A Geriatric Anesthesiology Curriculum

A ***Geriatric Anesthesiology Curriculum*** was created through the collaborative efforts of the members of the American Society of Anesthesiologists Committee on Geriatric Anesthesia and the Society for the Advancement of Geriatric Anesthesiology (SAGA). It was developed in cooperation with the American Geriatrics Society (AGS) and supported through the AGS/John A. Hartford Foundation of New York City Project: *Increasing Geriatrics Expertise in Surgical and Related Medical Specialties*.

Editors:

- Sheila R. Barnett, MD; Beth Israel Deaconess Medical Center, Harvard Medical School
- Christopher J. Jankowski, MD; Mayo Clinic College of Medicine, Rochester, MN
- Shamsuddin Ahktar, MD; Yale University School of Medicine, New Haven, CT

Contributors:

- Ruma Bose, MD; Beth Israel Deaconess Medical Center, Harvard Medical School
- Deborah J. Culley, MD; Brigham and Women's Hospital, Harvard Medical School
- Leanne Groban, MD; Wake Forest University School of Medicine, NC
- Michael C. Lewis, MD; Miller School of Medicine, University of Miami
- Terri G. Monk, MD, MS; Duke University Medical Center, NC
- G. Alec Rooke, MD, PhD; Beth Israel Medical Center, Harvard Medical School & University of Washington, Seattle
- Frederick E. Sieber, MD; Johns Hopkins Bayview Medical Center, MD
- Jeffrey H. Silverstein, MD; Mount Sinai School of Medicine, NY
- Mary Ann Vann, MD; Beth Israel Deaconess Medical Center, Harvard Medical School
- Zhongcong Xie, MD, PhD; Massachusetts General Hospital, Harvard Medical School
- *Resident participant:* Kai Matthes, MD, PhD; Beth Israel Deaconess Medical Center, Harvard Medical School

Created and approved by the American Society of Anesthesiologists (ASA) Committee on Geriatric Anesthesia: October 14th 2007

A Geriatric Anesthesiology Curriculum

Table of Contents

SUBSPECIALTY AREAS

24. ICU issues
25. Chronic Pain Syndromes

COMPLETE LIST OF REFERENCES

Reference Books: *These textbooks provide comprehensive up to date information on Geriatric Anesthesiology.*

Geriatric Anesthesia, Edited by Sieber FE, McGraw-Hill Companies, Inc., New York, New York, 2007

Geriatric Anesthesiology, Edited by Silverstein JH, Rooke GA, Reves JG, McLeskey CH (eds) 2nd Edition, Springer, New York 2008

Geroanesthesia Muravchick, S. St. Louis, Mosby, 1997.

ASA Syllabus

A Geriatric Anesthesiology Curriculum

The population is rapidly aging – and the oldest old (> 85 years) in our society represent the most rapidly growing section in the population. Thirty five percent of surgeries in the USA are performed on patients over the age of 65 years – totaling more than 16 million operations annually. For anesthesiologists this means that an understanding of the consequences of aging will be required to safely administer anesthesia to this segment of the population.

Aging results in a steady decline in functional reserve, and each organ system is affected to a variable degree by 'normal' aging. Accordingly, there are predictable changes that may affect an older person's ability to undergo surgery and anesthesia. The presence of numerous comorbid conditions in elderly patients unpredictably alter the aged patient's ability to respond to stress and illness. Thus, the challenge of administering an anesthetic to elders lies in gauging the individual's functional or physiological status vs. the stated *chronological* age.

The goal of this curriculum is to provide a comprehensive list of topics for the Consultant in Geriatric Anesthesiology. Each section contains one or more broad goal accompanied by corresponding objectives. A select bibliography is included, with a brief statement of relevance for each article. It is understood that the depth of knowledge and expertise will vary depending on the interest and practice of the practitioner.

BACKGROUND

1. Definitions and Demographics

Goals:

1. To understand common terms of senescence and aging.
2. To understand demographic trends in surgery and aging.
3. To understand evolving concepts of outcomes in geriatrics.

Objectives:

1. Define normative aging, including the following terms: Old; Old Old, Elderly and the Oldest Old. Definitions should include comments on heterogeneity, variability, and decreased organ system functional reserve in aging.
2. Describe characteristics associated with 'frailty'
3. Define the Medicare population.
4. Comment briefly on the role of a geriatrician and the surgical patient.
5. List primary surgical procedures in the elderly.
6. Describe the key factors affecting surgical survival in elderly patients, for example, surgical type and emergency status.

References:

1. Hosking MP, Warner MA, Lobdell CM, Offord KP, Melton LJ, 3rd. Outcomes of surgery in patients 90 years of age and older. Jama 1989;261:1909-15.
A *case series of 795 surgical patients 90 years of age and older and their long-term outcomes.*

2. Scott BH, Seifert FC, Grimson R, Glass PS. Octogenarians undergoing coronary artery bypass graft surgery: resource utilization, postoperative mortality, and morbidity. J Cardiothorac Vasc Anesth 2005;19:583-8.
In patients undergoing CABG, age 80 years or older is an independent predictor of increased resource utilization, postoperative morbidity, and mortality.

3. Geriatrics Review Syllabus 6th Edition; Chapter 1.
www.geriatricsreviewsyllabus.org
This chapter gives a comprehensive discussion of the demographics of aging in America.

4. Libow LS. Geriatrics in the United States--baby boomers' boon? N Engl J Med 2005;352:750-2.
A discussion of the role that geriatrics will play in the 'graying' of America.

5. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-47.
A good review of frailty.

6. Finlayson EV, Goodney PP, Birkmeyer JD. Hospital volume and operative mortality in cancer surgery: a national study. Arch Surg 2003;138:721-5; discussion 726.
Operative mortality decreases with increasing hospital volume for several cancer resections. However, volume may be most important in patients who are older.

7. Goodney PP, Siewers AE, Stukel TA, Lucas FL, Wennberg DE, Birkmeyer JD. Is surgery getting safer? National trends in operative mortality. J Am Coll Surg 2002;195:219-27..
This paper provides mortality rates for many types of procedures.

8. Liu LL, Leung JM. Predicting adverse postoperative outcomes in patients aged 80 years or older. J Am Geriatr Soc 2000;48:405-12.
This study looks at the importance of intraoperative versus preoperative risk factors in predicting adverse postoperative events in geriatric patients.

9. Hazzard W, Ouslander J, Blass J, Halter J, Tinetti M. Principles of Geriatric Medicine & Gerontology. McGraw-Hill 2003.
An excellent comprehensive textbook on all aspects of Geriatrics. Key chapters include those related to normal age-related changes.

10. Hamel MB, Henderson WG, Khuri SF, Daley J. Surgical outcomes for patients aged 80 and older: morbidity and mortality from major noncardiac surgery. J Am Geriatr Soc 2005;53:424-9.
This is a large prospective study looking at morbidity and mortality in old and very old veterans' postoperatively. They found that postoperative mortality at 30 days was greater in very old (over 80 years) vs. younger old patients; 8% vs. 3%. However for minor operations such as hernia repair or TURP the mortality rate was low (<2%) even in the oldest patients. Postoperative complications in the oldest patients was associated with a higher 30 day mortality.

2. Knowledge of Health Care/Economical Issues Related to Aged Patients

Goals:

1. To understand the basic distinction between Medicare vs. Medicaid.
2. To understand types of care facilities and the level of care provided in the facilities.
3. To understand the cost and importance of prevention of perioperative complications.

Objectives:

1. Define Medicare Part A, B, D.
2. Define Pay for Performance.
3. Describe distinguishing features of different types of post-hospitalization housing available for the elderly patient (e.g. skilled nursing facilities, nursing homes etc.

References:

1. Geriatrics Review Syllabus 6th Edition; Chapters 1 & 5.
www.geriatricsreviewsyllabus.org
These chapters provide comprehensive discussions on the demographics of aging in America (Ch 1) and on the financing of health care including Medicare for the elderly in America (Ch 5).

2. Birkmeyer NJ, Birkmeyer JD. Strategies for improving surgical quality--should payers reward excellence or effort? N Engl J Med 2006;354:864-70.
A discussion of several strategies to improve surgical care including centers of excellence, pay for performance, and pay for participation.

3. www.medicare.gov

The federal government's Medicare website.

4. Fisher ES. Paying for performance--risks and recommendations. N Engl J Med 2006;355:1845-7.
A perspective article which summarizes the advantages and disadvantages of pay for performance programs.

6. Hazzard W, Ouslander J, Blass J, Halter J, Tinetti M. Principles of Geriatric Medicine & Gerontology. McGraw-Hill 2003.
An excellent comprehensive textbook on all aspects of Geriatrics.

3. Knowledge of Ethical Considerations in Aged Patients

Goals:

1. Understanding the issues of consent.
2. Understand the distinction between advanced directives, DNR, health care proxy, and living wills
3. Understand concept of futility.

Objectives

1. Explain how to decide if a patient has the capacity to consent.
2. Explain who is able to consent if the patient is not able.
3. Explain the local rules regarding advanced directives.
4. How is DNR defined in your institution?
5. Explain mechanism and systems for withdrawal of care.

References:

1. Truog RD, Waisel DB, Burns JP. DNR in the OR: a goal-directed approach. Anesthesiology 1999;90:289-95.
   This report reviews our current understanding of DNR in the OR. In addition it provides practical recommendations for dealing with DNR orders in the OR and explores the concept of goal directed and procedure specific DNR orders.

2. Mueller PS, Hook CC, Fleming KC. Ethical issues in geriatrics: a guide for clinicians. Mayo Clin Proc 2004;79:554-62.
   This review provides an excellent case based overview of ethical dilemmas commonly encountered when caring for geriatric patients. The article reviews the determination of decision making capacity, explains the role of the Advance Directive and discusses DNR and withdrawal of care amongst other topics. The review provides an informative synopsis for those caring for elderly patients.

3. Corfield LF. To inform or not to inform: how should the surgeon proceed when the patient refuses to discuss surgical risk? J Vasc Surg 2006;44:219-21.
This brief article raises some provocative issues surrounding informed consent and full disclosure of risk related to a surgery. It emphasizes the sometimes contradictory wishes of the patient and the physician.

4. Marik PE. Should age limit admission to the intensive care unit? Am J Hosp Palliat Care 2007;24:63-6.
This brief report emphasizes the need to consider the patient's medical condition and wishes versus their age when considering admission to the ICU. It provides a succinct review of available data on admission of elderly patients to the ICU.

ORGAN SYSTEMS

4. Understanding Anesthesia and the Impact of Aging on the Central and Peripheral Nervous Systems

Goals:

1. Understand normal age-related cognitive changes, stroke, Parkinson's disease, Alzheimer's disease, normal pressure hydrocephalus, cervical myelopathy, anesthesia and the impact of aging on neurotransmitter systems.
2. Understand normal age-related changes in the autonomic nervous system and its effect on anesthetic administration.
3. Understand normal physiologic changes in visual, auditory, and tactile systems.
4. Understand changes in peripheral nervous system function affecting pain transmission and proprioception.

Objectives:

1. To be able to describe the major transmitter systems involved in cognitive function and how age and anesthesia modify them.
2. To be able to perform a basic assessment of auditory, visual, tactile senses.
3. Describe changes in the peripheral nervous system influencing anesthetic choices.
4. Describe the impact of normal age-related cognitive changes and common central neurologic diseases on anesthesia assessment, consent, and evaluation.

References

Goal 1:

1. Buckner RL. Memory and executive function in aging and AD: multiple factors that cause decline and reserve factors that compensate. Neuron 2004;44:195-208.
   This article reviews both normal and pathologic age-related changes in learning and memory. In addition, it describes some of the structural changes that occur in the normal and pathologic aged brain. In addition, it discusses normal compensations that occur in cognitively healthy aged individuals.

2. Blacker DJ, Flemming KD, Link MJ, Brown RD, Jr. The preoperative cerebrovascular consultation: common cerebrovascular questions before general or cardiac surgery. Mayo Clin Proc 2004;79:223-9.
   This article reviews risk factors for the development of perioperative stroke and potential mechanisms and risk factors involved in its development.

3. Burton DA, Nicholson G, Hall GM. Anaesthesia in elderly patients with neurodegenerative disorders: special considerations. Drugs Aging 2004;21:229-42.
   A review article that describes age-related neurodegenerative diseases with an emphasis on Parkinson's disease. The article describes normal and neurodegenerative changes in the aged brain, issues related to drug therapy and administration during the perioperative period and anesthetic implications of neurodegenerative diseases and the pharmacologic agents used to treat them.

4. Backman L, Nyberg L, Lindenberger U, Li SC, Farde L. The correlative triad among aging, dopamine, and cognition: current status and future prospects. Neurosci Biobehav Rev 2006;30:791-807.
   This article reviews the age-related changes in brain dopamine levels and its association with normal and pathologic cognitive decline in aging.

5. Terry AV, Jr., Buccafusco JJ. The cholinergic hypothesis of age and Alzheimer's disease-related cognitive deficits: recent challenges and their implications for novel drug development. J Pharmacol Exp Ther 2003;306:821-7.
   Impairment in cholinergic neural transmission has long been thought to be involved with both normal and aged related cognitive decline. This review highlights those findings as well as new evidence challenging the cholinergic hypothesis of normal age-related cognitive impairment.

6. Segovia G, Porras A, Del Arco A, Mora F. Glutamatergic neurotransmission in aging: a critical perspective. Mech Ageing Dev 2001;122:1-29.

This review describes the effects of aging on the glutamatergic neurotransmitter system.

Goal 2:

1. Seals DR, Esler MD. Human ageing and the sympathoadrenal system. J Physiol 2000;528:407-17.
   A review of normal age-related changes in the sympathetic nervous system.

Goal 3:

1. Jackson GR, Owsley C. Visual dysfunction, neurodegenerative diseases, and aging. Neurol Clin 2003;21:709-28.
   This article reviews the four most common causes of sight threatening diseases and how they alter quality of life in elders.

2. Shaffer SW, Harrison AL. Aging of the somatosensory system: a translational perspective. Phys Ther 2007;87:193-207.
   This article reviews alterations in the somatosensory system that occur with age and potential mechanisms by which these changes occur.

Goal 4:

1. Verdu E, Ceballos D, Vilches JJ, Navarro X. Influence of aging on peripheral nerve function and regeneration. J Peripher Nerv Syst 2000;5:191-208.
   A comprehensive review of the effects of aging on the peripheral nervous system and its ability to regenerate after injury are described in this review article.

2. Gibson SJ, Farrell M. A review of age differences in the neurophysiology of nociception and the perceptual experience of pain. Clin J Pain 2004;20:227-39.
   This article reviews normal age-related changes that occur in the peripheral and central nervous system that contribute to altered pain perception and response in the aged.

5. Understanding anesthesia and the impact of aging on the cardiovascular system

Goals:

1. Understand normal age-related changes in vascular structure and function that contribute to increases in systolic and pulse pressure and systolic hypertension.
2. Understand normal age-related changes in cardiac structure and function that contribute to left ventricular hypertrophy, diastolic dysfunction, and atrial arrhythmias.

3. Understand how normal age-related cardiovascular changes confer risk for overt cardiovascular diseases such as coronary artery disease, congestive heart failure, and atrial fibrillation.
4. Understand the impact of normal age-related cardiovascular changes on cardiovascular reserve capacity and understand methods to assess cardiovascular reserve capacity.

Objectives:

1. Describe how to preoperatively assess the aged cardiovascular system.
2. Describe the physiologic basis for blood pressure lability in the aged patient during general anesthesia and central regional anesthesia.
3. Define and differentiate between diastolic dysfunction and diastolic heart failure. Describe therapeutic management strategies for the aged patient with diastolic dysfunction, particularly volume management Goals.
4. Explain risk stratification and management of the aged cardiovascular-risk patient emphasizing ischemia, arrhythmias, and heart failure risks.

References:

General Physiology and Pathophysiology of CV Aging

1. Lakatta EG, Levy D. Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises: Part II: the aging heart in health: links to heart disease. Circulation 2003;107:346-54.
    a. Part 1of 3: Aging Arteries: A Set up for Vascular Disease. *Circulation* 107 (2003): 139-146.
    This paper presents the normal age-associated changes in vasculature, e.g. increased intimal thickness, large artery dilation, and increased central arterial stiffness, that contribute to systolic hypertension and increases in pulse wave velocity and pulse pressure, ultimately conferring risk for overt clinical cardiovascular disease. Epidemiologic evidence for unsuccessful vascular aging and increased cardiovascular morbidity and mortality is inlcluded.
    b. Part 2 of 3: The Aging Heart in Health: Links to Heart Disease. *Circulation* 107 (2003): 346-354.
    This paper presents normal age associated changes in cardiac structure and function, e.g. left ventricular hypertrophy, diastolic dysfunction, impaired responses to β-receptor stimulation, and atrial fibrillation, conferring risk for future cardiovascular disease. The concept that age-related changes in cardiac structure/function (e.g. diastolic dysfunction) often remain

subclinical until the occurrence of an acute stress (e.g. surgery, infection), at which time overt cardiovascular disease (e.g.diastolic heart failure) in the elderly becomes apparent, is discussed.

c. Part 3 of 3: Cellular and Molecular Clues to Heart and Arterial Aging. *Circulation* 107 (2003): 490-*497.*
This paper presents data from nonhuman primate and rodent studies of the various cellular and molecular mechanisms currently implicated in age-associated changes in vascular and cardiac aging. An understanding of these molecular mechanisms (e.g. vascular and cardiac remodeling) may provide hints to effective strategies that for preventing or attenuating the development of clinical disease of the aging heart and brain.

2. N Najjar SS, Scuteri A, Lakatta EG. Arterial aging: is it an immutable cardiovascular risk factor? Hypertension 2005;46:454-62.
Excellent review summarizing the biochemical, enzymatic, and cellular evidence that implicate accelerated arterial aging as a risk factor for cardiovascular disease and adverse cardiovascular outcomes of aging.

3. Kass DA. Ventricular arterial stiffening: integrating the pathophysiology. Hypertension 2005;46:185-93.
This review provides an outstanding explanation of ventricular-arterial stiffening disease and its impact on cardiovascular reserve in the elderly. Specifically, age-related increases in arterial and ventricular stiffness may enhance pressure lability with fluid and postural shifts, salt loading, and exertion in the elderly. Also, reference to the human study of vascular-ventricular coupling across ages can be found in: J Am Coll Cardiol 1998:32:1221-7.

4. Aurigemma GP, Gaasch WH. Clinical practice. Diastolic heart failure. N Engl J Med 2004;351:1097-105.
This paper reviews the clinical presentation, diagnosis, and management principles of the patient with diastolic heart failure.

Anesthetic implications of CV changes of aging

1. Priebe HJ. The aged cardiovascular risk patient. Br J Anaesth 2000;85:763-78.
This is an outstanding review of the most relevant age-related cardiovascular changes that impact perioperative management in the elderly. Specific discussions include a) age-related declines in resting organ function that ultimately limit reserve capacity, b) age-related progression of chronic diseases that limit baseline function and accelerate functional reserve, and c) the increased intake of

medications and altered pharmacodynamics of advanced age that contribute to untoward reactions to anesthetics and surgical interventions in the elderly.

2. Rooke GA. Cardiovascular aging and anesthetic implications. J Cardiothorac Vasc Anesth 2003;17:512-23.
   This excellent review discusses how changes in cardiovascular aging contribute to hemodynamic instability, myocardial ischemia, heart failure, arrhythmias, and stroke. Suggestions for anesthetic management are also provided.

3. Groban L. Diastolic dysfunction in the older heart. J Cardiothorac Vasc Anesth 2005;19:228-36.
   This paper reviews the physiology of diastole, the pathophysiology of diastolic dysfunction and the clinical implications of diastolic dysfunction in the perioperative period.

4. Groban L, Butterworth J. Perioperative management of chronic heart failure. Anesth Analg 2006;103:557-75.
   This is a comprehensive review of current medical management of chronic heart failure, focusing on the results of large-scale, randomized clinical trials and published guidelines. Given the increased incidence of heart failure in the elderly, this review provides the anesthesiologist with the contemporary 'best practices' to make appropriate diagnostic and treatment choices and appropriate judgments about the need for cardiac consultations. Perioperative implications relating to each drug class (e.g. ACE-inhibitors) are also discussed.

6. Understanding Anesthesia and the Impact of Aging on the Upper Airway and Pulmonary System

Goals:

1. Understand the interaction between pulmonary age-related changes and disease.
2. Understand how to assess pulmonary reserve.

Objectives:

1. Describe age-related changes in pulmonary mechanics and pulmonary function tests.
2. Explain how to assess pulmonary reserve.
3. Explain how age-specific mechanisms contribute to hypoxia.
4. Explain risk stratification and preventions of pneumonia.
5. Explain the interaction between lack of pulmonary reserve and anesthesia delivery.

References:

1. Sprung J, Gajic O, Warner DO. Review article: Age related alterations in respiratory function - anesthetic considerations: [Article de synthese : Les modifications de fonction respiratoire liees a l'age - considerations anesthesiques]. Can J Anaesth 2006;53:1244-57.
   This review examines the impact of aging on pulmonary reserve. It provides an overview of common anesthetic and surgical factors that impose substantial stress on respiratory system in elderly patients; contributing to an increased risk of post operative complications, including respiratory failure.

2. Janssens JP, Pache JC, Nicod LP. Physiological changes in respiratory function associated with ageing. Eur Respir J 1999;13:197-205.
   Physiological aging is associated with dilatation of alveoli, enlargement of air spaces decrease in exchange surface area and loss of supporting tissue for peripheral airways (senile emphysema). Decreased perception of bronchoconstriction and diminished physical activity may result in lesser awareness of disease and delayed diagnosis.

3. Zeleznik J. Normative aging of the respiratory system. Clin Geriatr Med 2003;19:1-18.
   There is no evidence that changes in respiratory system with aging impact day to day function of older patients but the decline in pulmonary reserve function may become evident under circumstances of increased stress, such as during surgery. Established predictive values of a diagnostic test done in young adults cannot be applied to geriatric patients.

4. Wahba WM. Influence of aging on lung function--clinical significance of changes from age twenty. Anesth Analg 1983;62:764-76.
   This is an older comprehensive review of the aging lung.

7. Understanding Anesthesia and the Impact of Aging on Endocrine and Metabolic Function

Goals:

1. Understand body composition changes.
2. Understand age-related changes in endocrine function.

Objectives:

1. Describe the hepatic and renal changes associated with aging.

2. Describe age-specific changes in the endocrine system and an approach to assessing its functional reserve..
3. Define hypo- and hyper-natremia, and hyperglycemia versus diabetes.
4. Describe consequences of acute electrolyte disorders (e.g. TURP syndrome, including common procedures associated with its occurrence and treatment.)
5. Define malnutrition and perioperative nutrition issues (for instance NPO guidelines).
6. Explain possible consequences of hypoalbuminemia.
7. Describe recommendations for renal, pancreatic and liver transplantation in the elderly patient.

References:

Diabetes

1. Jack L, Jr., Boseman L, Vinicor F. Aging Americans and diabetes. A public health and clinical response. Geriatrics 2004;59:14-7.
   Older Americans face an increased burden of diabetes. This article reviews both the public health and clinical response. It offers an overview of diabetes treatment strategies for the elderly; the function of psychosocial processes in diabetes management; execution of diabetes treatment guidelines; and identifies resources for patient education.

2. Connery LE, Coursin DB. Assessment and therapy of selected endocrine disorders. Anesthesiol Clin North America 2004;22:93-123.
   This review addresses the management of a several endocrine disorders during the perioperative period. A large section deals with diabetes (types 1 and 2). The authors point out that diabetes remains the most commonly encountered endocrinopathy. It is noted that patients with either type require more surgical procedures than their non-diabetic counterparts and exhibit greater peri-operative morbidity and mortality. The authors conclude with a call for more evidence based guidelines in caring for the ever increasingly encountered perioperative diabetic.

3. Robertshaw HJ, Hall GM. Diabetes mellitus: anaesthetic management. Anaesthesia 2006;61:1187-90.
   This article reviews the anesthetic management of diabetes. Although it does not deal specifically with the elderly it provides a useful overview of glucose management strategies relevant to many older patients. The authors note that in the postoperative period a decrease in catabolism as a result of good analgesia and the avoidance of nausea and vomiting contribute to early re-establishment of normal glycemic control.

Hepatic

1. Schmucker DL. Liver function and phase I drug metabolism in the elderly: a paradox. Drugs Aging 2001;18:837-51.
   The liver plays a major role in drug clearance and aging is accompanied by non-pathological changes in physiology both at the cellular and organ levels. Although aging is accompanied by minimal structural changes the authors report a report a reduction in the clearance of drugs that undergo mandatory oxidation by the microsomal cytochrome P450-dependent mono-oxygenase systems.

Renal

1. Beck LH. Perioperative renal, fluid, and electrolyte management. Clin Geriatr Med 1990;6:557-69.
   This comprehensive review provides an overview of age-related physiologic changes in the renal system and the impact of these changes during the perioperative period. The most important alterations are decreases in the GFR, decreased urinary concentrating ability, and narrowed limits for the excretion of water, sodium, potassium, and acid. The most important principle for the prevention of renal complications in the elderly surgical patient is maintenance of normal intravascular volume. Meticulous attention must be paid to salt and water balance and to drug dosing. In the event that perioperative renal insufficiency occurs, evaluation and management in the elderly patient are similar to usual practices in a younger individual.

Thyroid

1. Rehman SU, Cope DW, Senseney AD, Brzezinski W. Thyroid disorders in elderly patients. South Med J 2005;98:543-9.
   This review article provides an excellent overview of thyroid disease in the elderly, although not specific to the operative patient the information s still relevant.Thyroid disorders are associated with significant morbidity if left untreated. Often symptoms may be not present and may be mistakenly ascribed to normal aging or coexisting disease. Only myxedema coma requires levothyroxine parenterally; all other forms of hypothyroidism can be treated with oral levothyroxine. Low-dose levothyroxine should be initiated and increased gradually over several months. In unstable elderly patients with hyperthyroidism, antithyroid medication can quickly produce a euthyroid state. Parathyroid disease and consequent hypercalcemia and bone loss can occur at any age but is more common after the 6th decade.

Calcium Metabolism

Kebebew E, Duh QY, Clark OH. Parathyroidectomy for primary hyperparathyroidism in octogenarians and nonagenarians: a plea for early surgical referral. Arch Surg 2003;138:867-71.
The authors note that the diagnosis of hyperparathyroidism is often difficult because many of its symptoms are difficult to distinguish from the aging process. Furthermore, surgical referral of elderly

patients with hyperparathyroidism is often deferred because of the perceived risks of general anesthesia, increased age, and co-morbidities. It concludes that parathyroidectomy in elderly patients is frequenltly safe, curative, and beneficial.

Renal and Electrolytes

1. Novis BK, Roizen MF, Aronson S, Thisted RA. Association of preoperative risk factors with postoperative acute renal failure. Anesth Analg 1994;78:143-9.
   An older, but excellent review of risk factors for renal failure postoperatively. Postoperative renal failure is not common but is associated with high mortality.

2. Sear JW. Kidney dysfunction in the postoperative period. Br J Anaesth 2005;95:20-32.
   Although not specific to the elderly population, this is an excellent and comprehensive review of renal physiology and the potential impact of surgery and anesthesia on fluid homeostasis.

3. Gravenstein D. Transurethral resection of the prostate (TURP) syndrome: a review of the pathophysiology and management. Anesth Analg 1997;84:438-46.
   Although the TURP procedure has become less popular, this review provides an excellent summary of the procedure and potential physiological consequences. It addresses the controversies surrounding the pathophysiology related to the TURP syndrome.

Transplantation

1. Morrissey PE, Yango AF. Renal transplantation: older recipients and donors. Clin Geriatr Med 2006;22:687-707.
   This review provides a comprehensive overview of renal transplantation in the elderly patient.

2. Keswani RN, Ahmed A, Keeffe EB. Older age and liver transplantation: a review. Liver Transpl 2004;10:957-67.
   A useful review discussing liver transplantation from the preoperative through the postoperative phase. The article emphasizes that although age is a risk factor, age alone is not a contraindication for surgery in otherwise appropriate candidates.

8. Understanding Anesthesia and the Impact of Aging on Thermoregulation

Goals :

1. Understand changes in thermoregulation in aging.

Objectives:

1. Describe the risk of hypothermia in aging.
2. Discuss the changing role of fever as an indication of underlying infection in the elderly patient
3. Define proper temperature management in the aged.

References:

1. Sessler DI. Mild perioperative hypothermia. N Engl J Med 1997;336:1730-7.
   Definitive review of how general and regional anesthesia promote hypothermia in all patients. Also describes the risks, such as infection or myocardial infarction, associated with even mild perioperative hypothermia.

2. Kenney WL, Munce TA. Invited review: aging and human temperature regulation. J Appl Physiol 2003;95:2598-603.
   Excellent review of how aging alters thermoregulation and makes the older prone to hypothermia because of decreased heat production and impaired vasoconstriction.

3. Frank SM, Beattie C, Christopherson R, Norris EJ, Rock P, Parker S, Kimball AW, Jr. Epidural versus general anesthesia, ambient operating room temperature, and patient age as predictors of inadvertent hypothermia. Anesthesiology 1992;77:252-7.
   Documents that temperature decreases during anesthesia are more severe when general (vs. epidural) anesthesia is used, in a cold (vs. warm) OR, and when the patients are older.

PUTTING IT ALL TOGETHER

9. Assessment / Evaluation of the Elderly Patient: The Perspective of the Geriatrician

Goals:

1. Understand a comprehensive geriatric patient assessment.
2. Understand the value of a geriatric specialist consultation.
3. Understand terms such as functional status, ADL's etc.

Objectives:

1. Define a geriatric assessment, its impact on outcome, and who would benefit from it.
2. Development of ability to administer basic tests of functional status and understand when referral for more sophisticated functional testing is indicated.
3. Describe functional gait assessment and evaluation for the risk of fall.

References:

1. Roehrig B, Hoeffken K, Pientka L, Wedding U. How many and which items of activities of daily living (ADL) and instrumental activities of daily living (IADL) are necessary for screening. Crit Rev Oncol Hematol 2007;62:164-71.
   Geriatric Assessment is important to identify frail and vulnerable elderly oncology patients. The goal of this study was to identify simple screening questions that could be used to identify at risk elders in this population of cancer patients. They examined the questions used in the ADL and IADL tools and found that 6 simple screening questions could identify 98.5% of elders with limitations. This report is very useful for those interested in Geriatric Assessment.

2. Finlayson M, Mallinson T, Barbosa VM. Activities of daily living (ADL) and instrumental activities of daily living (IADL) items were stable over time in a longitudinal study on aging. J Clin Epidemiol 2005;58:338-49.
   The Aging in Manitoba Longitudinal Study was started in 1971. A specific goal of this study is to address stability of ADLs and IADLs over time and across settings (home and nursing home). It found that certain activities may be used as markers to identify an impending need for a transition in care. For instance difficulty walking outside may suggest the imminent need for in house services. This is a complex article; however it provides interesting data on the ADL and IADL tools and is valuable for those interested in functional outcomes in geriatrics.

3. Fukuse T, Satoda N, Hijiya K, Fujinaga T. Importance of a comprehensive geriatric assessment in prediction of complications following thoracic surgery in elderly patients. Chest 2005;127:886-91.
   Thoracic surgery can be associated with high morbidity and mortality in frail, elderly patients. The goal of this study was to examine the predictive value of different elements of a comprehensive geriatric assessment. It found that difficulty with activities of daily living (ADLs) and impaired cognition were predictive of complications postoperatively, especially when the operative time was prolonged.

10. Preoperative Assessment in the Elderly: The Perspective of the Anesthesiologist

Goals:

1. Understand what are the patient's Goals and expectations.
2. Understand the determination of preoperative physical / functional status.
3. Understand the formulation of a complete perioperative plan:

a. Preoperative, b. Intraoperative, c. Postoperative.

Objectives:

1. Describe indicated recommended preoperative testing in elderly patients.
2. Describe recommended methods of preoperative functional assessment
3. Develop a plan for risk reduction strategies.

References:

1. Fleisher LA. Routine laboratory testing in the elderly: is it indicated? Anesth Analg 2001;93:249-50.
   A useful editorial accompanying the article by Dznakic below.

2. Dzankic S, Pastor D, Gonzalez C, Leung JM. The prevalence and predictive value of abnormal preoperative laboratory tests in elderly surgical patients. Anesth Analg 2001;93:301-8.
   This prospective study examines the utility of routine laboratory testing in elderly patients. The most prevalent abnormal labs values found in this study of elderly patients, anemia (10%), high creatinine (12%) and hyperglycemia (7%) were not predictive of adverse postoperative outcomes. They conclude that the history and physical should guide selective laboratory preoperative testing.

3. Narr BJ, Warner ME, Schroeder DR, Warner MA. Outcomes of patients with no laboratory assessment before anesthesia and a surgical procedure. Mayo Clin Proc 1997;72:505-9.
   A useful but older study reaffirming that routine screening before ambulatory surgery is unnecessary.

4. Barnett, SR. The Preoperative Assessment of the Geriatric Patient. *Progress in Anesthesiology* 18:5 (2004): 65-80.
   A comprehensive review of the preoperative assessment of the older patient.

5. Poldermans D, Boersma E, Bax JJ, Thomson IR, van de Ven LL, Blankensteijn JD, Baars HF, Yo TI, Trocino G, Vigna C, Roelandt JR, van Urk H. The effect of bisoprolol on perioperative mortality and myocardial infarction in high-risk patients undergoing vascular surgery. Dutch Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography Study Group. N Engl J Med 1999;341:1789-94.
   A classic article. In this report the authors found a 10 fold reduction in postoperative death and non-fatal myocardial infarction in high risk vascular patients (mean age 67years) that received beta blockade prior to surgery. Although the role of perioperative beta blockade is becoming

more controversial, this article highlights the importance of developing a comprehensive preoperative plan, even in older very sick patients.

6. Schein OD, Katz J, Bass EB, Tielsch JM, Lubomski LH, Feldman MA, Petty BG, Steinberg EP. The value of routine preoperative medical testing before cataract surgery. Study of Medical Testing for Cataract Surgery. N Engl J Med 2000;342:168-75.
   In this large study of patients undergoing cataract surgery, the authors found that for patients undergoing cataract surgery under monitored anesthesia care, there was no benefit to the group who had routine medical testing prior to eye surgery. All patients, however, were followed by a primary care physician, and received testing only when it was appropriate for their ongoing medical care.

7. Liu LL, Dzankic S, Leung JM. Preoperative electrocardiogram abnormalities do not predict postoperative cardiac complications in geriatric surgical patients. J Am Geriatr Soc 2002;50:1186-91.
   ECG abnormalities were found to be common in elderly patients, and were of limited value in predicting postoperative cardiac complications for patients undergoing noncardiac surgery who were hospitalized postoperatively. The authors state that age should not be the sole consideration in ordering preoperative ECGs, instead the presence and severity of comorbidities should be the primary consideration.

8. Leung JM, Dzankic S. Relative importance of preoperative health status versus intraoperative factors in predicting postoperative adverse outcomes in geriatric surgical patients. J Am Geriatr Soc 2001;49:1080-5.
   Age was not found to be a significant predictor of postoperative adverse events in this elderly population who were followed in the hospital after surgery, (not outpatients). The severity of preoperative comorbidities and ASA classification, need for emergency surgery, and intraoperative tachycardia were predictive.

11. Atypical Presentations of Physiologic Disasters.

Goals:

1. Understand the need for a high index of suspicion for common conditions in the face of non-specific symptoms (e.g. agitation).

Objectives:

1. Describe alternative presentations of myocardial infarction, pulmonary embolus and acute abdomen in the elderly population
2. Explain possible diagnostic delays in diagnosis of the acute abdomen in the older patient.

3. Pneumonia.

References:

1. Sigurdsson E, Thorgeirsson G, Sigvaldason H, Sigfusson N. Unrecognized myocardial infarction: epidemiology, clinical characteristics, and the prognostic role of angina pectoris. The Reykjavik Study. Ann Intern Med 1995;122:96-102.
   These authors found that one third of all myocardial infarctions (MIs) were unrecognized in a population cohort of over 9000 men. The prevalence was more than 5% in the older group over 75 years compared to close to 0% in those under 40 years. In the group with unrecognized MIs, a prior history of angina was associated with a worse prognosis and suggested more severe cardiovascular disease.

2. Kokturk N, Oguzulgen IK, Demir N, Demirel K, Ekim N. Differences in clinical presentation of pulmonary embolism in older vs younger patients. Circ J 2005;69:981-6.
   This articles describes the differences in the clinical presentation of pulmonary embolus in elderly versus younger patients. In the elderly person the presenting symptoms may be subtle or atypical, suggesting a need for increased suspicion in the older patient.

3. Aalten CM, Samson MM, Jansen PA. Diagnostic errors; the need to have autopsies. Neth J Med 2006;64:186-90.
   In this study, the authors found a a major discrepancy between the premortem clinical diagnosis and postmortem autopsy in 39% of cases.

12. Geriatric Trauma

Goals:

1. Understand the distribution of trauma in the elderly.
2. Understand the outcomes and import of triage decisions.
3. Understand the implications of common geriatric injuries as they relate to comorbid conditions (e.g hip fracture with pneumonia, delirium, subdural hematoma, etc.).

Objectives:

1. Identify common trauma presentations
2. Define principles of triage in the elderly..

References:

1. Lee WY, Cameron PA, Bailey MJ. Road traffic injuries in the elderly. Emerg Med J 2006;23:42-6.

This retrospective study addresses the incidence and outcome of elderly car crash victims. Elderly patients in this study had a higher mortality related to injuries sustained. Significant chest injuries were more common in this elderly population compared to younger patients.

2. Pudelek B. Geriatric trauma: special needs for a special population. AACN Clin Issues 2002;13:61-72.
   This is a relatively simple report providing a comprehensive review of common injuries including discharge planning in the elderly trauma victim. It also includes a case study illustrating important geriatric trauma principles.

3. Perdue PW, Watts DD, Kaufmann CR, Trask AL. Differences in mortality between elderly and younger adult trauma patients: geriatric status increases risk of delayed death. J Trauma 1998;45:805-10.
   This is a relatively old retrospective study examining outcomes in young and old trauma patients. There was a two-fold increase in early mortality in elderly compared to young patients.

4. Siegmeth AW, Gurusamy K, Parker MJ. Delay to surgery prolongs hospital stay in patients with fractures of the proximal femur. J Bone Joint Surg Br 2005;87:1123-6.
   This study addressed the controversy surrounding surgical delay for non-medical reasons in elderly patients with hip fractures. In contrast to the study by Moran et al. (see below), this group found that a delay in surgery beyond 48 hours was associated with increased length of stay.

5. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am 2005;87:483-9.
   This is a prospective study of over 2500 hip fracture patients addressing outcomes with respect to the timing of hip surgery. The timing of surgery on hip fractures remains controversial. This study found no increase in morbidity or mortality in those with surgery delayed for non-medical reasons up to 4 days. However they found that when acute medical conditions delayed the surgery there was a 2.5 times increase in mortality at 30 days. A well-written study worth reading; especially for those responsible for prioritizing surgical case loads.

6. Tieves KS, Yang H, Layde PM. The epidemiology of traumatic brain injury in Wisconsin, 2001. Wmj 2005;104:22-5, 54.
   This article examined the epidemiology of Traumatic brain injury (TBI). Data on fatal and non-fatal TBI injuries in Wisconsin in 2001 was

obtained. They concluded that TBI is a major cause of death and hospitalizations in Wisconsin. Male teens, young adults, and the elderly are high-risk groups for TBI. The authors concluded that preventive measures should be aimed at these high-risk groups.

CHOOSING THE ANESTHETIC

13. Regional vs. General

Goals:

1. Understand the risk/benefit ratio of regional vs. general anesthesia in the elderly.
2. Understand the potential anatomical differences that may influence block placement in the elderly.
3. Understand the differences with regard to neuraxial drug distribution in the elderly.

Objectives:

1. Utilize an evidenced-based approach to anesthetic selection.
2. Describe anatomical changes in the older spine relevant to the administration of neuraxial anesthetic agents
3. Describe the influence of advanced age on neuraxial drug distribution

References:

1. Williams-Russo P, Sharrock NE, Mattis S, Szatrowski TP, Charlson ME. Cognitive effects after epidural vs general anesthesia in older adults. A randomized trial. Jama 1995;274:44-50.
   A classic article addressing cognitive dysfunction in elderly patients undergoing knee replacement surgery. The authors found no difference between the two groups.

2. Nydahl PA, Philipson L, Axelsson K, Johansson JE. Epidural anesthesia with 0.5% bupivacaine: influence of age on sensory and motor blockade. Anesth Analg 1991;73:780-6.

3. Watanabe S, Takeshima R, Asakura N, Kumagai M, Taguchi N, Satsumae T. The effect of age on retrieval of local anesthetic solution from the epidural space. Anesth Analg 1997;85:1091-6.

4. Rigg JR, Jamrozik K, Myles PS, Silbert BS, Peyton PJ, Parsons RW, Collins KS. Epidural anaesthesia and analgesia and outcome of major surgery: a randomised trial. Lancet 2002;359:1276-82.

5. Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, Sage D, Futter M, Saville G, Clark T, MacMahon S. Reduction of

postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. Bmj 2000;321:1493.
The benefits of neuraxial vs. general anesthesia have long been debated. This meta-analysis looks at mortality and morbidity data from 141 published trials. The results suggest that neuraxial anesthesia confers some benefits and reduces some postoperative complications. However, many of the studies included are small and the results have not been replicated elsewhere.

6. Urwin SC, Parker MJ, Griffiths R. General versus regional anaesthesia for hip fracture surgery: a meta-analysis of randomized trials. Br J Anaesth 2000;84:450-5.
This study specifically addressed the value of regional anesthesia in hip fracture patients. It found that regional anesthesia provided marginal advantages compared to general anesthesia.

7. O'Hara DA, Duff A, Berlin JA, Poses RM, Lawrence VA, Huber EC, Noveck H, Strom BL, Carson JL. The effect of anesthetic technique on postoperative outcomes in hip fracture repair. Anesthesiology 2000;92:947-57.
This large retrospective study addressed the controversial issue of regional vs. general anesthesia for hip fracture patients. They reviewed over 9000 cases, approximately 6000 general vs. 3000 regional anesthetics. The 30 day unadjusted mortality rates were not significantly different between the two groups. This paper demonstrates that outcomes in hip fractures patients are not heavily dependent on the anesthetic technique

14. Ambulatory Surgery

Goals:

1. Determine which elderly patients are appropriate for ambulatory surgery
2. Consider evidence for preoperative testing for elderly patients
3. Identify post discharge concerns

Objectives:

1. Describe selection criteria for elderly patients for ambulatory surgery
2. Describe appropriate preoperative testing
3. Identify elderly patients at risk for hospitalization after ambulatory surgery

References: ***See also Section 10: Preoperative Testing***

1. Fleisher LA, Pasternak LR, Herbert R, Anderson GF. Inpatient hospital admission and death after outpatient surgery in elderly patients:

importance of patient and system characteristics and location of care. Arch Surg 2004;139:67-72.
The authors identified several risk factors for inpatient admission or death following ambulatory surgery: more advanced age, prior inpatient admission within six months, surgery performed at a physician's office or outpatient hospital, and invasiveness of surgery.

2. Chung F, Mezei G, Tong D. Adverse events in ambulatory surgery. A comparison between elderly and younger patients. Can J Anaesth 1999;46:309-21.
Elderly patients were found to have a higher incidence of intraoperative (Odds Ratio = 1.4) or cardiovascular (O.R. = 2.0) events, but a lower risk of postoperative events such as pain, nausea and vomiting or dizziness.

3. Twersky R, Fishman D, Homel P. What happens after discharge? Return hospital visits after ambulatory surgery. Anesth Analg 1997;84:319-24.
Hospital returns were found to be independent of age and ASA Class. Return visits were more common in Urology patients, but not due to any age-related problems.

4. Bryson GL, Chung F, Finegan BA, Friedman Z, Miller DR, van Vlymen J, Cox RG, Crowe MJ, Fuller J, Henderson C. Patient selection in ambulatory anesthesia - an evidence-based review: part I. Can J Anaesth 2004;51:768-81.

A review of patient selection for ambulatory surgery, covering several different conditions, this contains a concise section summarizing the literature on perioperative management of elderly patients undergoing ambulatory surgery addressing both age and preoperative evaluation.

15. Fluid and Blood Administration

Goals:

1. Understand vulnerability of the elderly to hypo- and hypervolemia.
2. Understand indications for perioperative transfusion in the elderly patient

Objectives:

1. Describe methods to recognize fluid overload in the elderly patient
2. Develop an evidence-based approach to perioperative transfusion.

References:

1. Holte K, Sharrock NE, Kehlet H. Pathophysiology and clinical implications of perioperative fluid excess. Br J Anaesth 2002;89:622-32.

The article reviews pathophysiology and clinical implications of fluid management in the perioperative period. It succinctly describes the endocrine changes related to surgery and their impact on water and electrolyte balance. Consequences of salt and fluid administration in the perioperative period, on cardiovascular, respiratory, gut and renal system, are well described. Furthermore, issues related to regional anesthesia and fluid administration are also discussed. With 150 pertinent references, it is 'must' read for anybody interested in perioperative fluid and electrolyte issues.

2. Luckey AE, Parsa CJ. Fluid and electrolytes in the aged. Arch Surg 2003;138:1055-60.
   This is a very good review article describing salient changes in renal, water and electrolyte homeostasis with aging. The discussion of anti-diuretic hormone, atrial natriuretic peptide, and sodium and water handling is particularly elegant. Also mentioned are the commonly used medications in the elderly, which can significantly impact the fluid and electrolyte homeostasis. Though it is deficient in specific recommendations, it complements nicely the other two articles.

3. Allison SP, Lobo DN. Fluid and electrolytes in the elderly. Curr Opin Clin Nutr Metab Care 2004;7:27-33.
   Another wonderful review, discussing issues related to fluid and electrolyte administration, in the perioperative period. Describes some of the more important studies and has annotated bibliography. Strongly recommended for the clinician.

16. Procedural Skills - DO NO HARM

Goals:

1. Understand issues in vascular access in elderly patients.
2. Understand issues in positioning of the geriatric patients.
3. Understand the physiology, prevention and management of skin lesions in the elderly.
4. Understand the assessment of the uncooperative patient

Objectives

1. Define the alterations in vascular and perivascular anatomy of the jugular vein.
2. Describe safe positioning in the older operative patient
3. Describe strategies to prevent perioperative skin breakdown

References:

1. Troianos CA, Kuwik RJ, Pasqual JR, Lim AJ, Odasso DP. Internal jugular vein and carotid artery anatomic relation as determined by ultrasonography. Anesthesiology 1996;85:43-8.

Found that in older patients the internal jugular was frequently directly over the carotid artery.

2. Martin JT. Positioning aged patients. Anesthesiol Clin North America 2000;18:105-21.
   Useful review, applying what is known about positioning to the older patient.

3. Dini V, Bertone M, Romanelli M. Prevention and management of pressure ulcers. Dermatol Ther 2006;19:356-64.
   The authors provide a comprehensive, easy-to-read review including the etiology, predisposing factors, grading system, and the current recommendations for the surgical and medical management of pressure ulcers or decubiti.

DRUGS

17. Understanding Pharmacological Issues in Aging

Goals:

1. Understand age-related changes of pharmacokinetics and pharmacodynamics.
2. Understand significant drug interactions.
3. Understand concept of polypharmacy and the incidence in the elderly
4. To be familiar with commonly prescribed drugs of the elderly.

Objectives:

1. Describe age–related changes in pharmacokinetics and pharmacodynamics and their impact on drug effects.
2. Describe impact of age-related changes in the kidneys, liver and volume of distribution and their impact on drug administration.
3. Describe recommended adjustments to dosing of anesthetics in the elderly.
4. Explain how to obtain a valid medication history, including over-the-counter drugs.
5. List recommendations for preoperative administration of prescribed medications

References:

1. Hammerlein A, Derendorf H, Lowenthal DT. Pharmacokinetic and pharmacodynamic changes in the elderly. Clinical implications. Clin Pharmacokinet 1998;35:49-64.
   This is a classic review article, which describes age-related changes in pharmacokinetics. The review is not specific to anesthetic drugs; however, it is a starting point in understanding the changes which can

impact intravenous anesthetics.

2. Sadean MR, Glass PS. Pharmacokinetics in the elderly. Best Pract Res Clin Anaesthesiol 2003;17:191-205.
   An easy-to-read review article. It starts by reviewing age-related changes in the major organ systems and their impact on pharmacokinetics. The pharmacokinetics of commonly used intravenous and local anesthetic agents is described in a well organized way. Pertinent references are included and recommendations for altering drug dosing in the elderly are succinctly mentioned.

3. Vuyk J. Pharmacodynamics in the elderly. Best Pract Res Clin Anaesthesiol 2003;17:207-18.
   This article is an overview of the influence of age on the pharmacodynamics of drugs used during general and regional anesthesia. The article starts with an overview of effects of aging on cardiovascular and neuroendocrine function and includes a short account of the state-of-the-art in pharmacodynamic modelling. It describes the physiological changes that occur with aging and are associated with increased sensitivity to the effects of anesthetic agents. It complements the article by Sadean and Glass.

4. Cusack BJ. Pharmacokinetics in older persons. Am J Geriatr Pharmacother 2004;2:274-302.
   This article reviews age-related changes in pharmacokinetics and their clinical relevance. The review emphasizes literature from 1990 through April 2004. It describes the principles and influence of aging on pharmacokinetics. It also describes the effect of these changes on drugs common used in the elderly. It is comprehensive article and a good reference.

5. Merle L, Laroche ML, Dantoine T, Charmes JP. Predicting and preventing adverse drug reactions in the very old. Drugs Aging 2005;22:375-92.
   This article is oriented more for the primary care physician than anesthesiologists, but it nicely reviews the often adverse consequences of polypharmacy and drug interactions in the older patient.

18. Inhalation Anesthetics

Goals:

1. Understand pharmacokinetic versus pharmacodynamic changes that are relevant to aging and inhalation anesthetics.

Objectives:

1. Describe age-related changes in MAC.

References:

1. Nickalls RW, Mapleson WW. Age-related iso-MAC charts for isoflurane, sevoflurane and desflurane in man. Br J Anaesth 2003;91:170-4.
   This paper, together with other studies, illustrates that the MAC of inhalation anesthetics decreases with the age. For example, whereas the MAC of isoflurane for a 5 year old patient is 1%, it is 0.25% for a 95 year old patient.

2. Eger EI, 2nd. Age, minimum alveolar anesthetic concentration, and minimum alveolar anesthetic concentration-awake. Anesth Analg 2001;93:947-53.
   This study mathematically calculates expected MAC and MAC at different ages. It suggests that each decade of increased age is associated with a 6.7% decrease in MAC. Although the information is valuable, this is a complex article.

3. Xie, Z; Lanahan, J. In Clinical Anesthesia Procedures of Massachusetts General Hospital. *Geriatric Anesthesia.* 2006 Edited by Peter Dunn, M.D.
   This chapter describes that protein binding of anesthetic drugs is reduced and longer time required for drug elimination is required in elderly patients.

4. Xie, Z; Lanahan, J. In Clinical Anesthesia Procedures of Massachusetts General Hospital. *Geriatric Anesthesia.* 2006. Edited by Peter Dunn, M.D.
   This chapter describes the age-related reduction in anesthetic requirements in elderly patients.

19. Intravenous Anesthetics

Goals:

1. Understand principles of administration of sedatives and hypnotics to elderly patients .
2. Understand principles in administration of induction agents .
3. Understand principles in administration of neuromuscular blockers and reversal.

Objectives:

1. Describe approaches to the administration of sedation and anxiolysis to the older patient

2. Provide examples of drugs associated with adverse outcomes that should be avoided in the elderly
3. Describe strategies for evidence based drug selection.

References:

1. Jacobs JR, Reves JG, Marty J, White WD, Bai SA, Smith LR. Aging increases pharmacodynamic sensitivity to the hypnotic effects of midazolam. Anesth Analg 1995;80:143-8.
   An older article describing the mechanism behind elderly patients' increased sensitivity to midazolam.

2. Stambaugh JE, Wainer IW, Sanstead JK, Hemphill DM. The clinical pharmacology of meperidine--comparison of routes of administration. J Clin Pharmacol 1976;16:245-56.
   This is an old but valuable review of the meperidine and its potentially toxic metabolite normeperidine. In general, most geriatricians recommend avoiding meperidine in elderly patients.

3. Tsui BC, Wagner A, Finucane B. Regional anaesthesia in the elderly: a clinical guide. Drugs Aging 2004;21:895-910.
   Title can be misleading. The primary focus of the review is on the practical aspects of administering regional anesthesia in the elderly. However, it addresses the use of sedation (effective and safe sedative doses for benzodiazepines and other hypnotics), the pharmacokinetics of local anesthetics, and anatomical and physiological changes associated with age in relation to performance of regional anesthesia. Use of adjuvant (opioids, epinephrine) is also described. Literature cited was current to December 2003.

4. Shafer SL. The pharmacology of anesthetic drugs in elderly patients. Anesthesiol Clin North America 2000;18:1-29.
   Excellent review of the pharmacokinetic and pharmacodynamic changes of aging as it applies to common anesthetic drugs.

4. Cope TM, Hunter JM. Selecting neuromuscular-blocking drugs for elderly patients. Drugs Aging 2003;20:125-40.
   This is a comprehensive review of neuromuscular blockade and the pharmacokinetic and pharmacodynamic changes associated with aging. Cisatracurium and succinycholine appear to have the least alteration in metabolism in older patients. This article provides more pharmacology than most clinical reviews and serves as an excellent reference article.

20. Local Anesthetics

Goals:

1. Understand the differences in the duration and dosing of local anesthetics.

Objectives:

1. Describe responses to local anesthetics in the aging patient.

References:

1. Rosenberg PH, Veering BT, Urmey WF. Maximum recommended doses of local anesthetics: a multifactorial concept. Reg Anesth Pain Med 2004;29:564-75.
   This review article critically examines the current recommendations for maximal local anesthetic doses, specifically considering the effect of absorption from various sites of injection (e.g., local infiltration vs. direct nerve block). The author concludes that dosing in elderly patient should be modified, and reduced by a factor of 10-20% based on expected age-related pharmacokinetic and pharmacodynamic changes.

2. Veering BT. Hemodynamic effects of central neural blockade in elderly patients. Can J Anaesth 2006;53:117-21.
   This editorial accompanying the article below by Ezri provides an excellent review of the hemodynamic effects of spinal and epidural anesthesia in elderly patients.

3. Ezri T, Zahalka I, Zabeeda D, Feldbrin Z, Eidelman A, Zimlichman R, Medalion B, Evron S. Similar incidence of hypotension with combined spinal-epidural or epidural alone for knee arthroplasty. Can J Anaesth 2006;53:139-45.
   This is a prospective study of 80 patients comparing combined spinal epidural anesthesia to plain epidural anesthesia in patients undergoing knee replacements. The authors found that the incidence of hypotension was similar with both techniques.

POSTOPERATIVE CARE

21. Postoperative/PACU Issues

Goals:

1. Understand the differential diagnosis and evaluation of slow emergence.
2. Understand the risk factors and consequences of emergence delirium in the elderly.
3. To understand the implications and etiology of cognitive dysfunction in the PACU.

Objectives:

1. List causes of delayed emergence.
2. Provide recommendations for treating delirium acutely in the PACU.
3. Describe discharge criteria from the PACU.

References (see also Section 22: Delirium):

1. Chung F, Mezei G, Tong D. Adverse events in ambulatory surgery. A comparison between elderly and younger patients. Can J Anaesth 1999;46:309-21.
   This study enrolled 17,638 patients over a period of three years and compared the incidence rates of intraoperative and post op complications in the elderly population were compared with those of younger patients. Elderly patients had a higher incidence of intraop cardiovascular events and a lower incidence of post op events like pain and nausea vomiting.

2. Canet J, Raeder J, Rasmussen LS, Enlund M, Kuipers HM, Hanning CD, Jolles J, Korttila K, Siersma VD, Dodds C, Abildstrom H, Sneyd JR, Vila P, Johnson T, Munoz Corsini L, Silverstein JH, Nielsen IK, Moller JT. Cognitive dysfunction after minor surgery in the elderly. Acta Anaesthesiol Scand 2003;47:1204-10.
   This study enrolled 372 patients ≥ 60 years old and for inpatient versus outpatient surgery, and assessed their cognitive function preoperatively and at 7 days and 3 months postoperatively. The authors found that postoperative cognitive dysfunction at one week occurs less frequently after outpatient surgery. They supported the strategy of avoiding hospitalization of older patients when possible.

3. Lepouse C, Lautner CA, Liu L, Gomis P, Leon A. Emergence delirium in adults in the post-anaesthesia care unit. Br J Anaesth 2006;96:747-53.
   This is a prospective study addressing the incidence of and risk factors for emergence delirium in elderly patients. The authors enrolled over 1200 patients and found that preoperative benzodiazepines, and long surgeries were two of several risk factors for emergence delirium.

4. Sharma PT, Sieber FE, Zakriya KJ, Pauldine RW, Gerold KB, Hang J, Smith TH. Recovery room delirium predicts postoperative delirium after hip-fracture repair. Anesth Analg 2005;101:1215-20.
   This article investigated the effects of delirium in the post anesthesia care unit and the development of postoperative delirium in hip fracture patients. delirium.

22. Delirium and Postoperative Cognitive Dysfunction

Goals:

1. Understand delirium: what is it, how to diagnosis it, and how to differentiate it from POCD and dementia.
2. Understand its risk factors, and strategies for prevention and treatment.
3. Understand the impact of postoperative delirium on morbidity and mortality.
4. Understand the economic impact of delirium on health care resource utilization.

Objectives:

1. Describe etiology and incidence of post operative delirium
2. Describe how to assess preoperative risk for postoperative delirium.
3. Provide recommendations to prevent delirium in the older patient
4. Describe postoperative consequences of delirium
5. Describe methods to treat postoperative delirium using non pharmacological and pharmacological methods.
6. Describe the utility of the Confusion Assessment Method for follow up in patients with delirium
7. Discuss possible etiology of POCD and incidence

References:

1. Inouye SK. Delirium in older persons. N Engl J Med 2006;354:1157-65.
   A recent review of delirium in medical and surgical patients. It provides a general overview of severity of the problem, its consequences and predictors, as well as strategies for its prevention and treatment.

2. Dasgupta M, Dumbrell AC. Preoperative risk assessment for delirium after noncardiac surgery: a systematic review. J Am Geriatr Soc 2006;54:1578-89.
   An excellent systematic review of the risk factors for postoperative delirium.

3. Marcantonio ER, Flacker JM, Michaels M, Resnick NM. Delirium is independently associated with poor functional recovery after hip fracture. J Am Geriatr Soc 2000;48:618-24.
   Journal of the American Geriatrics Society 48.6 (2000): 618-624.
   A well-done article demonstrating that delirium results in diminished functional status.

4. Kalisvaart KJ, de Jonghe JF, Bogaards MJ, Vreeswijk R, Egberts TC, Burger BJ, Eikelenboom P, van Gool WA. Haloperidol prophylaxis for elderly hip-surgery patients at risk for delirium: a randomized placebo-controlled study. J Am Geriatr Soc 2005;53:1658-66.

A well-designed, randomized, controlled trial demonstrating that low-dose haloperidol prophylaxis reduces the severity and duration of postoperative delirium. Unfortunately, the study intervention did not reduce the incidence of delirium.

5. Wu CL, Hsu W, Richman JM, Raja SN. Postoperative cognitive function as an outcome of regional anesthesia and analgesia. Reg Anesth Pain Med 2004;29:257-68.
   A systematic review of articles addressing the impact of neuraxial vs. general anesthesia on postoperative cognitive function. The article provides an overview of issues related to postoperative cognitive dysfunction and delirium, including their public health impact, etiology and risk factors. The authors conclude that intraoperative neuraxial anesthesia does not does not appear to decrease the incidence of postoperative cognitive and delirium. However, they note that many of the studies included had methodological and design issues which prevented a definitive answer.

Three articles that examine intra- and postoperative risks for delirium:.

6. Marcantonio ER, Juarez G, Goldman L, Mangione CM, Ludwig LE, Lind L, Katz N, Cook EF, Orav EJ, Lee TH. The relationship of postoperative delirium with psychoactive medications. Jama 1994;272:1518-22.

7. Lynch EP, Lazor MA, Gellis JE, Orav J, Goldman L, Marcantonio ER. Patient experience of pain after elective noncardiac surgery. Anesth Analg 1997;85:117-23.

8. Marcantonio ER, Goldman L, Mangione CM, Ludwig LE, Muraca B, Haslauer CM, Donaldson MC, Whittemore AD, Sugarbaker DJ, Poss R, et al. A clinical prediction rule for delirium after elective noncardiac surgery. Jama 1994;271:134-9.
   These two studies describe two prediction rules that can be used to assess patients' risk for postoperative delirium:

9. Kalisvaart KJ, Vreeswijk R, de Jonghe JF, van der Ploeg T, van Gool WA, Eikelenboom P. Risk factors and prediction of postoperative delirium in elderly hip-surgery patients: implementation and validation of a medical risk factor model. J Am Geriatr Soc 2006;54:817-22.

10. Marcantonio ER, Goldman L, Orav EJ, Cook EF, Lee TH. The association of intraoperative factors with the development of postoperative delirium. Am J Med 1998;105:380-4.

11. Marcantonio ER, Flacker JM, Wright RJ, Resnick NM. Reducing delirium after hip fracture: a randomized trial. J Am Geriatr Soc 2001;49:516-22.
.A well-designed clinical trial demonstrating the utility of a non-pharmacological intervention for the prevention of postoperative delirium

12. Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. Ann Intern Med 1990;113:941-8.
A landmark article describing the design and validation of the Confusion Assessment Method (CAM). The CAM is one of the standard tests used in studies of postoperative delirium.

13. Ely EW, Inouye SK, Bernard GR, Gordon S, Francis J, May L, Truman B, Speroff T, Gautam S, Margolin R, Hart RP, Dittus R. Delirium in mechanically ventilated patients: validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). Jama 2001;286:2703-10.
Although the CAM is a valuable tool for delirium screening in hospitalized patients, it cannot be used in mechanically ventilated patients. This article describes the CAM-ICU, a modification of the original CAM that allows it to be applied in intubated intensive care unit patients, a group at particularly high risk for delirium.

14. Silverstein JH, Timberger M, Reich DL, Uysal S. Central nervous system dysfunction after noncardiac surgery and anesthesia in the elderly. Anesthesiology 2007;106:622-8.
An outstanding summary of the broad topic of postoperative central nervous system dysfunction

15. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-47.
This is a landmark international prospective study investigating the effects of general anesthesia and general surgery on long term cognitive performance in elderly patients using neuropsychometric testing.

16. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R, Aggarwal A, Marschall K, Graham SH, Ley C. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. N Engl J Med 1996;335:1857-63.
This is one of the earliest prospective studies demonstrating that cardiac surgery was associated with an increased risk of adverse cognitive outcomes (both stroke and cognitive performance) in elderly patients.

17. Newman MF, Kirchner JL, Phillips-Bute B, Gaver V, Grocott H, Jones RH, Mark DB, Reves JG, Blumenthal JA. Longitudinal assessment of

neurocognitive function after coronary-artery bypass surgery. N Engl J Med 2001;344:395-402.
This prospective study investigated the effect of cardiac surgery on cognitive performance 5 years later and demonstrated that impaired cognitive performance at hospital discharge following cardiac surgery was a predictor for cognitive decline five years later.

23. Acute pain management

Goals:

1. Understand unique issues in geriatric perioperative pain control, including preoperative planning, intraoperative course and postoperative strategies to minimize pain and side effects
2. Understand the risks/benefits of opioid agonists.
3. Understand the role non-opioid analgesics.
4. Understand the risks/benefits associated with peripheral and neuraxial regional analgesic techniques, including central neuraxial analgesic drug selection.
5. Understand adverse impact of inadequate pain treatment (e.g. delirium).
6. Understand pain assessment strategies in the cognitively impaired.

Objectives:

1. Describe possible treatment strategies for pain in the elderly, including dose adjustment, in the immediate postoperative period
2. Describe side effects prevalent in the elderly patient exposed to opioid medication and recommended strategies to reduce morbidity.
3. Discuss the pros and cons of meperidine and morphine therapy.
4. Describe use of non-opiate adjuvants in the perioperative period.
5. Describe appropriate peripheral and regional analgesic techniques for the elderly patient perioperatively.
6. Describe approaches to pain assessment in the elderly patient with visual and cognitive dysfunction, including dementia and delirium

References:

1. Aubrun F. Management of postoperative analgesia in elderly patients. Reg Anesth Pain Med 2005;30:363-79.
This is an excellent review of pain management. The author discusses the issues surrounding physiological changes, including a useful chart comparing young with old patients and the expected age-related pharmacokinetic and pharmacodynamic changes. He discusses strategies for pain control within the OR and in the immediate

postoperative period, including both intravenous and epidural modalities. Valuable for both specialists and nonspecialists.

2. Aubrun F, Monsel S, Langeron O, Coriat P, Riou B. Postoperative titration of intravenous morphine in the elderly patient. Anesthesiology 2002;96:17-23.
   This is a well-done study addressing titration of morphine in the PACU. These authors found that elderly patients had similar requirements for morphine during the immediate postoperative period. This study is well worth reading for anyone involved in the administration of pain medication in the PACU.

3. Aubrun F, Bunge D, Langeron O, Saillant G, Coriat P, Riou B. Postoperative morphine consumption in the elderly patient. Anesthesiology 2003;99:160-5.
   This is a prospective study comparing postoperative morphine consumption in young and old patients following a hip replacement. They found that the initial intravenous morphine requirement was similar in young and old patients. However, the post-acute requirement for subcutaneous morphine was lower in older patients. An excellent study for those interested pain control in the elderly.

4. Gagliese L, Katz J. Age differences in postoperative pain are scale dependent: a comparison of measures of pain intensity and quality in younger and older surgical patients. Pain 2003;103:11-20.
   This article compares 3 different pain scales used in the acute postoperative period, comparing young and elderly patients. Their results suggest that verbal pain scales may provide better pain assessments compared with non verbal scales. A useful article describing different types of pain scales.

SUBSPECIALTY AREAS

24. ICU issues

Goals:

1. Understand issues related to triage and resource utilization for potential elderly ICU patients.
2. Understand geriatric outcomes in intensive care.
3. Understand complications associated with geriatric ICU patients.

Objectives:

1. Define resource issues associated with geriatric ICU patients.
2. Define outcomes associated with geriatric ICU patients.
3. Define the diagnosis and treatment of common ICU issues such as delirium and ventilator-associated pneumonia,

References:

1. Somme D, Maillet JM, Gisselbrecht M, Novara A, Ract C, Fagon JY. Critically ill old and the oldest-old patients in intensive care: short- and long-term outcomes. Intensive Care Med 2003;29:2137-43.
   This prospective study examined the outcomes in old and very old patients admitted to the ICU. Age >75 years and premorbid limitation in activity were important markers for death at 3 months post discharge.

2. Kaarlola A, Tallgren M, Pettila V. Long-term survival, quality of life, and quality-adjusted life-years among critically ill elderly patients. Crit Care Med 2006;34:2120-6.
   These authors retrospectively looked at over 800 patients over the age of 65 admitted to their ICU over a 5 year period. They suggest that age alone is not a valid reason to withhold ICU care. This article emphasizes again the importance of the functional status in predicting ICU outcome in the aged population.

3. Cuthbertson BH, Scott J, Strachan M, Kilonzo M, Vale L. Quality of life before and after intensive care. Anaesthesia 2005;60:332-9.
   The aim of this investigation was to study quality of life before and after ICU admissions. The authors assessed quality of life prospectively in 300 patients admitted to the ICU. They found that patients generally had a reduction in quality of life after the ICU. This was more marked in those starting with lower quality scores.

4. Marik PE. Management of the critically ill geriatric patient. Crit Care Med 2006;34:S176-82.
   This is a recent review article dealing with the management of the critically ill geriatric patients. It provides a good overview of physiological changes and quickly mores on to discuss organ-specific

medical issues. The impact of respiratory problems and cognitive problems is highlighted. Discussion regarding outcomes is eye-opening. Reference list is comprehensive.

25. Chronic Pain Syndromes

Goals:

1. Understand common pain syndromes in the elderly.
2. Understand the role of coexisting psychological issues in pain management of the elderly.
3. Understand the challenges surrounding treatment of the older patient with chronic pain.

Objectives:

1. Define the epidemiology and treatment of common chronic pain syndromes, such as lower back pain, post herpetic neuralgia.
2. Describe the pharmacological therapies available for the treatment of chronic pain management in the older patient
3. Describe the use of adjuvant therapies in pain management

References:

1. Gagliese L, Melzack R. Chronic pain in elderly people. Pain 1997;70:3-14. A useful review of common chronic pain issues in the elderly patient.

2. Gloth FM, 3rd. Pain management in older adults: prevention and treatment. J Am Geriatr Soc 2001;49:188-99.
   This is a valuable and comprehensive review of pain management in the elderly patient.

3. Davis MP, Srivastava M. Demographics, assessment and management of pain in the elderly. Drugs Aging 2003;20:23-57.
   This is an exhaustive review of pain management in the elderly. It is a useful reference guide and methodically addresses all types of pain treatments from nonpharmacological through to the role of tricyclic antidepressants and other nonopioid pain alternatives. A valuable reference guide.

4. American Geriatrics Society releases persistent pain management guideline. J Pain Palliat Care Pharmacother 2002;16:127-9.

5. Barkin RL, Barkin SJ, Barkin DS. Perception, assessment, treatment, and management of pain in the elderly. Clin Geriatr Med 2005;21:465-90.

Complete Reference List:

References: [1-141]

1. American Geriatrics Society releases persistent pain management guideline. J Pain Palliat Care Pharmacother 2002;16:127-9.
2. American Geriatrics Society, Geriatrics Review Syllabus 6th Edition. 2007.
3. The Official US Government Site for People with Medicare. 2007.
4. Aalten CM, Samson MM, Jansen PA. Diagnostic errors; the need to have autopsies. Neth J Med 2006;64:186-90.
5. Allison SP, Lobo DN. Fluid and electrolytes in the elderly. Curr Opin Clin Nutr Metab Care 2004;7:27-33.
6. Aubrun F. Management of postoperative analgesia in elderly patients. Reg Anesth Pain Med 2005;30:363-79.
7. Aubrun F, Bunge D, Langeron O, Saillant G, Coriat P, Riou B. Postoperative morphine consumption in the elderly patient. Anesthesiology 2003;99:160-5.
8. Aubrun F, Monsel S, Langeron O, Coriat P, Riou B. Postoperative titration of intravenous morphine in the elderly patient. Anesthesiology 2002;96:17-23.
9. Aurigemma GP, Gaasch WH. Clinical practice. Diastolic heart failure. N Engl J Med 2004;351:1097-105.
10. Backman L, Nyberg L, Lindenberger U, Li SC, Farde L. The correlative triad among aging, dopamine, and cognition: current status and future prospects. Neurosci Biobehav Rev 2006;30:791-807.
11. Barkin RL, Barkin SJ, Barkin DS. Perception, assessment, treatment, and management of pain in the elderly. Clin Geriatr Med 2005;21:465-90, v.
12. Beck LH. Perioperative renal, fluid, and electrolyte management. Clin Geriatr Med 1990;6:557-69.
13. Birkmeyer NJ, Birkmeyer JD. Strategies for improving surgical quality--should payers reward excellence or effort? N Engl J Med 2006;354:864-70.
14. Blacker DJ, Flemming KD, Link MJ, Brown RD, Jr. The preoperative cerebrovascular consultation: common cerebrovascular questions before general or cardiac surgery. Mayo Clin Proc 2004;79:223-9.
15. Bryson GL, Chung F, Finegan BA, Friedman Z, Miller DR, van Vlymen J, Cox RG, Crowe MJ, Fuller J, Henderson C. Patient selection in ambulatory anesthesia - an evidence-based review: part I. Can J Anaesth 2004;51:768-81.
16. Buckner RL. Memory and executive function in aging and AD: multiple factors that cause decline and reserve factors that compensate. Neuron 2004;44:195-208.
17. Burton DA, Nicholson G, Hall GM. Anaesthesia in elderly patients with neurodegenerative disorders: special considerations. Drugs Aging 2004;21:229-42.

18. Canet J, Raeder J, Rasmussen LS, Enlund M, Kuipers HM, Hanning CD, Jolles J, Korttila K, Siersma VD, Dodds C, Abildstrom H, Sneyd JR, Vila P, Johnson T, Munoz Corsini L, Silverstein JH, Nielsen IK, Moller JT. Cognitive dysfunction after minor surgery in the elderly. Acta Anaesthesiol Scand 2003;47:1204-10.
19. Chung F, Mezei G, Tong D. Adverse events in ambulatory surgery. A comparison between elderly and younger patients. Can J Anaesth 1999;46:309-21.
20. Connery LE, Coursin DB. Assessment and therapy of selected endocrine disorders. Anesthesiol Clin North America 2004;22:93-123.
21. Cope TM, Hunter JM. Selecting neuromuscular-blocking drugs for elderly patients. Drugs Aging 2003;20:125-40.
22. Corfield LF. To inform or not to inform: how should the surgeon proceed when the patient refuses to discuss surgical risk? J Vasc Surg 2006;44:219-21.
23. Cusack BJ. Pharmacokinetics in older persons. Am J Geriatr Pharmacother 2004;2:274-302.
24. Cuthbertson BH, Scott J, Strachan M, Kilonzo M, Vale L. Quality of life before and after intensive care. Anaesthesia 2005;60:332-9.
25. Dasgupta M, Dumbrell AC. Preoperative risk assessment for delirium after noncardiac surgery: a systematic review. J Am Geriatr Soc 2006;54:1578-89.
26. Davis MP, Srivastava M. Demographics, assessment and management of pain in the elderly. Drugs Aging 2003;20:23-57.
27. Dini V, Bertone M, Romanelli M. Prevention and management of pressure ulcers. Dermatol Ther 2006;19:356-64.
28. Dzankic S, Pastor D, Gonzalez C, Leung JM. The prevalence and predictive value of abnormal preoperative laboratory tests in elderly surgical patients. Anesth Analg 2001;93:301-8, 2nd contents page.
29. Eger EI, 2nd. Age, minimum alveolar anesthetic concentration, and minimum alveolar anesthetic concentration-awake. Anesth Analg 2001;93:947-53.
30. Ely EW, Inouye SK, Bernard GR, Gordon S, Francis J, May L, Truman B, Speroff T, Gautam S, Margolin R, Hart RP, Dittus R. Delirium in mechanically ventilated patients: validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). Jama 2001;286:2703-10.
31. Ezri T, Zahalka I, Zabeeda D, Feldbrin Z, Eidelman A, Zimlichman R, Medalion B, Evron S. Similar incidence of hypotension with combined spinal-epidural or epidural alone for knee arthroplasty. Can J Anaesth 2006;53:139-45.
32. Finlayson EV, Goodney PP, Birkmeyer JD. Hospital volume and operative mortality in cancer surgery: a national study. Arch Surg 2003;138:721-5; discussion 726.

33. Finlayson M, Mallinson T, Barbosa VM. Activities of daily living (ADL) and instrumental activities of daily living (IADL) items were stable over time in a longitudinal study on aging. J Clin Epidemiol 2005;58:338-49.
34. Fisher ES. Paying for performance--risks and recommendations. N Engl J Med 2006;355:1845-7.
35. Fleisher LA. Routine laboratory testing in the elderly: is it indicated? Anesth Analg 2001;93:249-50.
36. Fleisher LA, Pasternak LR, Herbert R, Anderson GF. Inpatient hospital admission and death after outpatient surgery in elderly patients: importance of patient and system characteristics and location of care. Arch Surg 2004;139:67-72.
37. Frank SM, Beattie C, Christopherson R, Norris EJ, Rock P, Parker S, Kimball AW, Jr. Epidural versus general anesthesia, ambient operating room temperature, and patient age as predictors of inadvertent hypothermia. Anesthesiology 1992;77:252-7.
38. Fukuse T, Satoda N, Hijiya K, Fujinaga T. Importance of a comprehensive geriatric assessment in prediction of complications following thoracic surgery in elderly patients. Chest 2005;127:886-91.
39. Gagliese L, Katz J. Age differences in postoperative pain are scale dependent: a comparison of measures of pain intensity and quality in younger and older surgical patients. Pain 2003;103:11-20.
40. Gagliese L, Melzack R. Chronic pain in elderly people. Pain 1997;70:3-14.
41. Gibson SJ, Farrell M. A review of age differences in the neurophysiology of nociception and the perceptual experience of pain. Clin J Pain 2004;20:227-39.
42. Gloth FM, 3rd. Pain management in older adults: prevention and treatment. J Am Geriatr Soc 2001;49:188-99.
43. Goodney PP, Siewers AE, Stukel TA, Lucas FL, Wennberg DE, Birkmeyer JD. Is surgery getting safer? National trends in operative mortality. J Am Coll Surg 2002;195:219-27.
44. Gravenstein D. Transurethral resection of the prostate (TURP) syndrome: a review of the pathophysiology and management. Anesth Analg 1997;84:438-46.
45. Groban L. Diastolic dysfunction in the older heart. J Cardiothorac Vasc Anesth 2005;19:228-36.
46. Groban L, Butterworth J. Perioperative management of chronic heart failure. Anesth Analg 2006;103:557-75.
47. Hamel MB, Henderson WG, Khuri SF, Daley J. Surgical outcomes for patients aged 80 and older: morbidity and mortality from major noncardiac surgery. J Am Geriatr Soc 2005;53:424-9.
48. Hammerlein A, Derendorf H, Lowenthal DT. Pharmacokinetic and pharmacodynamic changes in the elderly. Clinical implications. Clin Pharmacokinet 1998;35:49-64.
49. Hazzard W, Ouslander J, Blass J, Halter J, Tinetti M. Principles of Geriatric Medicine & Gerontology. McGraw-Hill 2003.

50. Holte K, Sharrock NE, Kehlet H. Pathophysiology and clinical implications of perioperative fluid excess. Br J Anaesth 2002;89:622-32.
51. Hosking MP, Warner MA, Lobdell CM, Offord KP, Melton LJ, 3rd. Outcomes of surgery in patients 90 years of age and older. Jama 1989;261:1909-15.
52. Inouye SK. Delirium in older persons. N Engl J Med 2006;354:1157-65.
53. Inouye SK, van Dyck CH, Alessi CA, Balkin S, Siegal AP, Horwitz RI. Clarifying confusion: the confusion assessment method. A new method for detection of delirium. Ann Intern Med 1990;113:941-8.
54. Jack L, Jr., Boseman L, Vinicor F. Aging Americans and diabetes. A public health and clinical response. Geriatrics 2004;59:14-7.
55. Jackson GR, Owsley C. Visual dysfunction, neurodegenerative diseases, and aging. Neurol Clin 2003;21:709-28.
56. Jacobs JR, Reves JG, Marty J, White WD, Bai SA, Smith LR. Aging increases pharmacodynamic sensitivity to the hypnotic effects of midazolam. Anesth Analg 1995;80:143-8.
57. Janssens JP, Pache JC, Nicod LP. Physiological changes in respiratory function associated with ageing. Eur Respir J 1999;13:197-205.
58. Kaarlola A, Tallgren M, Pettila V. Long-term survival, quality of life, and quality-adjusted life-years among critically ill elderly patients. Crit Care Med 2006;34:2120-6.
59. Kalisvaart KJ, de Jonghe JF, Bogaards MJ, Vreeswijk R, Egberts TC, Burger BJ, Eikelenboom P, van Gool WA. Haloperidol prophylaxis for elderly hip-surgery patients at risk for delirium: a randomized placebo-controlled study. J Am Geriatr Soc 2005;53:1658-66.
60. Kalisvaart KJ, Vreeswijk R, de Jonghe JF, van der Ploeg T, van Gool WA, Eikelenboom P. Risk factors and prediction of postoperative delirium in elderly hip-surgery patients: implementation and validation of a medical risk factor model. J Am Geriatr Soc 2006;54:817-22.
61. Kass DA. Ventricular arterial stiffening: integrating the pathophysiology. Hypertension 2005;46:185-93.
62. Kebebew E, Duh QY, Clark OH. Parathyroidectomy for primary hyperparathyroidism in octogenarians and nonagenarians: a plea for early surgical referral. Arch Surg 2003;138:867-71.
63. Kenney WL, Munce TA. Invited review: aging and human temperature regulation. J Appl Physiol 2003;95:2598-603.
64. Keswani RN, Ahmed A, Keeffe EB. Older age and liver transplantation: a review. Liver Transpl 2004;10:957-67.
65. Kokturk N, Oguzulgen IK, Demir N, Demirel K, Ekim N. Differences in clinical presentation of pulmonary embolism in older vs younger patients. Circ J 2005;69:981-6.
66. Lakatta EG. Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises: Part III: cellular and molecular clues to heart and arterial aging. Circulation 2003;107:490-7.

67. Lakatta EG, Levy D. Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises: Part I: aging arteries: a "set up" for vascular disease. Circulation 2003;107:139-46.
68. Lakatta EG, Levy D. Arterial and cardiac aging: major shareholders in cardiovascular disease enterprises: Part II: the aging heart in health: links to heart disease. Circulation 2003;107:346-54.
69. Lee WY, Cameron PA, Bailey MJ. Road traffic injuries in the elderly. Emerg Med J 2006;23:42-6.
70. Lepouse C, Lautner CA, Liu L, Gomis P, Leon A. Emergence delirium in adults in the post-anaesthesia care unit. Br J Anaesth 2006;96:747-53.
71. Leung JM, Dzankic S. Relative importance of preoperative health status versus intraoperative factors in predicting postoperative adverse outcomes in geriatric surgical patients. J Am Geriatr Soc 2001;49:1080-5.
72. Libow LS. Geriatrics in the United States--baby boomers' boon? N Engl J Med 2005;352:750-2.
73. Liu LL, Dzankic S, Leung JM. Preoperative electrocardiogram abnormalities do not predict postoperative cardiac complications in geriatric surgical patients. J Am Geriatr Soc 2002;50:1186-91.
74. Liu LL, Leung JM. Predicting adverse postoperative outcomes in patients aged 80 years or older. J Am Geriatr Soc 2000;48:405-12.
75. Luckey AE, Parsa CJ. Fluid and electrolytes in the aged. Arch Surg 2003;138:1055-60.
76. Lynch EP, Lazor MA, Gellis JE, Orav J, Goldman L, Marcantonio ER. Patient experience of pain after elective noncardiac surgery. Anesth Analg 1997;85:117-23.
77. Marcantonio ER, Flacker JM, Michaels M, Resnick NM. Delirium is independently associated with poor functional recovery after hip fracture. J Am Geriatr Soc 2000;48:618-24.
78. Marcantonio ER, Flacker JM, Wright RJ, Resnick NM. Reducing delirium after hip fracture: a randomized trial. J Am Geriatr Soc 2001;49:516-22.
79. Marcantonio ER, Goldman L, Mangione CM, Ludwig LE, Muraca B, Haslauer CM, Donaldson MC, Whittemore AD, Sugarbaker DJ, Poss R, et al. A clinical prediction rule for delirium after elective noncardiac surgery. Jama 1994;271:134-9.
80. Marcantonio ER, Goldman L, Orav EJ, Cook EF, Lee TH. The association of intraoperative factors with the development of postoperative delirium. Am J Med 1998;105:380-4.
81. Marcantonio ER, Juarez G, Goldman L, Mangione CM, Ludwig LE, Lind L, Katz N, Cook EF, Orav EJ, Lee TH. The relationship of postoperative delirium with psychoactive medications. Jama 1994;272:1518-22.
82. Marik PE. Management of the critically ill geriatric patient. Crit Care Med 2006;34:S176-82.
83. Marik PE. Should age limit admission to the intensive care unit? Am J Hosp Palliat Care 2007;24:63-6.
84. Martin JT. Positioning aged patients. Anesthesiol Clin North America 2000;18:105-21.

85. Merle L, Laroche ML, Dantoine T, Charmes JP. Predicting and preventing adverse drug reactions in the very old. Drugs Aging 2005;22:375-92.
86. Moller JT, Cluitmans P, Rasmussen LS, Houx P, Rasmussen H, Canet J, Rabbitt P, Jolles J, Larsen K, Hanning CD, Langeron O, Johnson T, Lauven PM, Kristensen PA, Biedler A, van Beem H, Fraidakis O, Silverstein JH, Beneken JE, Gravenstein JS. Long-term postoperative cognitive dysfunction in the elderly ISPOCD1 study. ISPOCD investigators. International Study of Post-Operative Cognitive Dysfunction. Lancet 1998;351:857-61.
87. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am 2005;87:483-9.
88. Morley JE, Haren MT, Rolland Y, Kim MJ. Frailty. Med Clin North Am 2006;90:837-47.
89. Morrissey PE, Yango AF. Renal transplantation: older recipients and donors. Clin Geriatr Med 2006;22:687-707.
90. Mueller PS, Hook CC, Fleming KC. Ethical issues in geriatrics: a guide for clinicians. Mayo Clin Proc 2004;79:554-62.
91. Najjar SS, Scuteri A, Lakatta EG. Arterial aging: is it an immutable cardiovascular risk factor? Hypertension 2005;46:454-62.
92. Narr BJ, Warner ME, Schroeder DR, Warner MA. Outcomes of patients with no laboratory assessment before anesthesia and a surgical procedure. Mayo Clin Proc 1997;72:505-9.
93. Newman MF, Kirchner JL, Phillips-Bute B, Gaver V, Grocott H, Jones RH, Mark DB, Reves JG, Blumenthal JA. Longitudinal assessment of neurocognitive function after coronary-artery bypass surgery. N Engl J Med 2001;344:395-402.
94. Nickalls RW, Mapleson WW. Age-related iso-MAC charts for isoflurane, sevoflurane and desflurane in man. Br J Anaesth 2003;91:170-4.
95. Novis BK, Roizen MF, Aronson S, Thisted RA. Association of preoperative risk factors with postoperative acute renal failure. Anesth Analg 1994;78:143-9.
96. Nydahl PA, Philipson L, Axelsson K, Johansson JE. Epidural anesthesia with 0.5% bupivacaine: influence of age on sensory and motor blockade. Anesth Analg 1991;73:780-6.
97. O'Hara DA, Duff A, Berlin JA, Poses RM, Lawrence VA, Huber EC, Noveck H, Strom BL, Carson JL. The effect of anesthetic technique on postoperative outcomes in hip fracture repair. Anesthesiology 2000;92:947-57.
98. Perdue PW, Watts DD, Kaufmann CR, Trask AL. Differences in mortality between elderly and younger adult trauma patients: geriatric status increases risk of delayed death. J Trauma 1998;45:805-10.
99. Poldermans D, Boersma E, Bax JJ, Thomson IR, van de Ven LL, Blankensteijn JD, Baars HF, Yo TI, Trocino G, Vigna C, Roelandt JR, van Urk H. The effect of bisoprolol on perioperative mortality and myocardial infarction in high-risk patients undergoing vascular surgery. Dutch

Echocardiographic Cardiac Risk Evaluation Applying Stress Echocardiography Study Group. N Engl J Med 1999;341:1789-94.
100. Priebe HJ. The aged cardiovascular risk patient. Br J Anaesth 2000;85:763-78.
101. Pudelek B. Geriatric trauma: special needs for a special population. AACN Clin Issues 2002;13:61-72.
102. Rehman SU, Cope DW, Senseney AD, Brzezinski W. Thyroid disorders in elderly patients. South Med J 2005;98:543-9.
103. Rigg JR, Jamrozik K, Myles PS, Silbert BS, Peyton PJ, Parsons RW, Collins KS. Epidural anaesthesia and analgesia and outcome of major surgery: a randomised trial. Lancet 2002;359:1276-82.
104. Roach GW, Kanchuger M, Mangano CM, Newman M, Nussmeier N, Wolman R, Aggarwal A, Marschall K, Graham SH, Ley C. Adverse cerebral outcomes after coronary bypass surgery. Multicenter Study of Perioperative Ischemia Research Group and the Ischemia Research and Education Foundation Investigators. N Engl J Med 1996;335:1857-63.
105. Robertshaw HJ, Hall GM. Diabetes mellitus: anaesthetic management. Anaesthesia 2006;61:1187-90.
106. Rodgers A, Walker N, Schug S, McKee A, Kehlet H, van Zundert A, Sage D, Futter M, Saville G, Clark T, MacMahon S. Reduction of postoperative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. Bmj 2000;321:1493.
107. Roehrig B, Hoeffken K, Pientka L, Wedding U. How many and which items of activities of daily living (ADL) and instrumental activities of daily living (IADL) are necessary for screening. Crit Rev Oncol Hematol 2007;62:164-71.
108. Rooke GA. Cardiovascular aging and anesthetic implications. J Cardiothorac Vasc Anesth 2003;17:512-23.
109. Rosenberg PH, Veering BT, Urmey WF. Maximum recommended doses of local anesthetics: a multifactorial concept. Reg Anesth Pain Med 2004;29:564-75; discussion 524.
110. Sadean MR, Glass PS. Pharmacokinetics in the elderly. Best Pract Res Clin Anaesthesiol 2003;17:191-205.
111. Schein OD, Katz J, Bass EB, Tielsch JM, Lubomski LH, Feldman MA, Petty BG, Steinberg EP. The value of routine preoperative medical testing before cataract surgery. Study of Medical Testing for Cataract Surgery. N Engl J Med 2000;342:168-75.
112. Scott BH, Seifert FC, Grimson R, Glass PS. Octogenarians undergoing coronary artery bypass graft surgery: resource utilization, postoperative mortality, and morbidity. J Cardiothorac Vasc Anesth 2005;19:583-8.
113. Seals DR, Esler MD. Human ageing and the sympathoadrenal system. J Physiol 2000;528:407-17.
114. Sear JW. Kidney dysfunction in the postoperative period. Br J Anaesth 2005;95:20-32.

115. Segovia G, Porras A, Del Arco A, Mora F. Glutamatergic neurotransmission in aging: a critical perspective. Mech Ageing Dev 2001;122:1-29.
116. Sessler DI. Mild perioperative hypothermia. N Engl J Med 1997;336:1730-7.
117. Shafer SL. The pharmacology of anesthetic drugs in elderly patients. Anesthesiol Clin North America 2000;18:1-29, v.
118. Shaffer SW, Harrison AL. Aging of the somatosensory system: a translational perspective. Phys Ther 2007;87:193-207.
119. Sharma PT, Sieber FE, Zakriya KJ, Pauldine RW, Gerold KB, Hang J, Smith TH. Recovery room delirium predicts postoperative delirium after hip-fracture repair. Anesth Analg 2005;101:1215-20, table of contents.
120. Siegmeth AW, Gurusamy K, Parker MJ. Delay to surgery prolongs hospital stay in patients with fractures of the proximal femur. J Bone Joint Surg Br 2005;87:1123-6.
121. Sigurdsson E, Thorgeirsson G, Sigvaldason H, Sigfusson N. Unrecognized myocardial infarction: epidemiology, clinical characteristics, and the prognostic role of angina pectoris. The Reykjavik Study. Ann Intern Med 1995;122:96-102.
122. Silverstein JH, Timberger M, Reich DL, Uysal S. Central nervous system dysfunction after noncardiac surgery and anesthesia in the elderly. Anesthesiology 2007;106:622-8.
123. Somme D, Maillet JM, Gisselbrecht M, Novara A, Ract C, Fagon JY. Critically ill old and the oldest-old patients in intensive care: short- and long-term outcomes. Intensive Care Med 2003;29:2137-43.
124. Sprung J, Gajic O, Warner DO. Review article: Age related alterations in respiratory function - anesthetic considerations: [Article de synthese : Les modifications de fonction respiratoire liees a l'age - considerations anesthesiques]. Can J Anaesth 2006;53:1244-57.
125. Stambaugh JE, Wainer IW, Sanstead JK, Hemphill DM. The clinical pharmacology of meperidine--comparison of routes of administration. J Clin Pharmacol 1976;16:245-56.
126. Terry AV, Jr., Buccafusco JJ. The cholinergic hypothesis of age and Alzheimer's disease-related cognitive deficits: recent challenges and their implications for novel drug development. J Pharmacol Exp Ther 2003;306:821-7.
127. Tieves KS, Yang H, Layde PM. The epidemiology of traumatic brain injury in Wisconsin, 2001. Wmj 2005;104:22-5, 54.
128. Troianos CA, Kuwik RJ, Pasqual JR, Lim AJ, Odasso DP. Internal jugular vein and carotid artery anatomic relation as determined by ultrasonography. Anesthesiology 1996;85:43-8.
129. Truog RD, Waisel DB, Burns JP. DNR in the OR: a goal-directed approach. Anesthesiology 1999;90:289-95.
130. Tsui BC, Wagner A, Finucane B. Regional anaesthesia in the elderly: a clinical guide. Drugs Aging 2004;21:895-910.

131. Twersky R, Fishman D, Homel P. What happens after discharge? Return hospital visits after ambulatory surgery. Anesth Analg 1997;84:319-24.
132. Urwin SC, Parker MJ, Griffiths R. General versus regional anaesthesia for hip fracture surgery: a meta-analysis of randomized trials. Br J Anaesth 2000;84:450-5.
133. Veering BT. Hemodynamic effects of central neural blockade in elderly patients. Can J Anaesth 2006;53:117-21.
134. Verdu E, Ceballos D, Vilches JJ, Navarro X. Influence of aging on peripheral nerve function and regeneration. J Peripher Nerv Syst 2000;5:191-208.
135. Vuyk J. Pharmacodynamics in the elderly. Best Pract Res Clin Anaesthesiol 2003;17:207-18.
136. Wahba WM. Influence of aging on lung function--clinical significance of changes from age twenty. Anesth Analg 1983;62:764-76.
137. Watanabe S, Takeshima R, Asakura N, Kumagai M, Taguchi N, Satsumae T. The effect of age on retrieval of local anesthetic solution from the epidural space. Anesth Analg 1997;85:1091-6.
138. Williams-Russo P, Sharrock NE, Mattis S, Szatrowski TP, Charlson ME. Cognitive effects after epidural vs general anesthesia in older adults. A randomized trial. Jama 1995;274:44-50.
139. Wu CL, Hsu W, Richman JM, Raja SN. Postoperative cognitive function as an outcome of regional anesthesia and analgesia. Reg Anesth Pain Med 2004;29:257-68.
140. Zeleznik J. Normative aging of the respiratory system. Clin Geriatr Med 2003;19:1-18.
141. Schmucker DL. Liver function and phase I drug metabolism in the elderly: a paradox. Drugs Aging 2001;18:837-51.