Anesthesia considerations in the older adult patient
By Jennifer Garces, DNAP, CRNA, and Brittney Wallace, DNAP, CRNA

On January 1, 2011, the first members of the Baby Boomer generation turned 65 years old.1 Every day for the next 19 years, 10,000 baby boomers will reach age 65.1 Older adults undergo several age-related physiologic changes that directly impact their perioperative courses. Older adult patients experience profound alterations in pharmacokinetics and pharmacodynamics, directly or indirectly affecting individual responses to surgery. It’s imperative that all members of the perioperative team are aware of the physiologic changes associated with aging in order to provide safe and effective care. The purpose of this article is to provide the reader with a brief review of the cardiopulmonary, hepatic, and renal systems related to aging. In addition, pharmacokinetic and pharmacodynamic changes related to aging will be discussed within each of the three physiologic systems when appropriate. A review of normal musculoskeletal and integumentary changes that occur during aging will be provided to give a physiologic basis for perioperative positioning protocols. Awareness of normal physiologic changes that occur with aging can help the perioperative nursing team identify and prevent potential adverse events and contribute to successful surgical outcomes for older adult patients.

Cardiopulmonary changes
Aging is associated with a variety of cardiovascular changes. Lifestyle factors associated with nutrition, ability to exercise, and even dental care may affect cardiovascular health in ways that can decrease or amplify the aging process. Older adults are prone to cardiovascular disease related to vascular stiffening and alterations in cardiac diastolic function. These changes may predispose the patient to ischemia, heart failure, dysrhythmias, and other cardiovascular disorders. Changes at the cellular level that occur with the aging process may further increase one’s vulnerability to coronary artery, valvular, peripheral vascular, and cerebrovascular diseases.2 The stress of a surgical procedure may overwhelm any cardiovascular reserve that the patient may have and set the stage for a poor outcome. Excessive sympathetic stimulation experienced during the perioperative period may contribute to increased myocardial oxygen demand and decreased myocardial oxygen supply. Inadequate pain control and alterations in the daily routine of medication administration imposed by the “nothing by mouth” status may all lead to alterations in the physiologic response experienced by older adults during the surgical period. The complexity of determining baseline functional status due to the sedentary nature of many older adults may complicate the situation.

To illustrate, consider the incidence of perioperative dysrhythmias, which range from 4% to 20% for noncardiothoracic surgeries.3 Clinical experience reveals that when dysrhythmias occur in the perioperative setting, they’re often associated with profound hemodynamic instability and may be...
difficult to manage. Atrial fibrillation (AF) is the most common dysrhythmia seen postoperatively. While the mechanisms are poorly understood, surgical intervention and its accompanying sympathetic activation, fluid shifts, and electrolyte imbalances may contribute to the development of AF. Management of perioperative dysrhythmias begins with correction of electrolyte imbalances, severe anemia, hypoxemia, and hypoxia. Treatment for persistent AF may involve rate (and later rhythm) control and anticoagulation.

Perioperative myocardial ischemia may lead to significant increases in cardiac morbidity and mortality. In a large tertiary care hospital, 2.1% of patients undergoing major noncardiac surgery suffered severe cardiac events, including myocardial infarction (MI). For patients at high risk for perioperative MI, cardiac medications (excluding angiotensin-converting enzyme inhibitors, angiotensin II receptor antagonists, and diuretics) should be administered on the morning of surgery. Anticoagulant medications require special consideration and discussion with the surgical and anesthesia team, given the profound implications for bleeding associated with surgery as well as anesthetic choice (for example, regional anesthesia in which a needle or catheter may trigger bleeding).

The perioperative nurse must have a focused plan for patients presenting with hypertension, coronary artery disease, and dysrhythmias. The patient may be taking several antihypertensive agents. Part of a thorough preoperative interview is determining what medications the patient takes on a chronic or acute basis, including over-the-counter medications, herbal medicines, and dietary supplements. There is a wide range of variables regarding the interpretation and consumption of routine medications in older adults presenting for surgery. Patients may have discontinued some or all medications several days prior to presenting for surgery. A complete and detailed history regarding all medication consumption coupled with accurate preoperative vital signs can help the perioperative team prevent or manage adverse events.

Postoperative pulmonary complications are more common in older adults. Aging lungs resemble lungs with emphysema due to the alveolar enlargement. Normal lung aging is characterized by decreased elastic recoil of the lung, increased chest wall rigidity, and decreased respiratory muscle strength. There’s also a higher prevalence of chronic obstructive pulmonary disease in older adults. These patients experience a decline in airway protective cough and swallowing reflexes, which may be a concern during regional anesthesia and monitored anesthesia care where sedation drugs are used. In healthy, non-smoking, supine patients, the following equation is used to calculate arterial oxygen tension: \( \text{PaO}_2 = 109 - (0.43 \times \text{age}) \). While a decrease in arterial oxygen tension is seen in aging patients, the decrease isn’t likely to be linear after age 70.

**Hepatic changes**

Age-related changes in hepatic metabolism of medications don’t decrease uniformly. The aged liver decreases in size and regional blood flow, and there’s a moderate decline in the metabolism of certain drugs. It’s clear from the literature there’s a blunted hepatic response to oxidative stress, decreased rates of DNA repair, and impaired hepatic regeneration associated with normal aging.

**Renal changes**

Kidney function decreases in normal aging. Change is found in both renal structure and function; declines are seen in renal size, weight, and glomerular filtration rate (GFR). The renal plasma flow decreases, leading to an increased filtration fraction. The aging kidney has a reduced ability to react to pathophysiological changes due to diminished capillary loops per unit, thickening of the basement membrane of the glomerulus, and glomerulosclerosis. Blood flow is diverted from the cortex to the medulla through shunt vessels. After age 40, the kidney has fewer glomeruli, resulting in decreased capillary bed and blood flow. Kidney disease can occur without hypertension, but in patients with diabetes and hypertension, the functional deterioration is accelerated.

The renin-angiotensin-aldosterone system helps maintain BP and homeostasis. Plasma renin and aldosterone levels decline with age. Older adults typically respond well to diuretics and calcium antagonists because these decrease renin levels. Notably, the low levels of renin and aldosterone may lead to hyperkalemia. The commonly seen water retention and hyponatremia is related to an
increase in the response to vasopressin and a decline in renal function.\textsuperscript{11} Diuretic use itself may contribute to renal dysfunction. Prostate enlargement in male patients may cause a urinary obstruction that factors into electrolyte imbalance and fluid retention. Current research lacks the ability to detect if all renal changes are actually age-related or pathologic.

Decreased renal function causes prolonged duration of action and decreased renal excretion of medications. Drugs predominantly excreted by the kidney will likely have extended effects. Fluid balance must be monitored closely in all patients with renal disease.

**Musculoskeletal and integumentary changes**

A thinner layer of subcutaneous fat can lead to an increased risk of pressure ulcer development. Special attention is needed to prevent pressure ulcers that may increase morbidity and mortality. There’s also decreased skin elasticity and turgor along with skin thinning.\textsuperscript{12} Tape, electrosurgical unit dispersive pads, and ECG electrodes can cause injury to the skin. Noninvasive BP cuffs can damage fragile blood vessels during long surgeries. The perioperative nurse may consider adding a protective barrier underneath the BP cuff to prevent injuries.

Nearly all older adults are arthritic, and limited neck mobility can lead to a challenging intubation. Vascular disease can lead to verteobasilar insufficiency with neck extension, and symptomatic neck extension must be assessed while the patient is awake.

Thermoregulation is an important perioperative consideration when caring for older adult patients. In studies of human body temperature, advanced age is consistently associated with lower body temperature. Lower body temperature in the older adult may reflect age-related loss of thermoregulation.\textsuperscript{13} These patients can’t compensate for temperature changes due to a reduced efficiency in vasoconstriction and vasodilation.\textsuperscript{12}

**Pharmacokinetic and pharmacodynamic changes**

Research on pharmacokinetic and pharmacodynamic changes with aging is limited. Physiological changes in the older adult population affect the pharmacokinetics of drugs. The frequency and the severity of adverse drug reactions (ADRs) increase with age. Eighty percent of ADRs are due to dose-related complications.\textsuperscript{14} Polypharmacy in the older adult contributes to an increased risk of drug interactions and toxicity.

Absorption is normally unchanged in the older adult, despite an increased gastric pH, decreased secretory capacity, and diminished gastrointestinal blood flow. Body fat percentage increases, while lean body mass and body water decreases, altering drug distribution. Volume of distribution is normally increased for lipophilic drugs and decreased for hydrophilic drugs; fat-soluble drugs will have increased duration of action.\textsuperscript{9} The decrease in plasma albumin can lead to increased available drug, but drugs binding to alpha-acid glycoprotein (AAG) will have decreased distribution, as AAG levels generally increase with age.\textsuperscript{9} Examples of drugs with increased free fraction in plasma include acetaminophen, lidocaine, phenobarbital, and phenytoin. The loading dose of such drugs should be reduced due to the overall decrease in volume of distribution.

The impact of aging on pharmacodynamics is not well described; however, it’s generally appreciated that there are receptor alterations with aging. The number of parasympathetic nervous system muscarinic receptors is likely decreased, which may result in a decrement in memory. A diminished functionality of beta-adrenergic receptors leads to blunted inotropic (contraction strength) and chronotropic (rate) response.\textsuperscript{15} Alpha\textsubscript{1} adrenergic receptors are reduced in the liver, but the process of glycogenolysis stimulation remains unaltered.\textsuperscript{11} Changes in opioid receptor function lead to an increase in anorexia and hypodipsia symptoms.\textsuperscript{11} Reduced parathyroid function and decreased renal activation of vitamin D lead to alteration in circulating calcium levels.\textsuperscript{11}
Changes in the pharmacokinetic and pharmacodynamics can lead to adverse events before, during, and after surgery. The perioperative nurse must have heightened awareness of patient changes in vital signs or mental status, particularly following long surgeries that require large amounts of opiates or neuromuscular blocking agents. Both medications may lead to increased risk of respiratory depression if they’re not properly metabolized or antagonized. To optimize safety, some fragile older adult patients, especially those who have received central nervous system depressant drugs, may require continuous monitoring by pulse oximetry throughout the perioperative phases of their care, including during transport to the postanesthesia care unit.

Moving forward
In summary, the focus of the perioperative nurse during surgery and anesthesia in the older adult patient is to understand and minimize harmful physiological and psychological impacts (see Common physiologic changes and diseases in older adults). As our population ages and medical technology advances, perioperative teams that understand and manage the normal body system changes in the older adult patient can help prevent perioperative complications. Informed nurses can focus their assessments and devise care plans specific to the older adult.

REFERENCES

Jennifer Garces is a CRNA at Massachusetts General Hospital, Boston, Mass., and Brittnie Wallace is a CRNA at Spotsylvania Regional Medical Center, Fredericksburg, Va.

The authors have stated that they have no financial relationships related to this article.

DOI:10.1097/01.ORN.0000431591.66948.e2

Common physiological changes and diseases in older adults

Cardiovascular
- Left ventricular hypertrophy
- Thickened vascular intimal layer
- Left atrial hypertrophy
- Decreased vascular elasticity

Pulmonary
- Increased postoperative pulmonary complications
- Reduced response to hypercarbia and hypoxia

Hepatic
- Decreased serum albumin
- Reduced hepatic blood flow
- Reduced drug metabolism

Renal
- Low renin and aldosterone levels
- Decreased concentrating ability
- Prostate enlargement
- Prolonged effects of renally excreted drugs

Musculoskeletal
- Arthritis

Integumentary
- Thin subcutaneous layer
- Impaired thermoregulation
- Decreased skin elasticity and turgor