier assessment of elderly outpatients scheduled for ambulatory surgery may also identify those patients at risk of developing transient cognitive dysfunction in the postdischarge period.

Preoperative assessment clinics have become a common approach to improving the overall quality of perioperative care for elderly outpatients scheduled for ambulatory surgery procedures. The development of preoperative clinics has progressed from the concept of a comprehensive clinic as originally described by Fisher,[48] to the nurse-led preoperative health assessment[49] and, most recently, telephone-based evaluations.[50] A possible explanation for the move away from routine outpatient preoperative evaluation is the inability to demonstrate a cost–benefit with respect to improved patient outcomes. For example, Lee et al.[51] reported that even though preoperative clinic patients were more "optimally prepared" for surgery, their adjusted risk of unanticipated intraoperative events was actually higher than nonclinic-evaluated patients. However, the recognition and optimization of comorbid conditions[37]—particularly diabetes, cardiovascular disease, pulmonary disorders, hepatic disease, or renal impairment—in advance of surgery is especially important in the elderly because it allows perioperative implementation of preventative measures to reduce adverse events.[41,46] In addition, a recent study found emotional and cognitive factors were predictors of postoperative side effects such as pain, nausea, and fatigue.[52] This suggests the importance of preoperative evaluation of the psychological state of the elderly patient (e.g., presurgical distress, hearing deficiencies, and cognitive dysfunction).

Ordering routine "screening" laboratory and diagnostic tests for elderly patients undergoing ambulatory surgery has been a long-standing practice. However, a study by Chung et al.[53] involving >1000 outpatients (35% of whom were >60 years of age and more than one third had clinically significant cardiovascular disease) found no significant differences in the rates of acute perioperative adverse events or the rates of adverse events <30 days after surgery between those who underwent no preoperative testing and those in the "indicated" testing group.[53] Hospital revisits within the first week were actually higher in the indicated testing group. An earlier study by Imasogie et al.[54] reported that in elderly cataract surgery patients there was no difference in the incidence of adverse perioperative events between those receiving no preoperative laboratory testing and those undergoing "routine" lab testing. These data suggest that for the majority of older patients with well-controlled (stable) coexisting diseases, routine (screening) lab testing is a waste of time and financial resources.

Diabetic patients should undergo preoperative assessment of their fasting blood glucose level, and their treatment optimized using IV insulin for type I diabetics, and oral hypoglycemic drugs and/or parenteral insulin for type II diabetics. If glucose levels are significantly elevated, a perioperative IV insulin infusion should be used.[55] Frequent postoperative assessment of blood glucose levels has also been demonstrated to reduce infectious complications.[56]

Cardiovascular diseases are common among elderly outpatients presenting for ambulatory surgery, including hypertension, chronic heart failure, arrhythmias, and ischemic heart disease. There is a clear consensus to continue most, if not all, chronic medications up to and including the day of surgery (particularly β-blockers and statins).[57,58] However, there is less compelling evidence on continuing calcium channel blockers, and recent guidelines suggest stopping angiotensin converting enzyme inhibitors and angiotensin receptor blocking drugs.[57,59] A controversial issue in elderly outpatients is perioperative continuation of antithrombotic drugs and/or platelet inhibitors,[60] particularly when regional anesthesia is planned. A comprehensive guideline was recently published by the European Society of Anesthesiologists[61] on regional anaesthesia (and supported by other experts in the field),[62,63] suggesting that elderly patients continue antiplatelet drug therapy if they are undergoing ambulatory procedures.

Elderly patients with chronic pulmonary diseases should be carefully evaluated to determine whether they have a reversible component to their disease. Those with severe chronic obstructive pulmonary disease should undergo preoperative pulmonary function testing with and without bronchodilators.[64] Smoking cessation has been shown to decrease risk of perioperative complications,[65] and should be strongly encouraged at least 4 weeks before surgery.[66] Undergoing surgery is associated with an increased likelihood of smoking cessation in the elderly, and ambulatory surgery can be a "teachable moment" for smoking cessation.[67] Finally, for both smokers and nonsmokers with a reversible component of obstructive disease and/or airway hyperreactivity, a short (48 hour) preoperative course of β2-adrenergic agonist and systemic corticosteroid therapy is recommended.[68] The short-term use of steroids has not been found to have an adverse effect on wound healing or infection control.[69]

Although elderly obese patients with diagnosed and undiagnosed obstructive sleep apnea (OSA) are more frequently presenting for ambulatory surgery,[70] neither obesity nor OSA per se is a significant independent risk factor for unplanned admission or adverse events after ambulatory surgery.[71,72] Stierer et al. failed to find a relationship between unplanned hospital admission and the diagnosis of OSA or morbid obesity. However, patients with OSA had an increased risk of perioperative events requiring additional anesthetic management.[73] A decision regarding the suitability of elderly obese patients with OSA for ambulatory surgery should weigh the invasiveness of the procedure, the choice of anesthesia, the severity of the airway obstruction, the presence of comorbidities, the need for opioid analgesics, and the level of home care.[69] An algorithm for evaluating and preparing patients with OSA for ambulatory surgery has been recently published.[74]

Elderly patients with cirrhosis undergoing major surgery are at increased risk for mortality up to 90 days postoperatively.[75] However, no studies have been conducted in the ambulatory population. Preventing acute renal failure in the postoperative period is another important consideration in elderly patients, particularly those with preexisting renal insufficiency, diabetes, and longstanding hypertension.[76] Measures used to optimize the patient's clinical condition include careful blood pressure control, avoiding fasting-induced hypovolemia,[77] monitoring blood glucose, and estimating creatinine clearance.[78]

Finally, because many elderly patients are frail (up to 30%) improving functional status may be as important as optimizing medical status. The patient's frailty can be assessed using a validated scale that includes an assessment of weakness, weight loss, exhaustion, low physical activity, and slowed walking speed.[79] Functional exercise capacity can be increased through structured training programs,[80] and has been shown to improve outcome in elderly patients undergoing major surgery procedures.[81]

CHOICE OF ANESTHETIC TECHNIQUE

General Anesthesia

There is a belief that local or regional anesthesia is less likely to lead to complications in elderly patients than is general anesthesia. Although this may be true for very fragile (e.g., ASA III or IV) patients undergoing major surgical procedures,[82] in a study involving 800,000 consecutive patients in the Netherlands, advanced age per se was not an independent risk factor for serious morbidity or mortality after ambulatory surgery under general anesthesia.[83] In comparing randomized, controlled trials of general and regional anesthesia (i.e., central neuraxial and major peripheral [conduction] nerve blocks) for ambulatory surgery, Liu et al.[84] concluded that (1) both central neuraxial block and PNB were associated with prolonged induction times to the start of surgery, reduced pain scores, and decreased need for opioid analgesics in the PACU; (2) central neuraxial block was not associated with enhanced PACU bypassing (fast tracking) or reduced postoperative nausea, and prolonged the time to discharge home; and (3) use of a PNB was associated with decreased PACU stay and reduced PONV, but failed to decrease the time to discharge home.

Although elderly patients may have a higher incidence of transient (early) cognitive dysfunction after general anesthesia in comparison with local–regional techniques,[85] there appears to be no causative relationship between general anesthesia and long-term postoperative cognitive dysfunction (POCD). These investigators have also shown that the ambulatory (vs. inpatient) setting is beneficial in reducing POCD after general anesthesia.[6] In addition, postoperative delirium (POD) and agitation in the elderly can be minimized by avoiding potential triggering drugs (e.g., centrally active anticholinergics, benzodiazepines, butyrophenones).[86] In elderly patients undergoing ambulatory surgery with general anesthesia, the frequency and severity of both postoperative pain[87] and nausea[88] appear to be lower than in younger outpatients.

In choosing an anesthetic technique it is also important to consider side effects and potential complications associated with local–regional techniques in the elderly (e.g., nerve trauma, tissue ischemia from epinephrine injection with local anesthetics at the incision site).[89] In a large French survey of permanent nerve damage due to local–regional techniques, there was a significant association with advanced patient age.[90] Spinal and epidural anesthetic techniques can result in perioperative hypotension, postoperative urinary retention, nausea and vomiting, dizziness, and delayed ambulation time.[90] When IV sedation is used to supplement local–regional anesthetic techniques, the risks of respiratory depression and hemodynamic instability are similar or even higher than with general anesthesia.[91]

Drug selection and dosage must be adjusted to make general anesthesia as safe as possible in older outpatients. As was mentioned earlier, interpatient variability is higher in elderly patients than in younger patients with respect to drug pharmacokinetics and pharmacodynamics.[11] For example, elderly patients require a lower propofol dose for induction,[92] although the propofol maintenance rate is only slightly decreased in comparison with younger patients. However, the onset of propofol's sedative–hypnotic effect may be slower because of the slower blood–brain circulation times in the elderly. In addition, the onset time to maximal cardiorespiratory depression may be delayed in relation to the hypnotic effect.[93] Because the elderly have a less-compliant vasculature system and higher incidence of chronic hypertension, they are more prone to develop hypotension after induction of anesthesia.

Elderly patients have up to a 2-fold increase in sensitivity to the ventilatory-depressant effects of opioid analgesics compared with younger patients, and thus require lower doses.[94] Benzodiazepines also exert a more potent and prolonged sedative, amnestic, and respiratory-depressant effect in older patients.[95] There are very few controlled studies of ketamine in the elderly; however, untoward psychotomimetic reactions (e.g., hallucinations, delirium) appear to be uncommon in the elderly, particularly when ketamine is administered in combination with a benzodiazepine or propofol.[96] The α-2 agonist dexmedetomidine can be used as an alternative to opioid analgesics for maintenance of spontaneous ventilation in the fragile elderly patient.[97] However, residual sedation after discontinuation of a dexmedetomidine infusion can be problematic in the ambulatory setting.[98]

There is a 7% increase in the potency of inhalation anesthetics with every decade of age after 30 years.[99] The potent, less-soluble inhalation anesthetics may be particularly beneficial in elderly outpatients with compromised coronary circulation because of their recently described preconditioning effects.[100] Desflurane offers a more rapid early recovery than isoflurane and sevoflurane, especially after prolonged administration in the elderly.[101,102] Desflurane has also been shown to cause less fatigue in the first week after ambulatory anesthesia when compared with a propofol infusion technique for maintenance of anesthesia.[103] Despite a continuing controversy regarding its potential to increase PONV and risk of postoperative myocardial infarction, use of nitrous oxide as an adjuvant to the volatile and IV anesthetics can be beneficial for the elderly outpatient because of its rapid elimination and anesthetic and analgesic-sparing effects.[104,105]

The dose of neuromuscular blocking drugs should be modestly reduced in the elderly because of slower rate of elimination. The ester-based muscle relaxants (e.g., cisatracurium) have a more predictable duration of effect in the ambulatory setting than do the steroidal-based muscle relaxants (rocuronium). However, use of steroidal muscle relaxants allows for the use of the new cyclodextrin reversal drug sugammadex when the standard anticholinesterase reversal drugs fail to adequately reverse the residual neuromuscular blockade.[106]

The elderly outpatient should have minimal, if any, sedative premedication in the ambulatory setting to avoid prolonging emergence from anesthesia. If midazolam is administered for premedication, a dose of 0.5 to 1 mg IV is recommended. General anesthetic induction with titrated doses of propofol (e.g., increments of 0.5 mg/kg) will minimize acute cardiorespiratory depression. A small dose of a potent opioid analgesic (e.g., fentanyl 0.5 μg/kg IV) may be useful before the insertion of a laryngeal mask or tracheal tube, or before injecting local anesthetics (e.g., PNBs or tissue infiltration) to minimize acute hyperdynamic responses associated with painful stimuli.

The use of an electroencephalogram-based hypnotic brain monitor may be helpful in improving titration of anesthetics during the maintenance period in the elderly because of the high degree of interpatient variability in response to general anesthetics. Use of the bispectral index (BIS) monitor has been shown to facilitate recovery after maintenance of anesthesia with both propofol[107] and volatile anesthetics.[108] In addition, a preliminary study suggested that avoiding prolonged periods of "deep" hypnosis (i.e., low BIS values) may be associated with decreased morbidity and mortality in the elderly population.[109] Although still controversial, Lindholm et al.[110] confirmed the statistical relationship between 1-year mortality and low intraoperative BIS (<45), but suggested that the effect was weak in comparison with comorbidity as assessed by the patient's physical status score, preexisting malignancy status, and patient age. A more recent study of elderly patients undergoing cardiac surgery[111] found that the cumulative duration of low BIS was independently associated with intermediate-term mortality, with a 29% increased risk of death for every cumulative hour spent with a BIS <45. However, a more recent study by the same group involving patients undergoing noncardiac surgery failed to find evidence that a cumulative BIS value below a threshold of 45 was harmful to patients.[112]

Spinal and Epidural Anesthesia

The role of neuraxial blockade in ambulatory anesthesia has been described in 2 recent review articles.[113,114] A meta-analysis of published comparative trials showed reduced pain scores and decreased need for opioid analgesics in the PACU when outpatients received central neuraxial blockade in comparison with general anesthesia.[84] Unfortunately, the advantages of neuraxial block are offset by the longer induction and discharge times and a higher incidence of postoperative bladder dysfunction.[86] A nationwide study in Denmark suggested that use of regional (spinal) anesthesia for inguinal hernia repair in patients older than 65 years was associated with an increase in both medical (1.2% vs. 0.6%) and urologic (0.9% vs. 0.1%) complications in comparison with local or general anesthesia.[115] However, 2 other studies reported less arterial hypotension in elderly patients undergoing prostate biopsies[116] or knee surgery under spinal (vs. general) anesthesia.[117] Furthermore, the direct cost of performing a neuraxial block is less than that of general anesthesia.[116,118,119]

Studies involving ultrashort-acting local anesthetics[120,121] and use of small doses of conventional local anesthetics combined with potent opioids[116] have demonstrated recovery times after ambulatory surgery that are similar to those found with general anesthesia. However, the prolonged recovery associated with the traditional doses of spinal anesthetics (e.g., lidocaine 50 to 100 mg, tetracaine 5 to 10 mg, or bupivacaine 7.5 to 10 mg)[122] is clearly problematic when used for short-stay surgery procedures (e.g., hernia repair, prostate biopsy, and knee arthroscopy). A low dose of bupivacaine (2.5 to 5 mg) has been advocated as an alternative to lidocaine because of the lower incidence of transient neurologic symptoms with bupivacaine.[123] Unfortunately, even with this technique, the time to discharge home is unpredictable and remains longer than with general anesthetic techniques.[124]

Despite the addition of a small dose of fentanyl or sufentanil to reduce the dose of local anesthetic for outpatient procedures, the discharge times remain in the 2- to 4-hour range,[125] which is not acceptable in the modern practice of ambulatory anesthesia. Clonidine has also been used as an adjuvant to local anesthetics for spinal anesthesia. Unfortunately, this combination can produce significant hypotension[126] and prolonged recovery in the ambulatory setting.[127] Prilocaine similarly has a longer discharge time, and one study documented a 23% incidence of urinary retention that can further delay discharge.[128] Articaine, an amide-based local anesthetic with characteristics similar to lidocaine, has been investigated for outpatient spinal anesthesia. Although articaine was associated with a faster recovery than was prilocaine,[129] it does not appear to offer any significant advantages over 2-chloroprocaine.[130] Several recent reports suggest that intrathecal 2-chloroprocaine is associated with recovery times approaching general anesthesia.[120,121,131–133] However, intrathecal 2-chloroprocaine is not approved in the US, where it remains controversial.

Spinal anesthesia with ultrashort-acting local anesthetics should reduce the risk of urinary retention and may be no different from general anesthesia. However, elderly male patients with symptoms of prostatic hypertrophy may still be at increased risk of urinary retention after spinal anesthesia even after the use of an ultrashort-acting local anesthetic.[134] Advanced age is also associated with an increased risk of hypothermia during spinal anesthesia.[135] However, one positive effect of the aging process is a decline in the frequency of postdural puncture headache after spinal anesthesia.

Use of epidural anesthesia with a continuous catheter may provide more precise control of the duration of neuraxial blockade in the ambulatory setting. However, peridural techniques are associated with an unpredictable (lower) dosage requirement in the elderly,[136] as well as greater technical difficulty due to common arthritic changes in the elderly spine. Studies suggest that epidural anesthesia is associated with less pain in the early postoperative period, fewer nursing interventions in the PACU, lower overall anesthetic costs, and greater hemodynamic stability.[137] However, it is also associated with increased anesthesia time, frequently delayed discharge home after short surgery procedures, and the potential for postoperative urinary retention, particularly in the elderly male outpatient.

Peripheral Nerve Blocks

PNBs possess many of the characteristics of an ideal anesthetic for ambulatory surgery in the elderly, providing site-specific surgical anesthesia and analgesia with few side effects. For inguinal herniorrhaphy, one of the most frequently performed operations in the ambulatory setting, both ilioinguinal–hypogastric and paravertebral blocks have been successfully used in elderly outpatients. The recovery profile after hernia surgery with PNBs is superior to both general and spinal anesthesia.[115,118,138–141] In comparison with general anesthesia, a recent meta-analysis suggested that use of paravertebral blocks for breast surgery (at the thoracic level) or inguinal hernia surgery (at the lumbar level) was associated with less pain during the immediate postoperative period, as well as less PONV and greater patient satisfaction.[142] Another PNB option for hernia surgery would be the transversus abdominis plane block.[143] However, the least invasive block that provides adequate surgical analgesia is recommended in the elderly outpatient.[144] Although simple local infiltration anesthesia has been recommended for inguinal hernia repair, the addition of an ilioinguinal block improves both intra- and postoperative analgesia.[145,146]

Long and short saphenous vein stripping is another common ambulatory surgery procedure in which use of a combined saphenous–popliteal block with short-acting local anesthetics provides better perioperative analgesia and a faster recovery than does spinal anesthesia.[147] For upper and lower limb surgery, a wide variety of PNBs have been used.[148] For painful shoulder surgery, a single shot or continuous interscalene brachial plexus block is the most common approach.[149] However, interscalene block is an invasive procedure with potentially serious complications in the elderly. More "distal" interventions (e.g., infraclavicular nerve block,[150] axillary block) may reduce the incidence of adverse events.[151] For lower-extremity orthopedic procedures, femoral and popliteal-sciatic PNBs appear to be a better choice than does general or spinal anesthesia.[152] The infrapatellar block is another promising PNB technique for knee arthroscopy.[153]

In comparison with general[148,149] and spinal[152,153] anesthesia, PNBs offer several advantages for older patients undergoing elective ambulatory surgery, including reduced postoperative pain, decreased need for postoperative opioid analgesics, decreased incidence of PONV, increased chance of a "fast-track" recovery that bypasses the PACU,[122] and increased patient satisfaction, particularly when continuous PNB (CPNB) techniques were used.[145–152]

Unlike parenteral or epidural analgesia, CPNB (perineural) infusions may be used after hospital discharge using a portable infusion pump or disposable elastomeric device to provide local analgesia in the postdischarge period.[154] Continuous femoral nerve blocks can facilitate recovery by decreasing disability after orthopedic procedures.[155] Techniques for CPNB placement have developed in large part from the single-shot approach, and are now generally performed under ultrasound guidance.[156]

Richman et al.[157] examined 19 studies that enrolled a total of 603 patients receiving postoperative analgesia with a CPNB involving the upper or lower extremity (e.g., interscalene, infraclavicular, femoral, lumbar plexus, or popliteal-sciatic). These investigators concluded that regardless of the location of the catheter, postoperative analgesia was superior in patients who received CPNB in comparison with a placebo or parenteral opioid analgesics. For painful orthopedic procedures, the economic impact of CPNB on ambulatory surgery is increasingly evident[158] because more patients can be discharged home on the day of surgery owing to the reduced need for parenteral analgesics.[159]

Although most patients appreciate the superior pain relief provided by PNB techniques, the dense motor block and altered sensation are potentially dangerous for an elderly patient in an ambulatory setting. In a large prospective study involving 307 patients receiving CPNBs,[160] 4% could not move their arm or hand for 16 hours after surgery, preventing these patients from participating in active physical therapy. A CPNB involving the femoral nerve can lead to weakness of the quadriceps femoris muscle and interfere with early ambulation, resulting in patients falling and sustaining other injuries.[161] Feibel et al.[162] reported a 0.7% rate of falling in a series of 1190 patients after total knee arthroplasty with a femoral CPNB. Unfortunately, none of these series included an adequate control group to determine the degree to which the CPNB itself contributed to falling after surgery.[163–165] Importantly, a recent analysis[166] of 3 multicenter studies involving a total of 171 patients[155,167,168] reported 6 patients falling while receiving a postoperative continuous femoral nerve block with 0.2% ropivacaine and none in the control group receiving a perineural saline infusion.

The motor block typically resolves within a few hours after discontinuing the perineural infusion.[169] Nevertheless, to avoid potential complications from motor weakness after upper- and lower-extremity surgery, it is recommended that the local anesthetic perineural infusion rate be limited to no more than 4 mL/h of 0.2% solution of bupivacaine, ropivacaine, or levobupivacaine.[170] Anesthesiologists should (1) minimize the local anesthetic concentration,[160] (2) reduce the volume of supplemental patient-controlled bolus doses, and (3) progressively reduce the "basal" (background) infusion rate to minimize motor blockade while providing an adequate sensory block.[161,171] It is also recommended that patients use a knee immobilizer and walker/crutches during ambulation while receiving CPNBs,[172] and that physical therapists, nurses, and orthopedic surgeons be educated regarding the possibility of CPNB-induced muscle weakness and the importance of "fall precautions."

In a series of 620 outpatients who were treated with CPNB placed using ultrasound visualization and managed using a standardized protocol after orthopedic surgery, 2 patients experienced significant neurologic deficits after placement of the catheter in the popliteal fossa.[173] Another potential problem is catheter dislodgment and spontaneous removal with ambulation.[159] In a national survey involving 2476 patients, the cumulative incidence of catheter dislocation was 4.7%.[174] The vast majority of problems related to outpatient perineural catheters can be handled over the telephone. However, there are potential complications of peripheral nerve catheter removal at home.[175]

Many adjunctive drugs are combined with local anesthetics to speed the onset, prolong the duration, and increase the intensity and success while also decreasing the possibility of local anesthetic toxicity associated with the use of PNB in the ambulatory setting. Although opioid agonists[176] and partial agonists (buprenorphine,[177] tramadol,[178] ketamine,[179] neostigmine,[180] magnesium,[181] dexamethasone[182]) have all been evaluated, the use of these adjuvants for CPNBs remains unproven.[183,184] Current evidence[185] only supports the use of epinephrine (to prolong the duration and to delay the systemic absorption of local anesthetic[186]) or clonidine.[187]

Although numerous studies and systematic reviews discuss the many advantages of the PNB[138] and CPNB[149,151,154,156,171,188,189] techniques for patients undergoing painful ambulatory procedures, very few studies have focused exclusively on elderly or cognitively impaired patients.[148,152,157,163,164] Additional research is needed to demonstrate clinically meaningful benefits (e.g., shorter time to resumption of normal activities of daily living, reduced incidence of chronic postoperative pain) in the elderly outpatient undergoing ambulatory surgery.

Monitored Anesthesia Care and Local Anesthesia

In elderly patients scheduled for minor surgery or diagnostic procedures, monitored anesthesia care (MAC) is an excellent alternative to general and regional anesthesia because its use is typically associated with minimal changes in physiological and cognitive functioning.[190,191] According to the American Society of Anesthesiologists (ASA), MAC refers to those clinical situations in which the patient remains conscious and able to protect the airway for the majority of the procedure.

Most commonly, MAC involves monitoring the cardiorespiratory system and the level of sedation in patients receiving local infiltration anesthesia at the incision site. Incision site and intra-articular local anesthetic infiltration techniques are simple, safe, and inexpensive methods for providing periprocedural anesthesia for a wide variety of surgical and/or diagnostic procedures.[192] In addition, use of continuous wound catheters and disposable elastomeric pumps for delivering local anesthetics has been rediscovered as a technique for reducing pain after discharge.[193,194]

Guidelines for MAC in elderly patients have been published by Ekstein at al.[195] Standard monitoring includes pulse oximetry, intermittent noninvasive arterial blood pressure, and continuous display of electrocardiogram and heart rate. Clinical signs of adequate spontaneous ventilation (e.g., maintenance of a patent airway and respiratory rate >10 beats per minute [bpm], hemoglobin oxygen saturation values >90%) must be continuously monitored because of the risk of ventilatory depression in the elderly. In spontaneously breathing patients, the measurement of end-tidal CO_2 at the nasal oxygen cannula is useful for monitoring respiratory rate and apnea; however, the measured CO_2 value is not reliable.

In elderly patients, the continuous assessment of sedation is important to minimize the risk of inadvertent deep sedation in which responses to verbal commands are not present and protective airway reflexes may be compromised.[196] Sedation can be evaluated using the observer assessment of alertness and sedation or Ramsey scale, as well as a BIS monitor.[197,198] IV anesthetic drugs (e.g., midazolam, etomidate, propofol, dexmedetomidine) are frequently used for sedation, either by intermittent bolus or by continuous IV infusion. Propofol produces a rapid and controllable sedation, and is associated with predictably rapid recovery of cognitive function and excellent patient acceptance.[199,200] Propofol is generally the drug of choice for MAC sedation in the elderly outpatient population.[199] However, both etomidate and dexmedetomidine are used in elderly patients at increased risk for cardiovascular depression with propofol.[201–203] Although dexmedetomidine has the additional advantage over propofol and midazolam of providing analgesia, recovery from its sedative effects is significantly slower in the elderly population.[200,202,203]

Sedation may also be obtained by using combinations of sedative–analgesic drugs.[204–208] Because elderly patients can be extremely sensitive to the central depressant effects of hypnotics, benzodiazepines, and opioids, the window for titrating these drugs is often small. Because subhypnotic doses of propofol do not reliably produce amnesia,[209] small doses of midazolam (0.5 to 1 mg IV) can be administered before propofol sedation to obtain anxiolysis and anterograde amnesia.[210] Target-controlled infusion of propofol for moderate sedation does not compromise respiration, but reduces sympathetic activity and baroreflex responses to hypotension.[211] Midazolam also provides effective sedation and amnesia, but produces slower recovery than does propofol or dexmedetomidine.[210,212] Midazolam combined with an opioid analgesic for brief diagnostic procedures can produce prolonged sedation in elderly patients.[213]

In comparison with general anesthesia, use of small doses of IV sedative–analgesic drugs for MAC anesthesia minimizes the adverse physiologic effects on major organ systems. More important, MAC techniques result in shorter recovery times than do either general or spinal anesthesia.[118,119] As a result of the lower drug costs and early discharge home, MAC techniques are also more cost-effective for elderly surgical patients undergoing superficial operations.

PERIOPERATIVE SIDE EFFECTS AND COMPLICATIONS

Major morbidity and mortality after ambulatory surgery are surprisingly rare, even in the elderly population.[38] According to Fleisher et al.,[214] in 1997 only 1 in every 180 patients undergoing an outpatient procedure in New York required hospitalization for inadequate pain control or complications such as bleeding, nausea and vomiting, dizziness, adverse reaction to an anesthetic drug, or an irregular heartbeat. In the same study, only 19 of 783,558 outpatients studied died, a rate of 1 in 41,240. Age older than 65 years was one of the independent predictors of immediate hospital admission after ambulatory surgery. These data suggest that older outpatients with increasing comorbidities are at increased risk of admission to an inpatient facility after outpatient surgery.

In a large retrospective outpatient outcome study by Chung et al.,[215] 27% of the patients were older than 65 years. These investigators reported a 4.0% incidence of adverse events in the operating room, 9.6% in the PACU, and 7.9% in the ambulatory surgery unit. Not surprisingly, adverse cardiovascular events were more common in elderly patients with preexisting cardiovascular diseases. Adverse respiratory events in the elderly were usually associated with obesity, smoking, and asthma. In the previously mentioned study by Chung et al.,[215] older patients were 4 times less likely to experience any adverse event; 10-fold less likely to complain about excessive pain, shivering and agitation; and 4-fold less likely to develop symptoms of nausea and vomiting and drowsiness in the PACU than were their younger (<65 years) counterparts. It is possible that the elderly are more tolerant of the various stimuli causing side effects such as pain, nausea, and vomiting, or perhaps they are simply more reluctant to complain to their health care providers. These differences may also relate to the different types of surgery and anesthesia between the elderly and younger ambulatory surgery populations in this study. For example, younger patients were more likely to undergo gynecological and orthopedic procedures, which more frequently cause postoperative pain and require the use of opioid analgesic, a factor that can also contribute to the increased incidence of PONV. In contrast, the elderly most commonly underwent ophthalmic procedures, which cause minimal postoperative pain. The latter explanation is supported by the results of a nationwide survey in Denmark involving older (>65 years) versus young outpatients all undergoing inguinal hernia repair in which the postoperative complication rate was actually significantly higher in the older patients (4.5% vs. 2.7%).[115]

Postoperative Delirium and Cognitive Dysfunction

More than 50 years ago, clinicians recognized that subtle changes in cognitive functioning occurred in up to 10% of elderly patients undergoing noncardiac surgery.[216] POD is an acute temporary change in orientation and cognition, whereas POCD is a more subtle and persistent impairment in cognitive performance, typically assessed by formal testing.[217,218] Clinical characteristics for these 2 postoperative cognitive disorders are found in Table 3. The incidence of POD is variable depending on the type of surgery, but is reported to occur in approximately 5%–15% of all elderly patients undergoing noncardiac surgery.[219,220] POCD is present in 10%–13% of elderly patients at 3 months after noncardiac surgery.[26,221] The socioeconomic and medical implications of both cognitive disorders can be profound.[219,220] POD is associated with a longer, more costly hospital course and higher likelihood of death within the first 6 months after surgery or institutionalization.[220] POCD is associated with increased mortality,[222] risks of leaving the labor market prematurely, and dependency on social transfer (welfare) payments.[26]

Table 3. Clinical Characteristics of Postoperative Delirium and Postoperative Cognitive Dysfunction (POCD)[a]

	Delirium	POCD
Clinical presentation	Disoriented, fluctuating mood, inability to focus attention	Oriented, alert, vague complaints of attention/memory problems
Affect	Labile, variable	Depression may develop
Onset	Acute—within hours to days after surgery	Subtle—usually noticed days to weeks after surgery
Duration	Days to weeks	Usually improves within weeks to months, but occasionally persists for years
Subtypes	Hyperactive, hypoactive, or mixed type	Memory dysfunction, executive dysfunction or mixed type
Sleep–wake cycle	Worse at night, in darkness and upon awakening	No differences
Assessment	Confusion Assessment Method (CAM) is best for clinicians	Neuropsychological testing, but no defined criteria for diagnosis; not recognized in the *DSM–IV*

[a] Adapted from Krenk L, Rasmussen LS. Minerva Anesthesiol 2011;77:742–9, and Price CC, Tanner JJ, and Monk TG. Postoperative cognitive disorders. In: Mashour, GA, Lydic R, eds. Neuroscientific Foundation in Anesthesiology. New York: Oxford Press, 2011:255–69.

Marcantonio et al.[223] studied the risk factors associated with the development of POD. These authors identified 7 key predictors that could be used preoperatively to identify elderly patients at risk of developing delirium: (1) age older than 70 years, (2) self-reported alcohol abuse, (3) poor cognitive status, (4) poor functional status, (5) abnormalities of serum sodium, potassium, or glucose, (6) noncardiac thoracic surgery, and (7) abdominal aneurysm surgery. Current research suggests that decreased preoperative cognitive status and depression can also be useful in identifying patients at high risk for POD.[27,28] The etiology of POCD is likely to be multifactorial and includes the patient's preoperative cognitive and physical status, as well as surgical and anesthesia factors. It is accepted that older patients (>60 years old) are at an increased risk for long-term cognitive problems.[26] Other reported risk factors for POCD include lower educational level, a history of previous cerebral vascular accident with no residual impairment, and cognitive impairment at hospital discharge.[26]

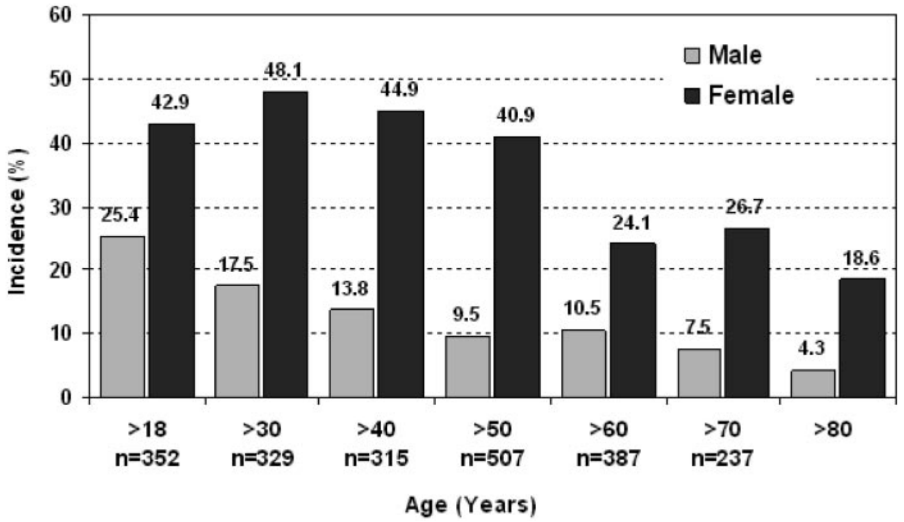

Figure 3. The incidence of postoperative vomiting (and retching) as a function of age in male and female patients in Germany. A total of 330 patients were older than 70 years, and 93 were >80 years old (from Apfel et al., 1998,[227] reproduced with permission).

It has been suggested that major versus minor surgery potentially contributes to the onset of POCD. In a large-scale study involving patients >60 years old undergoing minor surgery procedures, Canet et al.[6] found that older patients had a lower incidence of POCD 1 week after surgery in the ambulatory setting than their counterparts who had undergone similar surgery procedures in an inpatient setting. However, the significant differences reported in the early postoperative period were not apparent at later assessments conducted between 22 days and 6 months after surgery. When compared with an earlier study in which elderly patients underwent major inpatient surgical procedures, the incidence of POCD at 7 days was significantly lower after minor surgery (6.8%) than after major surgery (25.8%) and similar to the incidence in control patients who did not have surgery. These findings suggest that minor operations performed in an outpatient setting have minimal impact on cognition in the elderly population.[86]

There is controversy as to whether anesthetic type influences cognitive outcomes. Sieber et al.[224] randomized patients undergoing hip fracture surgery to spinal anesthesia with either light propofol sedation (depth of anesthesia with BIS ≥80) or deep sedation (i.e., IV general anesthesia with an average BIS of 50). Light sedation was associated with a 50% decrease in the incidence of POD after hip fracture surgery. Patients with better preoperative cognition were more likely to show a benefit from light levels of sedation. Although the results of this study are encouraging, it excluded patients with severe cognitive impairment.

Choice of anesthesia (general versus regional) has not been found to be a significant risk factor for POCD.[85,225] A large international study found that the incidence of POCD at 1 week after general anesthesia was 19.7% in comparison with 12.5% after regional anesthesia, and at 3 months, POCD was found in 14.3% versus 13.9%, respectively.[225] These investigators concluded that there was no association between general versus regional anesthesia and long-term POCD. Other factors such as inflammatory or metabolic (endocrine) stress responses associated with surgery may be responsible for the late changes that occurred in both anesthetic treatment groups.[226] The investigators did note that these findings used the intention-to-treat approach, and if the per protocol approach was used, POCD was found to be significantly less common at 1 week after regional anesthesia. However, no difference was observed at 3 months after either general or regional anesthesia in this older surgical population.

Postoperative Nausea and Vomiting

PONV is less common in elderly surgical patients (Fig. 3).[227] However, for some ambulatory procedures (e.g., brachytherapy) a high incidence of PONV has been reported even in low-risk populations (e.g., elderly males).[228] It has long been recognized that patient, anesthetic, and surgical factors all contribute to the persistently frequent incidence of emetic symptoms in the ambulatory setting.[229] With the increasing emphasis on earlier mobilization and discharge (fast tracking) after minor operations, postoperative factors such as postural hypotension due to inadequate hydration and the use of oral opioid-containing analgesics as rescue analgesics have become more important contributing factors to nausea and vomiting in the postdischarge period.[230]

Patients undergoing neurological, head or neck, or abdominal (laparoscopic) procedures received antiemetic rescue medication significantly more often in the PACU than patients undergoing integumentary, musculoskeletal, or superficial surgery.[231] Female, nonsmoker, history of PONV or motion sickness, anesthesia duration, and intraoperative or postoperative opioid administration were also significantly associated with antiemetic administration after admission to the PACU. Sinclair et al.[232] did an extensive analysis of a large outpatient database and identified the following independent predictors of PONV: age, type of anesthesia, gender, type of operative procedure (e.g., gynecologic laparotomy), and duration of surgery. Subsequently, Apfel et al.[233] developed a simple scoring system that identified 4 primary predictors of risk: female sex, nonsmoking status, history of PONV or motion sickness, and use of postoperative opioid analgesics. The number of preexisting risk factors that patients presented with before surgery was directly related to the incidence of nausea and vomiting in the postoperative period.

These well-known risk factors have been integrated into guideline-supported treatment algorithms for PONV.[234–236] The use of these risk factors as a guide for the management of surgical patients requiring antiemetic prophylaxis has been associated with a lower incidence of PONV in comparison with a nonselective approach to providing prophylaxis.[237,238] However, one study involving high-risk patients found a high incidence of PONV despite the frequent use of multiple antiemetic drugs for prophylaxis.[239] Interestingly, surgeon experience has been found to influence the incidence of emetic sequelae after ear, nose, and throat surgery.[240] The likely explanation is that more highly skilled surgeons have shorter operating times and the duration of surgery has been previously shown to influence the incidence of PONV in the ambulatory setting.[229]

The original Apfel criteria are less predictive of postdischarge nausea and vomiting (PDNV).[241] Administration of opioid analgesics and occurrence of emesis in the PACU are both predictive of PDNV.[242] Use of PNBs and/or local infiltration anesthesia (LIA) (i.e., MAC techniques) is associated with a lower incidence of emetic sequelae than is general (volatile) anesthesia.[118,119,150] The most important factor for reducing PDNV may be minimizing the perioperative use of opioid analgesics by using a multimodal analgesic approach as described in the next section.[243] Thagaard et al. found that 30 mg of IV ketorolac provided better analgesia and antiemesis than did 4 mg of IV dexamethasone or 12 mg IM betamethasone.[244] The use of sympatholytic drugs (e.g., esmolol, labetalol), α-2 agonist/antagonists, and even ketamine to control transient autonomic responses during surgery can reduce postoperative emetic sequelae due to their anesthetic and opioid-sparing effects.[245–247] The use of propofol (vs inhalation anesthetics) for induction and maintenance of anesthesia reduces the risk of developing PONV in the early postoperative period.[248,249] Improving the titration of volatile anesthetics by using a BIS monitor reduced the emetic sequelae after ambulatory surgery and accelerated the recovery process.[250,251]

Severe pain requiring opioid analgesics, hypotension due to inadequate hydration, premature ambulation and movement, and forcing oral fluids can all increase the risk of PONV.[252] For example, a liberal (40 mL/kg) versus restrictive (15 mL/kg) approach to perioperative IV hydration of outpatients undergoing laparoscopic cholecystectomy was found to improve organ function in the postoperative period, reduce emetic sequelae, and shortened the length of stay in the PACU and the time to discharge home.[253]

A wide variety of antiemetic drugs are available for the prevention and treatment of PONV and PDNV, including antihistamines, sympathomimetics, anticholinergics, dopamine antagonists, serotonin antagonists, and neurokinin-1 antagonists.[254] In a large multicenter study comparing 3 commonly used generic antiemetics—namely, ondansetron, dexamethasone, and droperidol—Apfel et al.[255] demonstrated that each drug reduced the risk for nausea and vomiting by approximately 25%. Using a multimodal management strategy with routine antiemetic prophylaxis for a high-risk outpatient population, Scuderi et al.[256] demonstrated an increase in the level of patient satisfaction in comparison with symptomatic (rescue) treatment.

A prospective observational study of treatments, outcomes, and patterns of care (POST-OP[c]) was conducted[239] using the guidelines for managing PONV and PDNV published by the Society for Ambulatory Anesthesia,[234] the American Society of Peri Anesthesia Nurses,[231] and the ASA.[236] Only 61% of clinicians adhered to the ASA guideline recommendations for prophylaxis, even in high-risk patients. When the physicians complied, the incidence of PONV and PDNV was significantly reduced. Nevertheless, in high-risk patients who had received 2 or more prophylactic antiemetic drugs, 29% of the patients vomited in the first 72 hours, almost 60% complained of moderate-to-severe nausea, and another 60% required rescue antiemetic medication, either in the hospital or after being discharged. Importantly, 40% of these patients reported that emetic sequelae interfered with their postoperative recovery.

For elderly outpatients with known risk factors for PONV undergoing highly emetogenic procedures, use of propofol for maintenance of anesthesia or sedation, nonopioid analgesics and routine antiemetic prophylaxis using dexamethasone (4 mg) and low-dose droperidol (0.625 mg) after induction of anesthesia and/or ondansetron (4 mg) at the end of surgery is a cost-effective multimodal therapy for preventing PONV and PDNV.[238]

Postoperative Pain Management

In an effort to minimize the adverse effects of opioid analgesics in the elderly, "balanced" (or multimodal) analgesic techniques involving the use of smaller doses of potent opioids in combination with nonopioid analgesic drugs including local anesthetics and nonsteroidal anti-inflammatory drugs (NSAIDs) have become increasingly popular during and after ambulatory surgery.[243,257] The beneficial role of multimodal analgesia for ambulatory surgery was originally described in younger outpatients undergoing gynecological surgery[258] and cholecystectomy procedures.[259] Both of these early clinical studies documented the benefits of LIA at the surgical site in combination with NSAIDs for improving recovery. Recent multimodal analgesia studies by White et al.[260,261] found additional beneficial effects on recovery after ambulatory surgery by extending the use of either ibuprofen or the more selective NSAID, celecoxib, into the postdischarge period. Few clinical studies have evaluated the efficacy of multimodal analgesia in the elderly undergoing ambulatory surgery. However, the clinical efficacy of multimodal postoperative analgesia in elderly inpatients suggests that similar benefits may result for the elderly outpatients undergoing ambulatory procedures.

The key components of a multimodal analgesic regimen include acetaminophen, NSAIDS, glucocorticoid steroids, local anesthetics, nontraditional analgesic drugs (e.g., ketamine, clonidine, gabapentanoids), and even nonpharmacological techniques.[257]

Acetaminophen

Acetaminophen has a long history of safe use for oral analgesia in the elderly.[262] When metabolism and excretion of acetaminophen were compared in elderly and younger adults, dosage adjustments were not recommended despite a reduced clearance rate in the elderly.[263] Interestingly, there is a report involving doses of 6 g/d in elderly patients without evidence of any adverse effects.[264] Both oral (1.5 g) and IV acetaminophen (1 g) are effective before and after ambulatory surgery. Oral acetaminophen, 1 g qid, is effective as part of a multimodal regimen and is well tolerated in the elderly outpatient undergoing an ambulatory surgery procedure.

NSAIDs

The efficacy of NSAIDs (e.g., ketorolac) for the prevention of postoperative pain and reducing the opioid analgesic requirement and opioid-related side effects is well documented.[265] The potential occurrence of side effects (e.g., gastrointestinal bleeding, thrombotic events) with more extended use of NSAIDs in the perioperative period is a consideration in the elderly.[266] The more selective cyclooxygenase (COX)–II inhibitors have been shown to reduce, but not eliminate, the risk of gastrointestinal side effects.[267]

The risk of experiencing an acute cardiovascular event is well established with long-term therapy involving the COX-II selective NSAIDs. However, in a prospective randomized study involving >1000 noncardiac surgery patients, Nussmeier et al.[268] reported that COX-II inhibitors were useful adjuncts to opioid analgesics for the treatment of postoperative pain without increasing the risk of cardiovascular events. Additional studies are needed to establish the safety profile of short-term administration of COX-II selective NSAIDs after ambulatory surgery in elderly patients with known atherosclerotic cardiovascular disease. In a meta-analysis assessing the risk of cardiovascular events associated with the perioperative administration of COX-II inhibitors after noncardiac surgery, Schug et al.[269] found no increase in the risk of cardiovascular complications even when stratifying for cardiac risk factors.

The COX-II-selective NSAIDs have less effect on platelet function and thus may be associated with a lower risk for postoperative bleeding. However, after general surgery procedures with a low risk of postoperative hemorrhage, the use of traditional nonselective NSAIDs may be a more cost-effective alternative to the COX-II selective NSAIDs.[261] These investigators found that ibuprofen (1.2 g/d) compared favorably to celecoxib (400 mg/d) as part of a multimodal pain management strategy after major ambulatory surgery procedures with respect to the patient's quality of recovery scores and satisfaction with their postoperative pain management. The incidence of postoperative constipation was significantly higher in the placebo (control) group (28%) than in the celecoxib (5%) and ibuprofen (7%) groups. There are also concerns about the effects of COX-II-selective NSAIDs on bone healing, based on animal models of bone healing.[270] Nevertheless, the benefits of using a combination of NSAIDs and acetaminophen for postoperative pain management have been extensively documented in the literature.[271] A recent meta-analysis by Ong et al.[272] concluded that the combination of acetaminophen (paracetamol) and an NSAID offers superior postoperative pain control in comparison with either drug alone.

Steroids

Although the beneficial effect of a single IV dose of dexamethasone (4 to 8 mg IV) in reducing the risk for PONV is well documented,[273] a single dose of glucocorticoid steroid also reduces pain after ambulatory surgery procedures.[274,275] In outpatients undergoing breast surgery, Hval et al.[275] reported that use of a higher dose of dexamethasone (16 mg IV) as part of a multimodal regimen provided prolonged postoperative analgesia lasting up to 72 hours after surgery. Romundstad et al.[276] showed that a single dose of methylprednisolone, 125 mg IV, given before breast augmentation surgery had analgesic effects comparable to a parenteral COX-II inhibitor, as well as reduced nausea, vomiting, and fatigue after surgery. However, a preliminary communication by Czarnetzki et al. suggested that postoperative bleeding may be increased in patients receiving dexamethasone for tonsillectomy procedures.[277] Interestingly, a meta-analysis involving the use of steroids during coronary artery bypass surgery failed to find any safety concerns with respect to postoperative bleeding. These authors reported that dexamethasone reduced the risk of new onset atrial fibrillation, postoperative bleeding, length of stay, and mortality.[278] Because of the slow onset of action and uncomfortable perineal pain occasionally associated with the IV administration of dexamethasone, it should be administered after induction of anesthesia.

Local Anesthetics

The adjunctive administration of local anesthetics during both general anesthesia and MAC is increasingly popular for day-case surgery in the elderly. Open hernia repair is a superficial surgical procedure that can be effectively managed with LIA[279] or a combination of local infiltration and a peripheral ilioinguinal–iliohypogastric nerve block.[146] In a meta-analysis published in 2005, Ong et al. reported that local anesthetic wound infiltration reduced analgesic consumption and time to first request for a rescue analgesic.[280] Intra-articular injection of local anesthetics provides postoperative analgesia after knee arthroscopy.[281] However, more recent studies have suggested that local infiltration at the portals is as effective as intra-articular administration, and may reduce the risk of chondro-toxic effects of local anesthetics.[282]

A variety of adjuncts to local anesthetics have been studied to improve and prolong the duration of local analgesia. The utility of adding epinephrine to prolong local analgesia has been known for many years.[283] Limited (and controversial) evidence suggests that intra-articular morphine improves control of pain after knee arthroscopy.[284] Adding a small amount of an opioid analgesic to a local anesthetic solution may enhance the success rate and prolong the duration of analgesia after central and peripheral blocks.[285,286] However, opioid-related side effects (e.g., nausea, vomiting, pruritis, and urinary retention) are often increased. The addition of a small dose of clonidine to local anesthetic improves and prolongs the duration of local analgesia but may be associated with an increased risk of hypotension, fainting, and sedation in elderly outpatients.[287] For LIA, ketorolac is often added to local anesthetics to improve the quality of postoperative analgesia.[288–290] However, no major differences were found between systemic and local administration of NSAIDs in patients undergoing hernia repair or anorectal procedures.[291,292] Glucocorticoids (e.g., methylprednisolone, dexamethasone) enhance the effects of local anesthetics by improving and prolonging postoperative local analgesia.[182]

Recent reports suggest major beneficial effects of LIA after major joint replacement surgery,[288–290] which has become an ambulatory procedure with the introduction of minimally invasive surgical approaches. The most popular LIA technique involves the periarticular infiltration of a high-volume, low-concentration mixture of ropivacaine (0.2%), ketorolac (30 mg), and epinephrine (10 μg/mL). A volume of 150 to 200 mL is typically injected after the analgesic mixture is diluted with normal saline, to deliver the drug mixture reliably throughout the surgical field. To minimize the risk of local anesthetic toxicity, the total dose of ropivacaine is limited to a maximum of 300 mg.[289,293]

As was mentioned earlier, the use of continuous local wound infiltration and perineuronal (i.e., CPNB) infusion techniques for postoperative pain management can prolong the local analgesic effects into the postdischarge period. The widespread availability of less costly disposable catheters and drug reservoirs with elastomeric pumps has facilitated the usefulness of this technique after painful upper- and lower-extremity orthopedic procedures in the ambulatory setting.[294–296] The meta-analysis by Liu et al. confirmed the efficacy of continuous wound catheters for improving postoperative analgesia, reducing the need for opioid rescue medications and opioid-related side effects, while increasing patient satisfaction.[194] With catheter placement guided by nerve stimulation or ultrasound, the safety and efficacy of PNB techniques has improved. However, the risk associated with prolonged local anesthetic blocks (e.g., possible nerve damage, bleeding/hematoma, and catheter infections) and the ability of an elderly patient to manage these systems outside the hospital may be an obstacle to more widespread use in the ambulatory setting. The possibility of "tele-robotic ultrasound-guided blocks" may become an option for practitioners in remote hospitals with limited experience in performing CPNB procedures.[297]

Recent studies suggest beneficial postoperative effects from a simple perioperative IV infusion of lidocaine (1 to 1.5 mg/kg/h) in older outpatients undergoing laparoscopic colectomy procedures.[298] In a recent systematic review, lidocaine infusion was shown to have both intra- and postoperative beneficial effects, including reduced pain, faster resumption of bowel function, and shorter hospital stay.[299]

Nontraditional Analgesic Drugs and Techniques

Several nontraditional analgesic drugs have been used for improving postoperative pain management. For example, small doses of ketamine have been alleged to reduce early postoperative pain and the development of chronic pain. In a recent study of opioid-dependent patients undergoing spine surgery, Loftus et al. showed that a low-dose ketamine infusion during surgery reduced opioid consumption and pain scores at 24 hours and 6 weeks after the operation.[300] Remerand et al. also reported that a 24-hour low-dose ketamine infusion had positive effects as part of a multimodal analgesia regimen, facilitating rehabilitation at 1 month and decreasing chronic pain at 6 months after joint replacement surgery.[301]

Evidence supports the clinical efficacy of gabapentanoid compounds as part of a multimodal analgesic regimen in the perioperative period. Although Adam et al.[302] reported no beneficial effect of a single 600-mg dose of gabapentin administered preoperatively to outpatients who also received a PNB for shoulder extremity surgery,[302] Turan et al. reported that gabapentin 1.2 g P.O. given before ear, nose, and throat surgery exhibited both intra- and postoperative analgesic effects.[303] Gilron et al. reported that gabapentin 1.2 g/d orally for 3 days after laparoscopic cholecystectomy was as effective as meloxicam 15 mg,[304] and Turan et al.[305] found that a similar dosing regimen of gabapentin had comparable effects to the COX-II inhibitor rofecoxib in women undergoing abdominal hysterectomy procedures. Buvanendran et al. reported similar short- and long-term benefits with pregabalin when an initial 300-mg dose was administered before surgery, followed by 50 to 150 mg/d for 14 days after surgery.[306] Unfortunately, increased postoperative sedation and dizziness may limit the utility of pregabalin in elderly patients undergoing ambulatory surgery.[303,306]

The perioperative effects of α-2-agonists have long been recognized.[246,307] In addition to their intraoperative anesthetic-sparing effect, these compounds can reduce the opioid requirement in the postoperative period in the elderly. The beneficial effects of clonidine premedication include sedation, decreased postoperative pain, and faster emergence from anesthesia.[308] Tufanogullari et al. showed that adjunctive use of an intraoperative dexmedetomidine infusion (0.2 to 0.8 μg/kg/h) during laparoscopic bariatric surgery decreased perioperative fentanyl use, postoperative antiemetic requirements, and reduced the length of the PACU stay. However, its use failed to facilitate late recovery (e.g., return of normal bowel function) or improve the patients' overall quality of recovery.[309]

White et al. have reported beneficial effects of intraoperative esmolol infusion in patients undergoing ambulatory surgery procedures.[245,310] The benefits of faster emergence from anesthesia, less postoperative pain, decreased emesis, and earlier discharge have been confirmed by Collard et al.[311] and others.[312] Although the routine use of longer-acting β-blocking drugs in nonregular users of these drugs has recently been questioned,[313] there are no data demonstrating adverse effects related to the intraoperative use of shorter-acting β-blockers in the elderly population undergoing ambulatory surgical procedures.[314]

Nonpharmacological Techniques

The use of "alternative" analgesic therapies could also provide beneficial effects in the elderly ambulatory population because of their simplicity and lack of side effects.[315] For example, transcutaneous electrical stimulation and transcutaneous acupoint electrical stimulation have been found to produce opioid-sparing effects and reductions in opioid-related side effects.[316,317] Unfortunately, the feasibility of using these techniques in the postdischarge period may be problematic in the elderly population because of technical issues.

In the future, multimodal analgesic regimens will include an even wider variety of central and peripheral-acting opioid and nonopioid analgesic compounds. However, minimal postoperative discomfort should be achievable for the majority of elderly outpatients undergoing ambulatory surgical procedures at the present time if practitioners implement existing evidence-based multimodal analgesic regimens involving both central and peripheral-acting analgesic drugs, as well as nontraditional analgesic therapies.[315] The aim of the analgesic technique should be not only to lower the pain scores and opioid analgesic requirement, but more important to facilitate earlier mobilization and rehabilitation of the elderly surgical patient by reducing complications after discharge home. Despite the increased use of multimodal analgesic regimens, a recent study from Sweden reported that 40% of the patients undergoing minor ambulatory surgery procedures (e.g., hernia repair, arthroscopy, cosmetic surgery) experienced pain or mobility problems at 1 week, 28% after 2 weeks, and 20% at 4 weeks postdischarge.[318]

KEYS TO FUTURE EXPANSION OF AMBULATORY SURGERY FOR THE ELDERLY

There are clear advantages for hospitals, patients, payers, and society-at-large in treating elderly surgical patients on an ambulatory basis. Moreover, a prospective, randomized study comparing patient satisfaction after knee reconstructive surgery performed on an inpatient versus outpatient basis confirmed that older patients preferred the ambulatory setting.[319] Therefore, it is important to consider the factors that will be crucial for expanding ambulatory surgery to an aging society in the years ahead.

Although cost containment has been the major driving force for the growth in ambulatory surgery, the economic benefits related to avoiding hospitalization after surgery must be balanced against the additional costs associated with unplanned hospital admissions to treat postoperative complications, as well as the increased need for postoperative medical and social support in extended care facilities and the home environment. In addition to selecting the best anesthetic and analgesic technique on a procedure-selective basis (Table 4), it is necessary to implement evidence-based clinical and social criteria for optimizing preoperative preparation and recovery after ambulatory surgery. When dealing with elderly surgical patients, careful preoperative planning for postoperative home care assumes increased importance. Providing a comfortable setting for the elderly surgical patient is also important because preoperative anxiety (distress) has been found to contribute to the severity of postoperative pain, nausea, and fatigue for up to 1 week after an elective operation.[52]

A growing body of literature supports the claim that even elderly patients with significant comorbidities, with the exception of acute heart failure,[57,320] can successfully undergo ambulatory surgery procedures.[38,321] When ambulatory surgery is performed by a skilled perioperative care team, minimizing operative duration and tissue trauma,[46,322] age per se and preexisting medical conditions should not preclude an elderly patient from undergoing ambulatory surgery.[323] However, there is a clear need for additional data on the influence of the elderly patient's preoperative functional status[324] (i.e., ability to maintain basic activities of daily life, degree of autonomy, and cognitive, psychological, and nutritional status) on postoperative outcomes. Whereas there are studies investigating this issue in elderly patients undergoing inpatient procedures,[325,326] no studies have been conducted in the ambulatory setting except for the previously mentioned POD/POCD study.[36]

It is widely accepted in the anesthesia community that poor baseline functional status in elderly patients increases their risk of an adverse outcome after ambulatory surgery. Worsening functional status caused by perioperative hospitalization, and the consequent loss of autonomy and risk of institutionalization, plays an important role in determining the long-term outcome of surgery.[327] The peer-reviewed literature[328–331] suggests that bed rest induces functional decline in elderly patients after merely 2 days of hospitalization. Paradoxically, the worse the patient's functional status is preoperatively, the greater the expected benefit of avoiding hospitalization. Nevertheless, there is general agreement that elderly patients scheduled for surgery in an ambulatory unit should be reasonably fit and any underlying medical conditions should be well controlled. Future studies are needed to determine whether it is better to treat frail individuals as outpatients, with the risk of falling and other postsurgical complications after returning to their home, or as an inpatient with the attendant risk of loss of autonomy, POCD, and nosocomial infectious and thrombotic complications, as well as functional decline due to bed rest and hospitalization.

It has recently been reported in the US[332] that when copayments for ambulatory care are increased, elderly patients (and especially those of low socioeconomic status with chronic illnesses) often forgo important outpatient care, leading to increased use of hospital and emergency room services. Considering that a lack of financial resources is a worldwide problem, and that copayments are often introduced as a means of reducing costs to hospitals and third-party payers, the long-term effect of these economic factors deserves more careful consideration with the aging surgical population presenting for elective surgery. Technological advancements in surgery and anesthesia will contribute to the future expansion of ambulatory surgery services for elderly patients. With the expected growth in minimally invasive, robotic surgery, and telemedicine, as well as improved anesthetic and analgesic techniques (e.g., ultrasound-guided nerve block procedures, long-acting local anesthetics [depo-bupivacaine]), ambulatory surgery for the elderly will continue to grow. New anesthetic and analgesic drugs (e.g., sugammadex, depo-bupivacaine) have the potential to reduce morbidity by facilitating a faster recovery for elderly patients.[333] However, these technological advances must be made available at a reasonable cost to the patient and the health care system.

Several articles[334–336] suggest that the use of mobile health systems and home telemedicine can lead to improved follow-up care after ambulatory surgery in the

Table 4. Recommendations Regarding Anesthetic and Local Analgesic Techniques, as well as Complications and Side Effects, for Commonly Performed Ambulatory Surgical Procedures in the Elderly Population

Type of surgery	Anesthetic techniques	Primary local anesthetic technique[a]	Complications and side effects
Cataract extraction and lens implant surgery	Local anesthesia with or without sedation (i.e., monitored anesthesia care)	Topical local anesthesia, peribulbar or retrobulbar blocks	Residual sedation, vasovagal reactions
Inguinal and femoral hernia surgery	Monitored anesthesia care or general anesthesia	Local anesthetic infiltration and ilioinguinal hypogastric nerve block	Urinary retention, peripheral nerve damage, difficulty walking and falling due to residual motor blockade
Breast surgery	Monitored anesthesia care or general anesthesia	Local anesthetic infiltration and/or paravertebral nerve blocks	Operative site bleeding and hematoma formation, nausea and vomiting
Cystoscopy; diagnostic (biopsy); TURBP, TURP, and bladder suspension	Monitored anesthesia care; general anesthesia or spinal anesthesia	Topical local anesthesia Topical instillation of local anesthetics	Dysuria; urinary retention (after catheter removal), bleeding, hyponatremia
Gynecologic surgery; cervical biopsy; vaginal hysterectomy	Monitored anesthesia care; general or spinal anesthesia	Paracervical nerve block	Vaginal bleeding, nausea and vomiting, dizziness, shoulder pain (if lap assisted)
Gastrointestinal endoscopy	Monitored anesthesia care	N/A	Residual sleepiness, dizziness on ambulation
Electroconvulsive therapy	General anesthesia	N/A	Transient amnesia, confusion, muscle aches, headaches
Knee arthroscopy	Monitored anesthesia care, general or spinal anesthesia	Local anesthetic infiltration at portals and intra-articular instillation	Difficulty walking, falling due to residual motor blockade
Shoulder arthroscopy	General or regional anesthesia	Single-shot or continuous brachial plexus block, and scapular nerve block	Difficulty utilizing upper extremity, inadvertent injury due to residual sensory block, catheter and pump-related problems
Foot and hand surgery	Monitored anesthesia care, general or spinal anesthesia	Local anesthetic infiltration and/or peripheral nerve block	Difficulty utilizing lower extremity (falling) and hand, respectfully, risk of inadvertent injury due to residual sensory block
Laparoscopic surgery; gynecology; general surgery	General anesthesia	Local anesthetic infiltration at portals and intraperitoneal	Shoulder (or right upper quadrant) pain, nausea and vomiting
Plastic surgery	Monitored anesthesia care or general anesthesia	Local anesthetic infiltration	Nausea and vomiting, hematoma formation
Anorectal surgery	Monitored anesthesia care, general or spinal anesthesia	Perirectal local anesthetic infiltration	Difficulty with defecation, wound infection, hematoma formation
Varicose vein surgery	General or regional anesthesia	Femoral-sciatic nerve block	Difficulty walking, pedal edema
Cardiac devices (e.g., pacemakers, defibrillators)	Monitored anesthesia care	Local anesthetic infiltration	Residual sedation
Dental (oral) surgery	Monitored anesthesia care	Local anesthetic infiltration	Bleeding, nausea and vomiting
Otolaryngologic surgery (e.g, otosclerosis, vocal cord lesions)	Monitored anesthesia care or general anesthesia	Topical and/or local anesthetic infiltration	Hoarseness, bleeding, upper airway obstruction, emesis, dizziness

TURP = transurethral resection of the prostate; TURBP = transurethal bladder biopsy; N/A = not applicable.
[a] All ambulatory surgery procedures should include a multimodal approach to perioperative pain management, which also incorporates both nonsteroidal anti-inflammatory drugs (NSAIDs) and acetaminophen (paracetamol) unless there is a specific contraindication to using these non-opioid analgesic drugs.

elderly. These systems are based on a mobile phone with built-in camera, which allows patients and their caregivers to send pictures of the surgical wound, blood pressure, heart rate, and pulse oximetry measurements to a hospital server. A trained professional reviews the data to assess the situation and resolve the concerns of the patient and/or their caregiver (e.g., hematomas or blood stained dressing, managing hypertensive or syncopal episodes due to sudden ambulation or arrhythmia). These systems may reduce the incidence of complications and unnecessary emergency room visits. In studies of telemedicine systems, patients reported feeling more secure and were highly satisfied using these systems in their home.[334,336] Elderly outpatients undergoing ambulatory procedures can benefit from this emerging technology if it is made more widely available and is intuitively easy to use after discharge by patients and/or their caregivers.

The aging population also has significant implication for the anesthesia and surgical workforce in the future. Etzioni et al.[337] analyzed the impact on the demand for specific

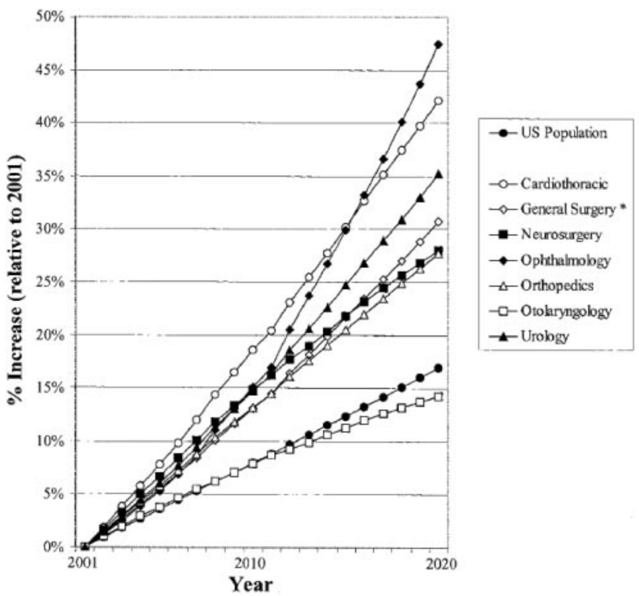

Figure 4. Percentage increase in the number of surgical subspecialists from 2001 through 2010 and the projected number that will be needed in 2020 in light of the projected increase in the number of elderly surgical patients in 2020 (from Etzioni et al., 2003,[337] reproduced with permission).

surgical services. These investigators reported that the numbers of ophthalmologic, cardiothoracic, urological, and general surgery procedures will likely increase at a rate exceeding overall population growth rate (Fig. 4). The ability of ancillary health care workers to manage the postoperative complications and side effects associated with the common ambulatory surgical procedures in the elderly (Table 1) outside the hospital environment will assume greater importance as the population ages.

Formulating a careful plan for postdischarge care on the basis of the patient's functional status should be undertaken during the perioperative period to assure effective communication among the patient, family, and health care providers. An effective organization for providing home health nursing care should be an integral part of the care plan for the elderly surgical population. This plan should identify and resolve age-related communication barriers, while incorporating provisions based on the patient's physical and medical condition and need for psychological support.[338] Elderly patients often face isolation from family and long-time friends, hearing and visual impairment, financial constraints, and emotional issues, which present unique challenges in expanding access to ambulatory surgical services for these patients in the future.

In conclusion, as ambulatory surgery continues to expand in our aging society, implementing evidence-based perioperative care programs for the elderly will assume increased importance. A recent study involving "elderly elderly" patients reported that postoperative ambulatory status is an important determinant of mortality in this growing surgical population.[339] Given the recent advances in anesthesia, surgery, and monitoring technology, the ambulatory setting offers many potential advantages for the elderly patient requiring elective surgery.

DISCLOSURES

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ACKNOWLEDGMENTS

We would like to thank Dr. Matthew Eng for his invaluable assistance with proofreading this manuscript and formatting the figures and tables.

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