

Understanding the concept of geriatric anesthesia and its implication in clinical practice:

A Learning Module for Student Registered Nurse Anesthetists.

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## **Abstract**

Increase in longevity of the geriatric population, and increase in number of the group has led to an increased frequency of requirement for anesthesia management. A thorough understanding of the physiological changes associated with aging, the effect of aging on various body systems, the intricate medication management, and dosing as it relates to anesthesia practice all become very important. A thorough knowledge of the healthcare implications concerning the geriatric population would be an important tool for the Senior Registered Nurse Anesthetists (SRNA).

The purpose of the project was to provide additional learning opportunities to Student Registered Nurse Anesthesia in clinical rotation as an addition to their knowledge base of adult anesthesia care. Grounded knowledge of the care of the geriatric involves a thorough understanding of all aspects of care for this population.

The presentation of this learning module involved use of current anesthesia textbooks and journal articles on geriatric anesthesia, as well as the use of visual and audio aids to educate underclassmen. Focusing on the physiology and pathophysiology changes with aging. Understanding of the pharmacological problems associated with aging, the implication of inhalation anesthesia, and local anesthesia on aging were addressed by using current anesthesia literatures and journal articles.

A pretest tool was used to evaluate the knowledge base of the SRNAs. A post-test was used to re-evaluate the knowledge base post presentation. Upon review of the pre-test and post-test statistical analysis it was identified that the educational module was instrumental in increasing the knowledge base of the SRNAs who participated in the study.

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## **Chapter 1: Introduction**

### **Introduction to the Problem**

It is important to have an in-depth knowledge of what physiological changes are normal in the geriatric population as it pertains to anesthesia. The American Association of Nurse Anesthetists (AANA) Code of Ethics 3.1 states that the Certified Registered Nurse Anesthetist (CRNA), as an independently licensed professional, is responsible and accountable for judgments made and actions taken in his or her professional practice (AANA, 2014). Neither physician orders nor institutional policies relieve the CRNA of responsibility for his or her judgments made or actions taken. This implies that the SRNA must be grounded in every aspect of care in the geriatric population. Such knowledge will become an asset in anesthesia delivery as professionals.

The rapidly increasing population of elderly patients requiring anesthesia mandates a thorough knowledge of the patient population. Because advanced age is a major risk factor for increased morbidity and mortality during the perioperative period, a thorough knowledge of the geriatric patient becomes essential (Bhaskar & Bajwa, 2014). A comprehensive knowledge of the patient population will also equip the SRNA to avoid complications postoperatively.

In addition, due to the rapidly changing patient population, repetition of geriatric patient care will help instill a knowledge base of how to care for patients. Thorough presentation of preoperative medications and how they impact the cerebral physiology in the elderly is necessary for an SRNA to understand in order to avoid cognitive dysfunction in the patient. Polypharmacy, over-the-counter medications, and supplements for the elderly and its implications in anesthesia care are other factors SRNAs should be made aware of.

Fluid management, postoperative pain management, and induction doses for anesthesia medication during geriatric anesthesia are critical perioperative challenges that require early and careful education of the SRNA in clinical practice. A thorough understanding of intravenous anesthesia, inhalation anesthesia and regional anesthesia regarding the geriatric population also become significant (Owusu & Berger, 2014).

## **Chapter 2: Literature Review**

As the number of geriatric patients increase, it is essential that healthcare professionals managing this patient population are well equipped with the necessary background knowledge to adequately care for this population. A gap in knowledge exists in the field of geriatric anesthesia in the area of research focusing on the challenges of geriatric anesthesia to the Student Registered Nurse Anesthetic (SRNA). Limited data is available with regard to the concept of assessing proper understanding of geriatric anesthesia in clinical practice among SRNAs.

Dilsen, Seyhan Serpil, Canan, Mustafa, and Nermin (2010) study the influence of various anesthesia techniques on postoperative recovery and discharge criteria among geriatric patients. Dilsen et al (2010) study 60 geriatric outpatient patients undergoing transurethral interventions using general anesthesia cases, or selective spinal anesthesia. Hemodynamic variations, nausea and vomiting, and patient and surgeon satisfaction are variables studied by Dilsen et al, 2010. Their discovery is that no variation exists between outcomes using either technique in terms of hemodynamic variation and surgeon/satisfaction. This finding reinforces the need for adequate knowledge in performing geriatric anesthesia because spinal anesthesia and general anesthesia should not have the same hemodynamic effect.

Also, Bettelli (2010) studies anesthesia care of the elderly patient in the outpatient setting. Preoperative assessment and evaluation, postoperative pain management, and anesthesia

technique are areas researched. Age and functional status as well as criteria for selection of geriatric patient's suitability for outpatient surgery are examined but nothing is said about the knowledge base and traineeship of anesthetists performing anesthesia in the outpatient clinical setting. In another journal article by Bettelli, 2011, a look at preoperative evaluation in geriatric surgery with emphasis on geriatric functional status, comorbidities and pharmacological history is addressed. The study looks at the disease states common to the elderly. Hypertension, diabetes, and coronary artery disease, among others, are analyzed as very common to the elderly patient (Bettelli, 2011, p. 643). The conclusion from the study reiterates that more education is needed in the preoperative evaluation of elderly patients because of their rapid increase in number, increased commodities, and pharmacological history (Bettelli 2011 p.644).

Furthermore, Rortgen, Kloos, Fries, Grottke, Rex, Rossaint and Coburn (2010) compare early cognitive function and recovery after desflurane or sevoflurane anesthesia in the elderly with the goal of finding which gas increases the risk of postoperative cognitive dysfunction more. The study highlights the importance of a thorough knowledge base on the vast implication of various anesthesia choices facing the certified registered nurse anesthetist and students in the area of geriatric anesthesia. Rortgen et al (2010) discover that there is little difference in the occurrence of postoperative cognitive dysfunction in choice of anesthesia gas between desflurane and sevoflurane among the geriatric patients studied (Rortgen et al, 2010, p. 173).

It has also been documented that the population growth of people over 65 years of age has tripled in the last 50 years. In Europe, 30% of the population will be represented by individuals 65 years and older. This increase in population directly impacts the healthcare system medically and surgically. Elderly patients are accompanied by factors that increase surgical risk: polypathology, polymedication and disorders at the cellular level. Publications (Bettelli, 2011;

Deiner & Silverstein, 2011) review the importance of the anesthesia provider's knowledge on the geriatric patient's preoperative evaluation, comorbidities, functional status and pharmacological history. These publications discuss in detail three primary factors that contribute to increased perioperative risk in the elderly patient: progressive functional decline and decreased reserve capacity to compensate for impaired function or increased demand; associated illnesses that will limit baseline function and an altered neuro-humoral response to stress; and increased incidence of unexpected reactions to medications, anesthesia and surgery.

Functional status of the elderly population is associated with surgical complications. Bettelli (2011) discuss that the majority of anesthesia and surgeons do not complete a measured assessment of the geriatric population's physical and cognitive function in their preoperative assessment. Currently there is no gold standard in assessing the geriatric patient's cognitive and functional status. Use of assessment tools such as the comprehensive geriatric assessment (CGA) and basic and instrumental activities of daily life (BADLs; IADLs) were useful in assessing surgical risk in patients undergoing thoracic surgery. It is reported by Fukuse et al., of 120 subjects it that "subjects who lack autonomy in performing BADLs and were more likely to have complications, especially for long operation times" (Fukuse et al., 2010, p. 889). Another study of 178 geriatric patients, Kristjansson et al., identifies that "CGA can identify frail patients;" these patients are found to have a significantly increased risk of "severe complications after elective colorectal surgery" (Kristjansson et al., 2009, p. 213). Noimark (2009) identifies that frailty is a risk factor for postoperative delirium.

Kozian et al. (2015) discuss the importance of the physiological changes that occur in the body due to aging and considerations to take with thoracic surgery anesthesia with emphasis on the pulmonary system. This is important to anesthesia practice because of the administration of

volatile agents to produce anesthesia. With the continued decline in the aging person's physiological reserves, respiratory complications considerably contribute to thoracic surgery outcomes. Preoperative lung function is a priority and must be evaluated via both clinical examination and lung function testing. The identified test parameter that is of importance for the anesthesia provider to know is the FEV1. This parameter has been identified by Licker et al. (2014) to show an augmented occurrence of postoperative pulmonary complications. "The most important variable is the global cardio-pulmonary reserve" (Licker et al, 2014, p. 127).

Use of different anesthesia techniques has been researched regarding lengths of stay and prolonged hospitalization. In the study done by Le-Wendling et. al. (2012), it is identified that the use of regional anesthesia when compared to general anesthesia for surgery on geriatric patients with hip fractures shows no statistical difference between the two groups. In addition, in-hospital mortality and readmission are not statistically different between the groups. This study includes all assessed costs of hospitalization, including procedures, labor and equipment, at "\$16,789 + 631 vs \$16815 +643 respectively, P=0.9557." (Le-Wendling et al., 2012, p.948).

Bettelli (2011) identifies that it would take an anesthesia provider an additional 10-15 minutes to interview geriatric patients on functional status. In today's operating arena it is not often that an anesthesia provider has an additional 10-15 minutes to add to a preoperative evaluation. The literature supports that some institutions have the pre-anesthesia interview outside of the day of surgery; this allows an increased time frame to implement a variables test that is followed by an action plan postoperatively when specific criteria are met. (See Index 1.) An example is BADL/IADL. If dependence is more than moderate, alert for perioperative extra nursing; and for Mini Mental State Examination, (MMSE) if MMSE <20, alert for perioperative psychological support.



Deiner & Silverstein (2011) discuss homeostasis; changes in physiologic reserves; cardiac physiology and pathophysiology changes on cardiac, respiratory, cerebral, hepatic and renal metabolism; and immunological function and the effect of anesthetic agents upon them. It is discussed that MAC decreases by 6% every decade after 40 years of age. Deiner & Silverstein (2011) discuss the condition “triple low.” “Triple low” is a state that occurs when the Bispectral Index (BIS) is  $<45$ , mean arterial pressure (MAP)  $<75\text{mmHg}$ , and end-titile volatile anesthetic MAC  $<0.7$ . This combination of values identifies patients who are sensitive to anesthesia and are at increased risk of cerebral hypoperfusion. This increased risk identifies that individuals with double low parameters are doubled the risk of 90-day mortality.

Unplanned perioperative hypothermia (UPH) is a complication that can be proactively prevented by the anesthesia provider. Erdling and Johansson (2015) research the differences between esophageal and nasopharyngeal temperature monitoring comparison with pre-warming, age, and weight. Unplanned perioperative hypothermia is defined as a core body temperature  $<36$  degrees centigrade. It is known that both general and regional anesthesia affect both the central nervous system and peripheral tissue properties of vasoconstriction. Review of the data results in finding the group that had pre-warming demonstrate an increase in core temperature double that of the no pre-warming group. The study also noted that in the first hour of surgery both groups have a drop in core temperature measured only by the esophageal temperature probe and not the nasopharyngeal probe. It is believed that the esophageal temperature probe provides a more accurate reading compared to the nasopharyngeal temperature probe. The study concludes that pre-warming is beneficial in intraoperative UPH prevention.

Hadzimesic et al. 2013 research the cognitive function recovery rate in patients averaging approximately 45 years old during the early postoperative period comparing the following

anesthetics, propofol, sevoflurane, and isoflurane. The three anesthetic agents are assessed using the Orientation-Memory-Concentration (OMC) Test at the 1, 5, and 10 minute times after extubation. Isoflurane demonstrates the longest recovery of cognitive function using the OMC when compared to the propofol and sevoflurane groups. Propofol anesthesia when compared to isoflurane shows a statistical significance at the three times measured. Hadzimesic et al. 2013 demonstrates an important anesthetic point for anesthesia providers to consider when administering these anesthetics to adults 40 years and greater.

In the retrospective study completed by Korhan et al. 2013 on mortality rates in the Cardiovascular Surgery Intensive Care Unit in Turkey with the age groups 65-74 years old and 75 years and older, the increase in elderly patient population requiring surgical intervention has demonstrated a gradual increase from 2003 to 2013. Cardiac surgery places a demanding stressor upon the elder patients' organ systems, increasing their sensitivity to poor outcomes. The study does not demonstrate a statistical significance between the two elderly patient populations and increased mortality related to cardiovascular surgery followed by a stay in the Cardiovascular Surgery Intensive Care Unit. This study supports that elderly patients have a good prognosis following cardiovascular surgery with recovery in a Cardiovascular Surgery Intensive Care Unit.

Research is completed by Li et al. (2014) on the outcomes of peripheral nerve blocks compared to general anesthesia for hip fractures in geriatric Chinese patients. Patients who undergo a hemiarthroplasty for hip fracture are divided into two groups: general anesthesia and peripheral nerve block. The researchers compare the two groups looking at postoperative complications and mortality during the time frames; in hospital, 30 day, and one year respectively postoperatively. Acute cardiovascular events, delirium, and electrolyte disturbances are the most common postoperative complications identified (Li et al., 2014). "The study showed

6.9%, 14.7%, 23.5% mortality at in-hospital, 30-day, and 1-year postoperatively in this study” (Li et al., 2014, p. 655). The research statistical analysis concludes that mortality and postoperative complications are statically significant between the two groups. The general anesthesia group did have a higher incidence of dementia post operatively than the PNB group. The researchers discuss the possibility of improving this patient population’s outcome by creating a team of practitioners to co-manage the geriatric hip fracture population. This team could have a stronger influence on improving patient outcomes than anesthesia type.

Research completed on anesthesia for the elderly in the outpatient setting by Aurini and White (2014) reviews evidence that supports the continued growth and expansion of ambulatory surgery centers for elective surgical procedures by the elderly patient population. The global population of the world is aging. This is a direct result from the parallel decline in mortality and fertility rates (Aurini and White, 2014). As of 2009 the US Census Bureau documents the elderly population number at 39.6 million, or 12.9% of the population. By 2030, the elderly population will almost double to approximately 72.1 million, or 19% of the US population. Elderly patient physiology is associated with cardiovascular system loss of compliance, autonomic nervous system decline, and increased risk of intraoperative hypothermia. Cerebral perfusion and neuron numbers decrease with aging. This increases the postoperative complication of post-operative cognitive disorder (POCD). The ambulatory setting has been identified as an arena that POCD, post-nausea and vomiting, and frequency and severity of post-operative pain is reduced after general anesthesia (Aurini and White, 2014). General anesthesia versus regional anesthesia does not show one greater than the other in outpatient surgery. Use of non-opioid pain medications such as acetaminophen, NSAIDS, Cyclooxygenase-2 inhibitors, and glucocorticoid steroids results in good pain control without the increase of postoperative bleeding risk in the elderly

patient. The American Society of Anesthesiologists is encouraging anesthesiologists to include surgical home care programs as part of the perioperative care given to the elderly patient in the outpatient surgical setting. Proactive anesthesia management and evidence-based perioperative management of the elderly population will improve outcomes and create a savings to the healthcare system.

Surgery is a life altering event that affects the elderly body, deviating it from the original preoperative diagnosis (Kim et al., 2015). Intraoperative and postoperative stress is both physically and psychologically an imbalance to the body's autonomic, endocrine, metabolic, and immune functions. The aging adult body has a reduction in physiologic reserve, or frailty. Kim et al (2015) discuss the two phenotypes of frailty, physical and multidomain. Physical phenotype of frailty is a clinical syndrome which an individual must have three or more of the following criteria present: unintentional weight loss (10 pounds in the last year), self-reported exhaustion, weakness (grip strength), slow walking speed, and low physical activity (Kim et al., 2015). Multidomain phenotype of frailty considers additional components such as cognitive impairment, mood disorders, sensory impairment, chronic diseases, poor social conditions and support, and disability (Kim et al., 2015). With use of the modified Frailty Index (mFI), which was created from comparing the Canadian Study of Health and Aging Frailty Index with the mathematically measured outcomes from the National Surgical Quality Improvement Program (NSQIP), eleven items can be assessed without hands-on measurement. This is important since preanesthesia evaluation is not a time for a full hands-on assessment by an anesthesia provider. The following are the eleven items of the mFI: History of diabetes mellitus, CHF, hypertension requiring medication, transient ischemic attack or cerebrovascular accident, myocardial infarction, either peripheral vascular disease or rest pain, cerebrovascular accident with

neurological deficit, COPD or pneumonia, either prior PCI, PCS, or angina, impaired sensorium, functional status 2 (not independent). In the case of emergency surgery the higher the mFI score the higher the complications of wound infection, wound occurrence, any infection, any occurrence of complications, and mortality. With the elderly population increasing in numbers, the demand for surgical services and perioperative care will also increase. A thorough preoperative evaluation that includes use of mFI will aid the anesthesia provider in anesthesia administration with the goal of decreasing perioperative complications.

Neuroaxial versus general anesthesia administration in the geriatric patient population who have sustained a hip fracture remains a controversial topic in the medical literature. In a retrospective analyses of current literature search covering 18,715 patients with hip fractures, it is concluded that spinal anesthesia is associated with a reduction in mortality, deep vein thrombosis, less acute postoperative confusion, fewer myocardial infarctions, pneumonia, fatal pulmonary embolisms, and postoperative hypoxia (Luger et al., 2010). General anesthesia demonstrates advantages of lower incidence of hypotension, postoperative delirium, and fewer cerebrovascular accidents (Luger et al., 2010). These differences between Neuroaxial and general anesthesia have limited evidence leading to a definitive conclusion that one is superior to the other.

The current research completed by Makary et al. (2010) supports that frailty can be used as a predictor of surgical outcomes in the older patient population. In the past frailty has been used to evaluate surgical patient outcomes. Through a prospective study of 594 patients 65 years of age and greater who were undergoing elective surgery, frailty is categorized using the following validated scale of zero to five that includes weight loss, weakness, low physical activity, exhaustion, and slowed walking speed. Patients are put into three groups: 4-5 frail, 2-3

intermediately frail, and 0-1 non-frail. After analysis of the data it is identified that frailty is associated with an increased risk for postoperative complications, increased length of stay, and placement into a skilled nursing facility. Use of frailty assessment tools can aid patients, physicians, and Nurse Anesthetists in making a more informed decision.

Further research of frailty has lead researchers in to the area of ensuring assessment tools and scales have validity and reliability. Rolfson et al. (2006) research the validity and reliability of the Edmonton Frail Scale. The researches conclude that the Edmonton Frail Scale (EFS) has “good construct validity, good reliability and acceptable internal consistency.” (Rolfson et. al., 2006, p. 528). It supports the use of EFS as a measure of frailty in a variety of settings. The researchers do state “it is no gold standard,” but is a good scale to use to alert health care professionals of frail populations so they may be optimized prior to elective procedures.

Geriatric surgery is viewed by surgeons as a clinical community rather than an independent society. Researchers Zenilman, Kathlic, and Rosenthal (2015) have reviewed current scientific data and opinions from surgical leaders in the field of surgery in the elderly population. The definition of a clinical community by the researchers is described as a “state of mind.” They further discuss the details of a clinical community being “a group of people who work together interdependently as a team who share a common commitment” (Zenilman, Kathlic, Rosenthal, 2015, p.948). As the geriatric surgical community continues to develop and grow over time areas, the researchers see further development would assist the interdependent practitioners with outcomes. The following areas are mentioned: frailty, tests of cognition, education of geriatric principles in surgical internships and fellowships, prevention and treatment of post-operative delirium, increased focus on multidisciplinary care at annual meetings, and partnering with nurses to improve geriatric care. One last area discussed by the researcher is the

importance to generate new evidence on geriatric surgery with the goal of creating a specialty unit and care team.

### **Chapter 3: Project Description**

The capstone project focuses on the anesthesia care of the geriatric patient. The purpose of the project was to provide additional learning opportunities to Student Registered Nurse Anesthesia in clinical rotation as an addition to their knowledge base of adult anesthesia care. The rapidly increasing number of the geriatric population seeking anesthesia care makes it important to ensure a broad understanding of the care of these patients during clinical rotations. Grounded knowledge of the care of the geriatric involves a thorough understanding of all aspects of care for this population.

The presentation of this learning module involved use of current anesthesia textbooks and journal articles on geriatric anesthesia, as well as the use of visual and audio aids to educate underclassmen. Focusing on the physiology and pathophysiology changes with aging. Understanding of the pharmacological problems associated with aging, the implication of inhalation anesthesia, and local anesthesia on aging was be addressed using current anesthesia literatures and journal articles.

A pretest tool was be used to evaluate the knowledge base of the SRNAs. A post-test tool was used to re-evaluate to the knowledge base post presentation. Clinical challenges encountered as students during anesthesia care of the geriatric patient necessitate this learning model as a reinforcement tool aimed at increasing the knowledge base of SRNAs.

### **Evaluation**

The 60-minute Power Point presentation will be presented to the SRNAs. The presentation was held in the classroom. The evaluation of the success of the lecture was based on

the results of the SRNAs post lecture evaluation test compared to a pretest evaluation test before the learning module presentation. The evaluation of the outcome of the teaching model was hoped to reflect increased understanding of all aspects of geriatric anesthesia and its implication in clinical practice. The evaluation scores from the pretest were averaged and compared to the average scores of the post test scores to assess the effectiveness of the Power Point presentation in knowledge enrichment on geriatric anesthesia implications in clinical practice among SRNAs.

The evaluation plan was reassessed via in-lecture review questions to help realize the project goal of assisting in the overall growth and development of SRNAs to be better providers of anesthesia in the fast growing geriatric population.

### Results and Conclusion

**Paired Samples Statistics**

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PreTest Scores	13.3810	21	2.85440	.62288
	PostTest Scores	18.2857	21	3.83592	.83707

**Paired Samples Test**

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 PreTest Scores - PostTest Scores	-4.90476	4.67873	1.02098	-7.03449	-2.77503	-4.804	20	.000



The paired samples statistics table shows the average score increase from 13.3810 to 18.2857 demonstrating an improvement from pretest scores. In the paired samples test table, the obtained t value is -4.804 with an associated p that is less than .05 level of confidence. This signifies statistical significance is achieved. In addition, the negative t value is indicative that a significant improvement was achieved after the presentation of the educational module.

In conclusion, the educational module was instrumental in increasing the knowledge base of the SRNAs who participated in the study. Results and conclusion of the statistics of this study are based on the pre-test and post-test statistical analysis results.

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**APPENDIX A**

## Geriatric Anesthesia Assessment tool Pre/Post test

1. At what age are half of the glomeruli are lost?
  - a. 60
  - b. 70
  - c. 80
  - d. 90
  
2. Renal sodium management is affected in the elderly by which of the following:
  - a. Reduction in the secretion of aldosterone
  - b. Decreased elimination of excessive sodium
  - c. Decreased retention of sodium
  - d. All of the above
  
3. Renal Cortex decreases by what percent with age?
  - a. 10-15%
  - b. 20-25%
  - c. 30-35%
  - d. 40-45%
  
4. How does the decline in the overall endocrine function in the elderly affect anesthetic management?
  - a. Typically it does not
  - b. They have lower insulin requirements
  - c. They have higher insulin responses to glucose loads
  - d. They have decreased insulin resistance in skeletal muscle
  
5. How much does brain mass decrease by age 80?
  - a. 10%
  - b. 20%
  - c. 30%
  - d. 50%
  
6. How is blood circulatory time affected by aging?
  - a. Unaffected
  - b. Decreased
  - c. Increased
  - d. None of the above
  
7. How does blood circulatory time affect intravenous and inhalation induction times? (pick all that apply)
  - a. Inhalation induction will proceed more quickly
  - b. FA/FI ratio will approach 1 more slowly

- c. Intravenous induction will proceed more slowly
  - d. Intravenous induction time is unaffected by blood circulatory time
8. Liver mass and blood flow are affected how with aging?
- a. Increases in size
  - b. Decreases in size
  - c. 10-15% of blood flow decreases with age
  - d. 20-40% of blood flow decreases with age
  - e. A and B
  - f. B and C
  - g. B and D
9. Which is false regarding cerebral blood flow and brain mass changes in the elderly?
- a. Neuronal density decreases
  - b. Cerebral blood flow and CRMO<sub>2</sub> decreases
  - c. Loss in mass is primarily due to loss of white matter
  - d. Loss of mass is primarily due to loss of gray matter neurons in the cortex and frontal lobes
10. Which of the following is false regarding thermoregulation impairment in the elderly patient?
- a. Lower basal metabolic rate
  - b. High proportion of body surface area to body mass
  - c. Lower ability to produce peripheral vasoconstriction to reduce heat loss
  - d. Low incidence of hypothyroidism
11. Which of the following is false regarding disadvantages of hypothermia in the elderly patient?
- a. Drug metabolism can be impaired with hypothermia
  - b. Decreased platelet function
  - c. Increased risk of infection
  - d. Shivering decreases oxygen consumption by 400%
12. How do plasma protein levels change with age?
- a. Serum albumin decreases slightly
  - b. Serum albumin is unchanged
  - c. Alpha-1 acid glycoprotein levels are usually unchanged or slightly increased
  - d. A and C
13. Which is true regarding changes in total body water with age?
- a. Total body water increases with age
  - b. There is an increase in cellular water from the loss of muscle mass and decreased in adipose tissue
  - c. Total body water decreases with age

- d. None of the above
14. Which of the following are true regarding age-related hepatic function required dose-adjustments for medication in the elderly? (pick 2)
- a. Decrease opiate dose by 50%
  - b. Decreases in hepatic function can result in a prolongation of anesthetic agents
  - c. Plasma clearance of opiates is unchanged
  - d. None of the above
15. How does the response to beta-adrenergic agents change in the elderly?
- a. Decreased response to beta-adrenergic stimulation
  - b. Increased response to drugs that rely on beta-adrenergic stimulation
  - c. Increased response to beta-adrenergic stimulation
  - d. None of the above
16. Why are geriatric patients more susceptible to intraoperative hypotension under anesthesia?
- a. due to dehydration
  - b. due to chronic use of diuretics
  - c. decreased capacity for sodium and water conservation by the kidney
  - d. limited response to beta-adrenergic drugs and decreased cardiac contractility that is exacerbated by anesthesia drugs
  - e. all of the above
17. The protective laryngeal reflexes such as swallowing and coughing decreases with increasing age. As a result of the decrease in the protective laryngeal reflexes aging patients are increase risk of which pulmonary complications?
- a. Pulmonary inflammation
  - b. Loss of alveolar surface area due to repeated microaspirations
  - c. Contamination of the lower airway with enteric organisms
  - d. All of the above
18. Plasma norepinephrine levels are:
- a. Increased in elderly patients
  - b. Decreased in elderly patients
  - c. Unaffected with age
  - d. None of the above
19. Of the following surgical procedures which two have the highest incidence of postoperative delirium in the elderly population?
- a. Urology
  - b. Orthopedic
  - c. Cardiac
  - d. Hepatic



20. The elderly have a diminished tachycardic response to the following hemodynamics:
- Hypotension
  - Hypovolemia
  - Hypoxia
  - All of the above
21. How is MAC affected by age?
- Is decreased by about 4-6% per decade after the age of 40
  - Is decreased by about 8-10% per decade after the age of 40
  - Unaffected by age
  - None of the above
22. Elimination half-lives of atracurium and cisatracurium are affected by aging in which of the following ways?
- They are increased
  - They are decreased
  - They are not affected
  - None of the above
23. With longer circulatory time and a decrease in skeletal muscle blood flow, the onset of all muscle relaxants ...
- Is up to twice as long in elderly patients
  - Is up to four times as long in elderly patients
  - Is unaffected by age
  - None of the above
24. The duration of action of midazolam, diazepam and lorazepam are affect by aging in what ways?
- Midazolam effects are increased in the elderly
  - Diazepam has the greatest lipid solubility increasing accumulation in lipid stores
  - Half-life of diazepam is increased from 30 hours to 36 hours in the elderly
  - Lorazepam is less lipid soluble, its half-life remains relatively unchanged
  - All of the above
25. The elderly patient has changes in body composition that affect the volume of distribution for water-soluble and fat-soluble drugs in which manor. What statement is false?
- Total body water increases while total body fat decreases
  - Total body of water decreases while total body fat increases
  - Volume of distribution for water-soluble drugs such as gentamicin, glycopyrrolate and succinylcholine decreases
  - Volume of distribution for lipid-soluble drugs such as benzodiazepines, volatile anesthetics, and barbiturates increases

**APPENDIX B****ANSWER SHEET FOR PRE/POST ASSESSMENT TOOL  
ON GERIATRIC ANESTHESIA**

1. C
2. D
3. B
4. A
5. C
6. B
7. A / C
8. G
9. C
10. D
11. D
12. D
13. C
14. A / B
15. A
16. E
17. D
18. A
19. B / C
20. D
21. A
22. C
23. A
24. E
25. A

## APPENDIX C

### IRB Research Proposal

#### TITLE

Understanding the concept of geriatric anesthesia and its implication in clinical practice:

A learning module for Student Registered Nurse Anesthetists.

#### DESCRIPTION AND PURPOSE OF THE CAPSTONE

Increase in longevity of the geriatric population, and increase in number of the group has led to an increased frequency of requirement for anesthesia management. A thorough understanding of the physiological changes associated with aging, the effect of aging on various body systems, the intricate medication management, and dosing as it relates to anesthesia practice all become very important. A thorough knowledge of the healthcare implications concerning the geriatric population would be an important tool for the Senior Registered Nurse Anesthetists (SRNA).

It is important to have an in-depth knowledge of what physiological changes are normal in the geriatric population as it pertains to anesthesia. The American Association of Nurse Anesthetists (AANA) Code of Ethics 3.1 states that the Certified Registered Nurse Anesthetist (CRNA), as an independently licensed professional, is responsible and accountable for judgments made and actions taken in his or her professional practice (AANA, 2014). Neither physician orders nor institutional policies relieve the CRNA of responsibility for his or her judgments made or actions taken. This implies that the SRNA must be grounded in every aspect of care in the geriatric population. Such knowledge will become an asset in anesthesia delivery as professionals.

Furthermore, the rapidly increasing population of elderly patients requiring anesthesia mandates a thorough knowledge of the patient population. Because advanced age is major risk factor for increased morbidity and mortality during the perioperative period, a thorough knowledge of the geriatric patient becomes essential (Bhaskar & Bajwa, 2014). A comprehensive knowledge of the patient population will also equip the SRNA to avoid complications postoperatively. In addition, due to the rapidly changing patient population, repetition of geriatric patient care will help instill a knowledge base of how to care for patients. Thorough presentation of preoperative medications and how they impact the cerebral physiology in the elderly is necessary for an SRNA to understand in order to avoid cognitive dysfunction in the patient. Polypharmacy, over the counter medications and supplements for the elderly and its implications in anesthesia care are other factors SRNAs should be made aware of.

Fluid management, postoperative pain management, and induction doses for anesthesia medication during geriatric anesthesia are critical perioperative challenges that require early and careful education of the SRNA in clinical practice. A thorough understanding of intravenous anesthesia, inhalation anesthesia and regional anesthesia regarding the geriatric population also become significant (Owusu & Berger, 2014).

#### BACKGROUND AND RATIONALE

The capstone project focused on the anesthesia care of the geriatric patient. The purpose of the project is to provide additional learning opportunity to Student Registered Nurse Anesthetist in clinical rotation as an addition to their knowledge base of adult anesthesia care. The rapidly increasing number of the geriatric population seeking anesthesia care makes it important to ensure a broad understanding of the care of these patients during clinical rotations.

Grounded knowledge of the care of the geriatric involves a thorough understanding of all aspects of care for this population.

The presentation of this learning module will involve use of current anesthesia textbooks and journal articles on geriatric anesthesia, as well as the use of visual and audio aids to educate underclassmen. Focusing on the physiology and pathophysiology changes with aging.

Understanding of the pharmacological problems associated with aging, the implication of inhalation anesthesia, and local anesthesia on aging will be addressed using current anesthesia literatures and journal articles.

### PROBLEM STATEMENT

As the number of geriatric patients increase, it is essential that healthcare professional managing this patient population are well equipped with the necessary background knowledge to adequately care for this population. A gap in knowledge exists in the field of geriatric anesthesia in the area of research focusing on the challenges of geriatric anesthesia to the Student Registered Nurse Anesthetist (SRNA). Limited data is available with regard to the concept of assessing proper understanding of geriatric anesthesia in clinical practice among SRNAs.

Dilsen, Seyhan Serpil, Canan, Mustafa, and Nermin (2010) studied the influence of various anesthesia techniques on postoperative recovery and discharge criteria among geriatric patients. Dilsen et al (2010) studied 60 geriatric outpatient patients undergoing transurethral interventions using general anesthesia cases, or selective spinal anesthesia. Hemodynamic variations, nausea and vomiting, patient and surgeon satisfaction were variables studied by Dilsen et al, 2010. Their discovery was that no variation existed between outcomes using either technique in terms of hemodynamic variation and surgeon/satisfaction. This findings reinforces

the need for adequate knowledge in performing geriatric anesthesia because spinal anesthesia and general anesthesia should not have the same hemodynamic effect.

Also, Bettelli (2010) studied anesthesia care of the elderly patient in the outpatient setting. Preoperative assessment and evaluation, postoperative pain management, and anesthesia technique were areas researched. Age and functional status as well as criteria for selection of geriatric patient's suitability for outpatient surgery were examined but nothing was said about the knowledge base and traineeship of anesthesiologists performing anesthesia in the outpatient clinical setting. In another journal article by Bettelli, 2011, a look at preoperative evaluation in geriatric surgery with emphasis on geriatric functional status, comorbidities and pharmacological history was addressed. The study looked at the disease states common to the elderly. Hypertension, diabetes, coronary artery disease among others were analyzed as very common to the elderly patient (Bettelli, 2011, p. 643). Conclusion from the study reiterated that more education is needed in the preoperative evaluation of the elderly patient because of their rapid increase in number, increased comorbidities, and pharmacological history Bettelli 2011 P.644.

Furthermore, Rortgen, Kloos, Fries, Grotke, Rex, Rossaint and Coburn (2010) compared early cognitive function and recovery after desflurane or sevoflurane anesthesia in the elderly with the goal of finding which gas increases the risk of postoperative cognitive dysfunction more. The study highlights the importance of thorough knowledge base on the vast implication of various anesthesia choices facing the certified registered nurse anesthetist and students on the area of geriatric anesthesia. Rortgen et al (2010) discovered that there is little difference in the occurrence of postoperative cognitive dysfunction in choice of anesthesia gas between desflurane and sevoflurane among the geriatric patients studied Rortgen et al, 2010, p. 173).

The increasing number of geriatric patients, and the physiologic changes associated with aging necessitates a thorough background knowledge by anesthesia providers, especially student registered nurse anesthetists, on best practice for care of the population, but has not been studied the literatures reviewed.

### PROJECT OBJECTIVES

The learning module will equip the Student Registered Nurse Anesthetist with the necessary knowledge with regard to the concept of geriatric anesthesia and its implication in clinical practice. Acquisition of this knowledge will contribute to enhance the student learning opportunity during their clinical rotations and in their future practice as Certified registered Nurse Anesthetists.

The capstone project focused on the anesthesia care of the geriatric patient. The purpose of the project is to provide additional learning opportunity to Student Registered Nurse Anesthetist in clinical rotation as an addition to their knowledge base of adult anesthesia care. The rapidly increasing number of the geriatric population seeking anesthesia care makes it important to ensure a broad understanding of the care of these patients during clinical rotations. Grounded knowledge of the care of the geriatric involves a thorough understanding of all aspects of care for this population.

The presentation of this learning module will involve use of current anesthesia textbooks and journal articles on geriatric anesthesia, as well as the use of visual and audio aids to educate underclassmen. Focusing on the physiology and pathophysiology changes with aging. Understanding of the pharmacological problems associated with aging, the implication of inhalation anesthesia, and local anesthesia on aging will be addressed using current anesthesia literatures and journal articles?

## RESEARCH DESIGN AND METHODOLOGY

- The project design is a learning module that will include a pre-lecture, and a post-lecture quiz. Quizzes will not have any names attached, and will be assigned random numbers to de-identify the subjects.

See attached multiple choice quiz questions.

- The population to be studied include Student Registered Nurse Anesthetists at the Adventist University of Health Sciences (ADU) in the Fall of 2015.
- The sample size is 23 subjects.
- The independent variable will include a formal educational lecture. This lecture material will be measured by administration of a pre and post lecture assessment tool on the topic.
- The dependent variable will include a post lecture survey to evaluate the effectiveness of the presentation.
- Data analysis will include the difference between pre and post lecture quiz score



## **APPENDIX D**

### **ADU NAP CAPSTONE PROJECT – INFORMED CONSENT**

Our names are Oluchi B. Uchegbu and Kim Rolfsen Simpson, and we are MSNA students in the Nurse Anesthesia Program (NAP) at Adventist University of Health Sciences (ADU). We are doing a Capstone Project called *Understanding the Concept of Geriatric Anesthesia and its Implication in Clinical Practice: A Learning Module for Student Registered Nurse Anesthetists*. This project is being supervised by Dr. Manuel Tolosa. We would like to invite you to participate in this project. The main purpose of this form is to provide information about the project so you can make a decision about whether you want to participate.

#### **WHAT IS THE PROJECT ABOUT?**

As the number of geriatric patients increase, it is essential that healthcare professional managing this patient population are well equipped with the necessary background knowledge to adequately care for this population. The purpose of the project is to provide additional learning opportunity to Student Registered Nurse Anesthetists in clinical rotation as an addition to their knowledge base of adult anesthesia care.

#### **WHAT DOES PARTICIPATION IN THIS PROJECT INVOLVE?**

If you decide to participate in this project, you will be asked to complete an anonymous pre-assessment, attend a classroom presentation, and then complete an anonymous post-assessment. The assessment will address information provided in the learning module. Your participation by attendance at the presentation and completion of the survey is anticipated to take approximately ninety minute.

#### **WHY ARE YOU BEING ASKED TO PARTICIPATE?**

You have been invited to participate as part of a convenience sample of students currently enrolled in the ADU NAP. Participation in this project is voluntary. If you choose not to participate or to withdraw from the project, you may do so at any time.

#### **WHAT ARE THE RISKS INVOLVED IN THIS PROJECT?**

Although no project is completely risk-free, we don't anticipate that you will be harmed or distressed by participating in this project.

#### **ARE THERE ANY BENEFITS TO PARTICIPATION?**

We don't expect any direct benefits to you from participation in this project. The possible indirect benefit of participation in the project is the opportunity to gain additional knowledge about the concept of geriatric anesthesia in clinical practice.

#### **HOW WILL THE INVESTIGATORS PROTECT PARTICIPANTS' CONFIDENTIALITY?**

The results of the project will be published, but your name or identity will not be revealed. To maintain confidentiality of assessments, we will conduct this project in such a way to ensure information is submitted without participants' identification. Numbers will be assigned to the assessment tool in place of names and the results analyzed by comparing the pre and post-test assessment results. Data generated will be evaluated without names attached. We will not have access to participants' identity.

#### **WILL IT COST ANYTHING OR WILL I GET PAID TO PARTICIPATE IN THE PROJECT?**

Your participation will cost approximately ninety minutes of your time, but will require no monetary cost on your part. You will not be paid to participate.

#### **VOLUNTARY CONSENT**

By signing this form, you are saying that you have read this form, you understand the risks and benefits of this project, and you know what you are being asked to do. We will be happy to answer any questions you have about the project. If you have any questions, please feel free to contact Oluchi B. Uchegbu [oluchi.uchegbu@my.adu.edu](mailto:oluchi.uchegbu@my.adu.edu) or Kim Rolfsen Simpson [Kim.Rolfsen.Simpson@my.adu.edu](mailto:Kim.Rolfsen.Simpson@my.adu.edu). If you have concerns about the project process or the investigators, please contact the Nurse Anesthesia Program at (407) 303-9331.

\_\_\_\_\_  
Participant Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Participant Name (PRINTED LEGIBLY)

## APPENDIX E

### Poster Presentation

#### Understanding the Concept of Geriatric Anesthesia and its Implication in Clinical Practice: A Learning Module for Student Registered Nurse Anesthetists

Presentors: Kim Rolfsen Simpson, RN, MSN, BSN, SRNA and Oluchi B. Uchegbu, RN, BSN, SRNA  
Advisor: Manuel Tolosa, CRNA, DNAP Mentor: Emily Whitcome, CRNA, MSNA Statisticians: Roy Lukman, PhD

#### ABSTRACT

- A learning module was created to provide additional learning opportunities to the Student Registered Nurse Anesthesia (SRNA) about geriatric anesthesia and its implication in clinical practice.
- The module focused on the physiology and pathophysiology changes with aging, along with the understanding of the pharmacological problems associated with aging, the implication of inhalation anesthesia, and local anesthesia on this population.
- A pretest tool was used to evaluate the knowledge base of the SRNAs, along with a post-test tool that was used to re-evaluate the SRNAs knowledge base post learning module presentation.

#### BACKGROUND

- A gap in knowledge exists in the field of geriatric anesthesia.
- Limited data is available with regard to the concept of assessing proper understanding of geriatric anesthesia in clinical practicing SRNAs.

#### METHODS

- A pretest tool was used to evaluate the knowledge base of the SRNAs.
- 60-minute educational module was then presented.
- A post-test was used to re-evaluate the knowledge base post presentation.

#### RESULTS

- Paired samples statistics table shows the average score increased from 13.3810 to 18.2857.
- Paired samples test table value is -4.804 with an associated p that is less than .05 level of confidence.
- Statistical significance was achieved.

#### CONCLUSIONS

- The educational module was instrumental in increasing the knowledge base of the SRNAs.

#### REFERENCES

- Available upon request.

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test Scores	13.3810	21	2.85444	.61289
	Post-Test Scores	18.2857	21	3.03392	.63547

  

Paired Samples Test									
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower Upper				
Pair 1	Pre-Test Scores - Post-Test Scores	-4.90476	3.47875	1.42890	-7.83349	-1.77505	-4.804	18	.000

## APPENDIX F PowerPoint

1/17/2016

**Geriatric Anesthesia  
and  
Its Implication in Clinical Practice:  
A Learning Module for Student Registered Nurse Anesthetists**

Kari Nathan Simpson, RN, MN, BSN, NFA  
Curtis S. Uchegbu, RN, BSN, NFA

**Introduction**

- ▶ Increase in longevity of the geriatric population, and increase in number of the group has led to an increased frequency of requirement for anesthesia management.
- ▶ A thorough understanding of:
  - the physiological changes associated with aging;
  - the effect of aging on various body systems;
  - the intricate medication management;
  - doing so is critical to anesthesia practice and become very important.

**Learning Modules**

1. Pre-anesthesia Evaluation	7. Thermoregulation
2. Cardiovascular	8. Pharmacology
3. Respiratory	9. Postop delirium
4. Renal	Cognitive dysfunction
5. Hepatic	10. Clinical Scenario
6. Endocrine	
7. Neurologic	

**Preanesthesia Evaluation**

- ▶ It is important to understand the body system changes in the elderly patient.
- ▶ Advanced age is considered to be a major risk factor for morbidity and mortality.
- ▶ Prevention, detecting, and managing complications is the greatest challenge by the anesthesia provider caring for an elderly patient.
- ▶ Goals of the Preanesthesia Evaluation for the anesthesia provider are:
  - Speedy recovery
  - Avoidance of functional decline
  - Maintenance of independence

**Introduction**

- ▶ Aging.
- ▶ Population growth of people over 65 years of age has tripled over the last 50yrs.
- ▶ As the number of geriatric patients increases, it is essential that healthcare professionals managing this patient population are well equipped with the necessary background knowledge to adequately care for this population.

**Primary Factors associated with Perioperative Risk**

1. Reduced reserve capacity
2. Comorbidity
3. Altered reactions to medications, anesthesia and surgery (patients that are difficult to premed)
4. Frailty - weakness, weight loss, exhaustion, low physical activity

1/17/2016

### Clinical Scenario

Ans. G, 68yr old, having a spinal fusion L3-L4.  
 Medical history: Hypertension, osteoarthritis, and diabetes.  
 Vital signs: BP 161/72, HR 61, RR 20, sat 92% room air, temp 98.2°  
 A/O x3

### Cardiovascular

- Reduced beta-receptor responsiveness  
 Doses of adrenergic agents need to be increased due to reduced adrenergic receptors at end organs.
- There is a reduced capacity to increase heart rate in response to:  
 - Hypotension  
 - Hypovolemia  
 - Hypoxia

### Clinical Scenario

Presq. Ans. G, received 2mg of Nitroglycerin  
 Vital signs upon arrival to room—  
 sat 95%, Sp O2 92%, RR 20, HR 80, BP 110/70  
 secondary vital signs: BP 90/52 labile on removal of 0.5 mg of nitro, RR 45, sat 98% on 4L.

### Cardiovascular System

Heart and vascular system have decreased compliance.

Implication:

- Increased pulse pressure
- Increase in afterload
- Increase in systolic blood pressure
- Decreased blood circulation
- Ventricular thickening (hypertrophy)
- Prolonged ejection time
- Quick relaxation (diastole)
- Slowed intravenous induction

### Cardiovascular

Decreased vein compliance leads to decreased venous return and consequently reduced atrial filling.

Vital other effect!

- Higher blood pressure due to:  
 - Increased peripheral vascular resistance  
 - Decreased arterial elasticity  
 - Increased cardiac workload
- Prolonged circulation time causes a faster induction time with inductive agents but delays the onset of intravenous drugs.

### Cardiovascular

Large Heart Changes:  
 - Enlarged  
 - Tortuous  
 - Dilated  
 - Intercardiac thickened causing vessel to be less distensible

Decreased vein compliance leads to decreased venous return and reduced atrial filling.

1/17/2016

### Cardiovascular

- Increased episodes of hypertension
- Receptors
  - Decreased sensitivity of baroreceptors in the aortic arch and carotid sinuses in response to blood pressure changes
  - Loss of Atrial BCC
  - Reduced Atrial Filling due to decreased vent compliance
  - Decreased maximum heart rate in response to stress

### Cardiovascular: Parameter Changes

<b>Decreased:</b>	<b>Increased:</b>
- Cardiac reserve	- Response to chemotropic and isotropic
- Cardiac output	- Baroreceptor function
- Cardiac index	- Perfusion to vital organs
- Resting heart rate	- Adrenergic sensitivity
- Left ventricular compliance	
- Creatinine time	

### Cardiovascular

What is the problem??

Myocardial hypertrophy	Reduced $\beta$ -receptor responsiveness
Myocardial stiffening	Conduction system abnormalities
Reduced LV relaxation	LVH arteries
	LVH veins

### Cardiovascular: Norepinephrine

- Chronic increased Norepinephrine stimulation
- Deficient catecholamine receptors at nerve endings

### Cardiovascular: Parameter Changes

<b>Increased</b>	<b>Unchanged</b>
- Left ventricular wall thickness	- Diastolic function
- LV Hypertrophy	- Left atrium contractile coupling
- LV wall tension	- Left ventricular levels
- Systemic BP	- Contractile proteins
- PVR	
- Cardiac workload	

### Orthostatic Hypotension

<b>Decreased response</b>	<b>Anesthesia Concerns</b>
- Baroreceptor reflex	- Unstable air
- PV constriction	- Volume
	- Positive pressure ventilation
	- Inhaled anesthesia

1/17/2016

### Cardiac Anesthesia Implications

- Myocardial hypertrophy (myocardial stiffening/reduced O<sub>2</sub> release)
  - inability to maintain pressure
  - exaggerated decrease in CO
- Caution: use of fluids to increase preload may lead to CRF
- Reduced beta-receptor responsiveness
  - hypotension from anesthetic: blunting of sympathetic tone
  - weak response to vasoactive drugs (alpha 1/2)
- Conduction system abnormalities
  - bradyarrhythmias can occur with potent opioids

### Respiratory

- The Elderly will have decreased chest wall compliance due to:
  - calcification of the chest wall, intervertebral joints, and costovertebral joints.
  - decreased intercostal muscle mass
  - chest is a flattening of the diaphragm
  - a loss of intervertebral disc height, and
  - changes in spinal lordosis.

### Cardiac Anesthetic Implications

- Reduced beta-receptor responsiveness
- Conduction system abnormalities
- SOB arteries
- SOB veins

### Respiratory System

- Multi-factorial decline in respiratory functional reserve
- Under normal circumstances, the decrease in respiratory function is not associated with significant limitation of daily activity
- Decrease in respiratory reserve may be associated by illness, surgery, anesthesia.

### Cardiac Anesthetic Implications

- SOB arteries
  - SOB of, elastic dysfunction, sensitive to volume status
- SOB veins
  - Changes in blood volume result in an exaggerated change in CO
- Perioperative events that decrease ventricular filling during decline
  - hypovolemia
  - Positive Pressure ventilation
  - Increased venous capacitance decreases CO
- SOB RA

### Respiratory

- Loss of elastic tissue (stiff) of the lung leads to reduced functional alveolar surface area for gas exchange
- Increase in lung compliance:
  - impairs the mechanics of ventilation and perfusion
  - increases physiologic shunt
  - results in the reduction of oxygen exchange at the alveolar level.

1/17/2016

### Respiratory: Increased lung compliance

<b>Increase</b>	<b>Decrease</b>
<ul style="list-style-type: none"> <li>• narrowing of small airway</li> <li>• diameter leads to increased closing volume</li> <li>• residual volume (RV)</li> <li>• Functional residual capacity (FRC)</li> </ul>	<ul style="list-style-type: none"> <li>• vital capacity (VC)</li> <li>• expiratory reserve volume (ERV)</li> <li>• expiratory reserve volume (ERV)</li> </ul>

### Respiratory

- There is decrease in longitudinal and pharyngeal support
- Increased incidence of airway obstruction
- Decreased protective airway reflexes the coughing and sneezing
- Increased risk for pulmonary infection
- Contamination of the lower airway with orotic organisms
- Pulmonary inflammation
- Loss of alveolar surface area due to repeated microatelectasis

### Respiratory

- Total lung capacity remains unchanged or may slightly decrease due to its correlation with height.
- Decrease in forced vital capacity (FVC)
- Decrease in forced expiratory volume in 1 second (FEV1)

### Respiratory

- AAC of skeletal agents is decreased by 4-6 % per decade after the age of 50.

### Respiratory: Chemoreceptors

- The aortic, carotid and aortic bodies chemoreceptors affect ventilation with changes in  $pO_2$ ,  $pH$ , and  $P_{aCO_2}$ .
- Respiratory response to hypoxemia and hypercapnia is decreased in the elderly population predisposing them to increased episodes of apnea.

### Respiratory: Diaphragm

- The diaphragm and abdomen and abdominal muscle have a great role in total breathing with aging.
- Decline in diaphragm function increases respiratory fatigue when required to significantly increase alveolar ventilation.
- The diaphragm does not undergo significant atrophy or changes in muscle fiber type. It has a faster position and it is a less than optimal mechanical position.



1/17/2016

### Respiratory: Decreased Intrinsic Functions

- Elasticity
- Lung recoil
- Alveolar surface tension
- Ability to cough
- Chest compliance
- Vital capacity
- Expiratory Reserve Volume

- Inexpiratory reserve volume
- Response to hypoxia and hypercapnia
- Protective reflexes
- Control of airway and tidal volume
- Ease of work ventilation

### Respiratory: Volume Capacities

- With the increases and decreases with volume capacities in the lungs.

The TLC remains relatively constant with aging.

### Respiratory: Increased Intrinsic Factors

- Risk for aspiration
- Risk for airway obstruction
- Risk for pulmonary consolidation
- Physiologic dead space
- Work of breathing
- Potential for hypoxia
- Work of breathing

- Closing capacity
- Closing volume
- FRC
- Alveolar compliance
- Respiratory depression with opioid administration

### Lets practice...

Which lung parameter decreased with aging?

- RV
- FRC
- CC
- IRV

Which lung parameter is unchanged with aging?

- CC
- IRV
- RV
- VC

### Lung Volume and Capacities

<b>Increased</b>	<b>Decreased</b>
• FRC	• VC
• RV	• IRV
• CC	

### Lets practice...

Which lung parameter decreased with aging?

- RV
- FRC
- CC
- IRV

Which lung parameter is increased with aging?

- CC
- IRV
- RV
- VC



1/17/2016

### Neurological System

- Age-related physiologic changes of the central nervous system are characterized by:
  - Progressive loss of neurons and neuronal substance
  - Decrease in neurotransmitter activity
  - Decreased brain mass
  - Loss in mass is primarily due to loss of **glutamate** neurons in the cortex and frontal lobes
  - Brain mass decreases by 30% by age 80 years

### Neurological

- CNS changes in the elderly also affect neuronal anesthesia due to reduced number of peripheral nerve fibers that, increased risk for neural damage with regional anesthetics
- Age-related changes in the aging patient include:
  - decreased intervertebral disc height
  - narrowing of the intervertebral foramina
  - decreased space between the posterior spinal processes
  - presence of calcifications, and changes in spinal flexibility
- These changes contribute to difficulties associated with patient positioning and spread of agents under placement.

### Neurological

- The physiologic changes include:
  - decrease in axonal cytoskeleton (NAF)
  - decrease in nerve conduction velocity
  - degeneration of peripheral nerve axons
  - decreased number of myelinated nerve fibers

### Neurological

- neuraxial anesthesia in the elderly can be complicated because of:
  - impaired baroreceptor response
  - increased hypotension refractory to adrenergic stimulation may result from post-sympathetic sympathetic activity. This could potentially be detrimental in the presence of impaired cardiac function.
  - There is also an enhanced spread of local anesthetics with spinal blockade.

### Neurological

- Increased sensitivity to anesthetic agents that, increased risk for preoperative delirium or cognitive dysfunction.
- increased sensitivity to drugs due to decreased receptors
- altered response to CNS depressant drugs especially general anesthetics, hypnotics, opioids, and benzodiazepines

### Neurological

- Use of an epinephrine "test dose" for identification of intrathecal injection is less reliable in the elderly because of the decreased end organ adrenergic responsiveness
- Decreased dose of local anesthetic is recommended for subarachnoid and spinal blockade

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### Neurological

- Increased skeletal muscle atrophy
- Increased degeneration of peripheral nerve cells
- Increased proprioceptive threshold
- Increased hearing threshold
- Increased temperature threshold
- Increased touch threshold
- Increased CF
- Increased density of spinal action
- Increased sensory block with opioids
- Increased epidural block cerebral spinal

### Renal

- Decrease in cortical nephron population
- Decrease in renal mass
- Decrease in glomerular filtration rate
- Minimal changes in the medullary nephron population
- The typical 80 year old person has lost 1/3 of the glomeruli
- Renal cortex decreases 10-15% with aging

### Neurological

- Decreased cerebral blood flow
- Decreased intracranial release
- Decreased gray matter
- Decreased brain mass
- Decreased nerve conduction velocity
- Decreased flow for local
- Decreased duration of synaptic action
- Decreased dose of epidural block
- Decreased dose of epidural segment anesthetic

### Renal

The cumulative effect:

- Decrease in the glomerular filtration rate resulting in decreased renal drug clearance
  - Decreased renal blood flow (20%-30%)
  - Decreased renal clearance of hydrophilic drugs and its metabolism.

### Renal Function

- Elderly adults have a significant functional decline in renal function characterized by:
  - progressive atrophy of kidney parenchymal tissue
  - deterioration of renal vascular structures
  - decreased renal blood flow
  - an overall decrease in renal mass

### Renal

- Production of renin and aldosterone is decreased with age, this results in impaired sodium conservation.
- Sodium conservation and hydrogen ion excretion are decreased, resulting in:
  - reduced ability of the kidneys to respond to changes in electrolyte concentrations
  - reduced ability of the kidneys to respond to changes in intravascular volume, and free water

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### Renal

- The serum creatinine is often unchanged.
- Creatinine clearance is the best indicator of drug clearance.

### Hepatic Function

- age-related changes in hepatic function are characterized by a decrease in liver mass.
- Decrease in portal and liver blood flow.
- Decreased serum albumin.
- Decreased enzyme activity.

### Renal

- Older patients with renal impairment may be at increased risk for fluid overload.
- accumulation of metabolites and drugs that are excreted by the kidneys.
- decreased drug elimination, which can prolong the effects of a wide range of anesthetic drugs and adjuncts.
- electrolyte imbalances, which can lead to arrhythmias by affecting cardiac conduction.

### Hepatic

<h4>Decrease</h4> <ul style="list-style-type: none"> <li>• Liver mass</li> <li>• Hepatic blood flow (20-40%)</li> <li>• Serum albumin</li> <li>• Plasma cholinesterase (greatly decline in men)</li> </ul>	<h4>Unchanged</h4> <ul style="list-style-type: none"> <li>• hepatocellular function</li> <li>• Alpha-1 acid glycoprotein levels are usually unchanged or slightly increased.</li> </ul>
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### Renal: Parameters that decrease with Aging

<ul style="list-style-type: none"> <li>• Kidney mass</li> <li>• Renal blood flow</li> <li>• GFR</li> <li>• Renal function</li> <li>• Muscle mass</li> <li>• Creatinine production</li> <li>• Fluid handling</li> </ul>	<ul style="list-style-type: none"> <li>• Sodium handling</li> <li>• Concentration ability</li> <li>• Response to ADH</li> <li>• Response to aldosterone</li> </ul>
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### Hepatic

- Aging effect on hepatic function may cause:
  - decreased drug clearance
  - prolonged drug half-life
  - either increased or decreased volume of distribution of the drugs.

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### Hepatic

- Increased body fat and decreased water content in the older patient has considerable impact on the volume distribution (V<sub>d</sub>) of many drugs.
- The fat of hydrophilic drugs in the older patient is decreased, resulting in increase in plasma concentration.
- The fat of lipophilic drugs in the older adult is increased, causing a decrease in their plasma concentration.
- The end result is premeditation of anesthetic agents.
- Important to decrease opiate doses by 50%.

### Thermoregulation and Body Composition

- Loss of lean body mass
- Increased total body fat
- Decreased metabolic rate
- Decreased total body water
- Reduction in blood volume of 30% to 50%

### Endocrine System

- Multiple feedback loops.
- Strongly influenced by anesthesia and surgical stress.
- Anesthesia and surgery cause a neuroendocrine stress response that is reflected by increased secretion of many hormones.
- Increased insulin resistance.
- Increased renal loss.
- Hypothyroid is common.

The overall decline in the elderly patient's endocrine function typically does not affect anesthetic management.

### Thermoregulation Impairment: Hypothermia

- Decrease in the function of the hypothalamus
- A lower basal metabolic rate (hypothyroidism is common)
- A high ratio of surface to body area mass
- Less effective peripheral vasoconstriction in response to cold
- Decreased muscle mass (unable to generate heat)
- GA/MA reduces the cold stress response

### Effect of Aging on Thermoregulation and Body Composition

- As a result of decreased total body water, older adults are more vulnerable to hypothermia.
- They have difficulty compensating for positional changes.

### Thermoregulatory Responses

<h4>Heat Stress</h4> <ul style="list-style-type: none"> <li>Decreased sweat gland output</li> <li>Decreased ability to increase cutaneous blood flow output</li> <li>Decreased ability to increase CO</li> <li>Less reduction of CO from core to peripheral circulation</li> </ul>	<h4>Cold Stress</h4> <ul style="list-style-type: none"> <li>Loss of muscle mass</li> <li>Decreased ability for vasoconstrictor response/initial</li> </ul>
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### Thermoregulation and Anesthesia Concern

- Slow anesthetic offsetation due to impaired metabolism with hypothermia
- Prolonged recovery from anesthesia
- Impaired coagulation
- Increased risk of infection
- Increases the chance that the patient will shiver
- Shivering increases oxygen consumption by up to 400%, which leads to hypoxia, arrhythmia, and cardiac compromise
- Induced anesthetics inhibit the temperature regulating centers in the hypothalamus

### Thermoregulation

- Methods to maintain normothermia include:
  - the administration of all fluids and blood transfusions through a warming device
  - thermal blankets or forced air warmers
  - an environmental humidity higher than 30%

### Thermoregulatory Responses

- Intact thermal agency: thermoregulatory responses after the regulatory thresholds such that body temperature must fall by as much as 4°C (7°F) before initiation of vasoconstriction or shivering
- aging further impairs the threshold, by approximately 1°C (2°F), not only during general anesthesia but during spinal anesthesia as well

### Pharmacology Implications

- Decreased volume of distribution with water-soluble medications:
  - higher plasma concentrations of water-soluble
  - higher than anticipated initial plasma concentration with intravenous anesthetic agents
- Increase in total body fat:
  - fat-soluble medications have a longer half-life

### Thermoregulation and Anesthesia Concern

- Elderly adults may be unable to maintain their heat in the cooler environment of the operating room. Thermoregulatory vasoconstriction can cause peripheral vasoconstriction
- It is difficult to reduce surgical body temperature once there is a decrease in body temperature
- Methods to maintain normothermia in the older adult patient should include:
  - administration of heat loss and active warming (infused in the preoperative area and continue perioperatively)

### Pharmacology

- Decreased blood volume:
  - leads to decrease in initial volume of distribution
  - higher initial concentration of drug with intravenous bolus injection
- Decreased plasma protein binding:
  - increase in free plasma concentration for drugs that are highly protein bound

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### Pharmacology

- Pharmacokinetic alterations linked to:
  - Volume of distribution
  - Renal and hepatic clearance rates
  - Redistribution
  - Elimination half-life
- Pharmacodynamic effects:
  - Exaggerated responses to synthetic drugs
  - Prolonged duration of action

### Effect of Age on Drug Dosing

Propofol - 20-40% reduction, dose on low body mass, 1 mg/kg in very old

Diazepam - reduce dose 25-50%

Midazolam - modest reduction at age 60, 75% reduction at age 90

Green, 2014 pg 40

### Pharmacology

- Pharmacodynamic changes:
  - altered receptor density and binding
  - changes in signal transduction
  - impaired cellular response

### Effect of Age on Drug Dosing

- Morphine - 50% reduction
- Fentanyl - 50% reduction
- Alfentanil - 50% reduction
- Sufentanil - 50% reduction
- Ramifenazil - 50% reduction
- Hydroxyzine - no studies on aging exist, but assume increased potency in elderly

Green, 2014 pg 40

### Pharmacology

- Increased serum concentration and prolonged effects of drugs dependent on renal elimination due to:
  - decrease in renal function
  - lower renal blood flow
  - decreased glomerular filtration
  - decreased tubular secretion

### Effect of Age on Drug Dosing

- Neuraxial - slower onset (-50%)
- Cardiac drugs - slower onset (-30%)
- Neurolept - initially slower onset
- Local anesthetics - slower onset (-40%)
- Neostigmine - increase dose with aging

Green, 2014 pg 40

### Muscle Relaxants on set time Difference of Opinion is noted

**Hoffman Elimination**

- not affected by aging
- atracurium half life of atracurium and mivacurium are not affected by aging (Butterworth et al., 2012)
- atracurium takes 10% longer (Barash, 2009)

**Non-depolarizing Muscle Relaxants**

- Take up to twice as long (Butterworth et al., 2012)
- Side up to three times as long (Barash, 2009)

### Postoperative Delirium

- Postoperative delirium is characterized by:
  - disturbance of perception
  - disturbance of thinking
  - memory
  - psychomotor behavior
  - sleep-wake cycle
  - consciousness, and
  - attention

### Anxiolytics and Aging

Onset of action: midazolam, diazepam and lorazepam are affected by aging

- When administering midazolam to an elderly patient you anticipate it's medication to have an increased effect.
- Diazepam has a greater lipid solubility than midazolam increasing its accumulation in lipid stores.
- Diazepam half-life is increased from 10 hours to 36 hours.
- Lorazepam is less lipid soluble making its half-life relatively unchanged.

### Postoperative Delirium

**Risk factors**

- older age
- male gender
- delirium
- history of alcohol abuse
- depression
- duration of anesthesia
- poor functional status
- inadequate pain control
- type of surgery

**Risk factors**

- abnormal electrolytes and glucose
- Parkinson's disease
- cardiovascular disease
- dehydration
- metabolic disease (e.g., diabetes, hypothyroidism)
- anticholinergic drugs used intraoperatively
- patients requiring admission to the intensive care unit

Hopkins, 2014 pg. 1100

### Postoperative Delirium

- Neurological problems are the most common complication in older adults.
- Postoperative delirium is the most frequent neurologic complication
- Delirium is associated with:
  - depression
  - functional decline
  - prolonged hospitalization
  - increased healthcare costs
  - and death

### Postoperative Delirium

- Symptoms of delirium begin early during the postoperative period and last for several days or weeks.
- Thorough preoperative assessment is important because history of neurologic deficits and neurologic diseases are most often associated with risk of delirium.

Hopkins, 2014 pg. 1100

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### Post Operative Delirium

Orthopedic and Cardiac surgical procedures

- Have been identified to have the highest risk for Post-operative Delirium.

Hughes, 2014 pg. 1122

### Conclusion

- Thorough PREOP/History can affect outcomes
- DIFFICULT wean AND BRIDGE AIRWAYS
- QUESTION analgesics USE
- QUESTION narcotics DOSIS

### Postoperative Cognitive Dysfunction

- POCD characterized by cognitive impairment, like memory deficits, difficulty with concentration, impaired comprehension, delayed psychomotor speed
- Onset of POCD is subtle
- Neurocognitive deficits may take weeks to months after surgery.

### Conclusion

- Small hypotension, hypoxia
- Long IT induction time; Short intensive induction time
- DECREASE MAC
- STOP WALKS

### Conclusion

- Less is more in the elderly patient population...
- Physiological changes decrease responses to anesthesia and perioperative stress associated with anesthesia.

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