Review Article

Considerations in Geriatric Anesthesia - An overview

Priyanka Das¹, Swati Sujeer¹, Kavya K¹, Shalini Subramanian²,
Abhimanyu Kadapathri^{3,*}

¹Dept. of Anaesthesiology, Sri Devaraj Urs Medical College, Kolar, Karnataka, India

²Dept. of Anaesthesiology, Narayana Nethralaya, Bengaluru, Karnataka, India

³Dept. of ENT, Sri Devaraj Urs Medical College, Kolar, Karnataka, India

ARTICLE INFO

Article history:

Received 03-10-2020

Accepted 15-12-2020

Available online 04-02-2021

Keywords:

Geriatrics

Anaesthesia

Elderly

Ageing

ABSTRACT

Summary- Geriatric population is estimated to be 12.4% of population in India by the year 2026. As the population continues to age, the number of surgical interventions in the elderly (≥ 65 yr) also continues to rise. Two important principles that makes the elderly more vulnerable is that first aging is associated with a progressive loss of functional reserve in multiple organ systems and secondly the extent and onset of these changes are highly variable on an individual basis. This article reviews the perianesthetic considerations for geriatric population emphasizing the need for utmost care and concern in the following three categories: preoperative evaluation and considerations, intra-operative management, and postoperative concerns. Due to the increased incidence of adverse events in geriatric population a meticulous risk stratification of these patients undergoing various surgical procedures preoperatively may help guide decisions on adequate perioperative management as well as reduce untoward complications.

© This is an open access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

1. Introduction

Geriatric population is estimated to be 12.4% of population in India by the year 2026.¹ The number of “elder” people in India (≥ 60 years) has increased by 54.77% in the last 15 years.² As the population continues to age, the number of surgical interventions in the elderly (≥ 65 yr) also continues to rise. Surgeries in geriatric population that were rare previously have become a routine nowadays with advancements in surgical techniques and perioperative care.³ Two important principles that makes the elderly more vulnerable is that first aging is associated with a progressive loss of functional reserve in multiple organ systems and secondly the extent and onset of these changes are highly variable on an individual basis.^{4,5} This article reviews the perianesthetic considerations for geriatric population emphasizing the need for utmost care and concern in the following

three categories: preoperative evaluation and considerations, intra-operative management, and postoperative concerns. While patients and surgeons worry about their treatment plan and future prognosis, anesthesiologists are concerned about patient’s age, complexity of the underlying comorbidities and the physiological status of the patient at the time of surgery with an eye to anticipate any perioperative critical or adverse events and its management. Thus a multidisciplinary approach will contribute to a better management of these high risk population and help in successful safe completion of their surgical procedure.

2. Preoperative geriatric evaluation and considerations

A detailed pre-anesthesia evaluation has been established as an effective tool to improve long term outcomes.⁶ A comprehensive geriatric evaluation aims at determining the physical, psychosocial and environmental factors that can have a significant impact on the health of the elderly.⁴ Preoperative evaluation of a geriatric patient should include

* Corresponding author.

E-mail address: priyanka.agcs@gmail.com (A. Kadapathri).

an assessment of activities of daily living and also incorporate an in-depth evaluation process focused on specific organ systems.⁷ Knowledge about the underlying co morbidities, the medications, nutritional status and substance abuse can have a positive impact on postoperative outcomes in older patients undergoing elective surgery.⁶

2.1. Medical co-morbidities

Assessment of co-morbid conditions with disease severity is important.

2.2. Cardiac evaluation

Older patients are more vulnerable to perioperative cardiac adverse events. A retrospective study conducted in 2018 showed age > 65 years as an important predictor of cardiac events after surgery (OR 4.9, 95% CI 3.4–6.9, $P < 0.01$).⁷ Prevalent in this age group are varying cardiac illnesses and hence may require detailed risk stratification with cardiac tests for evidence-based optimization strategies applied before surgery.⁸ The concept of METS (metabolic equivalent of activities of daily living) has been integrated into the cardiac evaluation to evaluate the functional activity.⁹ Induction of general anesthesia (GA) in elderly patients with an already compromised cardiac reserve often results in severe hemodynamic instabilities such as exaggerated drop in blood pressure. This associated with functional reductions in the responsiveness of beta-receptors caused by a beta-blocked state further limits patients' ability to respond adequately and normalize the cardiac output. Reduced responsiveness to angiotensin II and baroreceptor dysfunction further restricts appropriate response to hypovolemia.

2.3. Pulmonary evaluation

Age has been identified as one of the reliable risk factors for postoperative pulmonary complications (PPC). In elderly patients of ages ≥ 65 years and ≥ 70 years undergoing non-cardiac surgery, the rates of PPC has been reported as high as 14% and 15% respectively.¹⁰ It is an established fact that age related decline in both lung and chest wall compliance leads to an increased work of breathing. Decreased cough reflex and ciliary clearance more so in long term smokers further compromises the pulmonary function. This can manifest intra-operatively under GA as various complications like desaturation, bronchospasm, laryngospasm etc leading to an overall difficulty in ventilation. Thus various studies have similarly shown that pulmonary complications were an independent predictor of mortality in elderly patients.¹¹

2.4. Neuro-cognitive status and depression

Dementia is very common in the elderly having a prevalence of 5% to 8% among people ≥ 65 years old and may affect more than one third of population > 85 years.¹² A retrospective study in 2014 conducted on 45,602 aged patients who had a hip fracture revealed that dementia was associated with an increased risk of long-term care (hazard ratio [HR] 2.49, 95% CI 2.38–2.61, $P < 0.001$), higher mortality (HR 1.47, 95% CI 1.41–1.52, $P < 0.001$) and poor prognosis.¹³ Detailed evaluation of patient's preoperative cognitive status is crucial for diagnosing and anticipating postoperative complications like postoperative delirium (POD) or postoperative cognitive dysfunction (POCD). Preexisting cognitive dysfunction is known to predict POD. Postoperative cognitive impairment is associated with longer hospital stay causing a high risk of developing postoperative complications such as cerebrovascular accident, neurologic deficit, pneumonia, deep vein thrombosis etc.^{14,15} Studies reveals cognitive deficits are very often associated with poorer rehabilitation outcomes, functional decline and higher surgical mortality.^{16,17} Whether anesthesia contributes to postoperative cognitive impairment still remains a controversial area of investigation, studies reveal after coronary artery bypass grafting there is a 42% incidence of cognitive decline 5 years postoperatively.¹⁸

2.5. Assessment and optimization of nutritional status

The prevalence of malnutrition ranges from 15% to 26% among the hospitalized geriatric population.^{19,20} Malnourished aged patients undergoing surgical interventions have increased morbidity and mortality.²¹ Preoperative history taking with adequate physical and laboratory tests aid the diagnosis of malnutrition. A review study in 2016 that included 41 trials on 3,881 participants revealed that oral multivitamin supplements started before or soon after surgery might prevent complications within the first 12 months after a hip fracture. The study however did not reveal any significant effect on mortality.²²

2.6. Depression

In aged population with hip fracture the prevalence of depression has been reported to be as high as 13%.²³ Depression is an important issue because it may not only prolong the duration of hospital care and the expenditure but may also significantly impair the quality of life postoperatively.^{23,24}

2.7. Pre-operative counseling, decision-making and informed consent

Several recommendations about patient counseling has been provided in the best practices guideline 2016 from the ACS and the AGS on optimal perioperative management of elderly patients.⁵ Risk tools like the ASA classification and mortality risk calculator can help and guide in decision making.²⁵ However a recent study showed that although more than half of the patients over the age of 60 years desired to make independent decisions regarding medical care, more than 70% of these patients lacked the decision-making capacity.²⁶

2.8. Pre-operative investigations and polypharmacy

The requirements of preoperative laboratory testings broadly depend on the associated co-morbid illnesses and the functional reserve of the patients. Although low-risk surgeries like cataract surgery may not require elaborate testing but selected routine preoperative testing based on the history and physical examination maybe advised for intermediate risk or high risk procedures.²⁷ Elderly patients are more likely to be on numerous medications based on multiple co-existing diseases. The brain is more sensitive to drugs in the elderly. The risk of adverse drug reactions increases with the number of drugs taken and age directly leading to prolonged hospital stays and expenses.²⁸

3. Intra-operative management

Data suggest that co-existing disease is a greater determinant as compared to anesthetic management in predicting postoperative complications.²⁹ Most studies show that there is no significant difference in outcome between administration of general versus regional anesthesia(RA) in the elderly patients.³⁰ The type of anesthesia administered may only play a secondary role in immobilization, rehabilitation and prolonged duration of hospital stay.³¹ A retrospective study done in 2014 on 6,135 age-matched adult pairs with dementia undergoing hip fracture surgery revealed that both GA and RA were associated with identical rates of perioperative complications and adverse events (GA, 11.3%; RA, 10.8%, $P = 0.44$).³² However regional anesthesia may have certain beneficial role such as reducing the incidence of deep vein thrombosis and achieving better hemodynamic control associated with reduced intra-operative bleeding.^{33–35} Regional anesthesia also avoids unnecessary instrumentation of the airway allowing patients to maintain patency of their own airway with better pulmonary function. Several studies suggest that elderly are highly susceptible to hypoxemic episodes and the use of regional anesthesia have known to lower this risk.³⁶ The use of peripheral blocks in the elderly may be of some advantage without compromising the airway or risking major

hemodynamic effects. However the anatomic difficulties in geriatric age group and peripheral nerve blocks showing prolonged duration of action should be considered before planning the type of anesthesia.³⁷ Although evidence to support a single best anesthetic plan to produce the best surgical outcome for elderly patients still remains a controversy, adequate monitoring techniques with good hemodynamic control and fluid management should continue to remain as primary intra-operative goals for anesthesiologists. Several studies have validated that goal-directed hemodynamic therapy (GDHT) significantly reduces postoperative mortality and morbidity in high-risk surgical patients.^{38,39} Although liberal RBC transfusion and its role in increasing the chances of infection still remains unclear, studies like TRIFE-The Transfusion Requirements In Frail Elderly conducted on 284 patients showed that a more liberal RBC transfusion strategy ($Hb < 11.3$ g/dl; 7 mmol/L) when compared to the restrictive RBC strategy (hemoglobin [Hb] < 9.7 g/dl; 6 mmol/L) was not associated with higher infection risk in patients undergoing hip fracture surgery.⁴⁰ Invasive intra-arterial blood pressure monitoring for beat to beat variations and central venous catheterization for additional route of venous access and for administration of vasoactive drugs can be considered in complex surgeries of long duration.³¹ Electroencephalogram (EEG) neuromonitoring including a bispectral index or entropy monitor is recommended for assessing the depth of anesthesia to avoid excessive depth thereby preventing the development of POD or POCD in geriatric patients.^{41,42} Neuromuscular monitoring is also strongly recommended as it permits an adequate degree of neuromuscular blockade as well as its safe reversal.^{43,44} It is very important to maintain a normal range of body temperature throughout the perioperative period as advanced age and general anesthesia are known to be associated with hypothermia. Hypothermia has been related to hypoxemia and myocardial ischemia during the postoperative period in high-risk patients undergoing lower extremity vascular surgery.⁴⁵ Perioperative normothermia has shown to reduce incidence of cardiac adverse events and ventricular tachycardia in patients with cardiovascular illness undergoing non-cardiac surgeries.⁴⁶ Use of warmed intravenous fluids, various active or passive warming devices like forced-air warming blanket or heated humidifier circuit is highly recommended.

3.1. Geriatric Pharmacology

Reduced proportions of muscle and fat, as well as a reduced neural mass and organ dysfunctions, can alter drug pharmacodynamics and pharmacokinetics considerably meaning that the usual drug dosages can have toxic effects in the elderly.⁴⁷ Short acting drugs with minimum hepatic and renal effects are advisable. Careful titration of drugs is also essential.⁴⁸ Lower dosages are required for

propofol, remifentanyl and ropivacaine. Adequate titration of desflurane is advisable. Special attention should be given to hypnotic agents, as the dose requirement is much lower and the drugs can have prolonged duration of action.^{49,50}

4. Postoperative care

A vigilant postoperative care is essential for early recovery and mobilization. A study conducted on 517 patients of more than 70 years of age undergoing non-cardiac surgery showed that 31.7 percent of patients were deceased at the time of follow-up and age (HR 1.42 per decade, 95% CI 1.11–1.81, $P = 0.005$), postoperative pulmonary complication (HR 2.41, 95% CI 1.30–4.48, $P = 0.005$), and renal complication (HR 6.07, 95% CI 2.23–16.52, $P < 0.001$) were all significant independent predictors of reduced long-term survival.⁵¹

4.1. Post-operative analgesia

Physiological frailty, medical co-morbidities compounded with cognitive impairment makes pain assessment and management very difficult in the elderly. Hence elderly remains largely untreated for pain.³¹ A 2014 review showed that multimodal drug therapy and regional analgesic techniques can be very useful tools for adequate pain management in elderly.⁵²

4.2. Post-operative pulmonary complications

Age is a significant predictor of risk for pulmonary complications which is known to considerably increase the risk of mortality after surgery.^{10,53} A large retrospective study on 8,920 elderly patients with hip fracture repair showed that pulmonary and cardiac complications were most frequent (4% and 8% of patients, respectively).⁵⁴ Strategies to prevent aspiration precautions along with bedside evaluation of any patient with signs, symptoms or history of dysphagia should be implemented. Patients should be educated and motivated about use of incentive spirometer and chest physical therapy. Regular deep breathing exercises are vital. Techniques like epidural analgesia can also help in early mobilization.⁵

4.3. Post-operative delirium

Delirium is one of the most dreadful age-related postoperative complications and can be responsible for an acute decline in cognitive function and attention that can be related to any physiologic derangement, medications or multifactorial.⁵⁵ The best treatment for delirium is prevention hence routine delirium screening in all patients is suggested as evidences suggest that there are considerable benefits in terms of earlier detection and management.⁵⁵ A study conducted on 144 patients of above 50 years of age undergoing a surgical intervention requiring a postoperative

intensive care unit (ICU) showed that 44 percent of patients developed delirium.⁵⁶

4.4. Post-operative nausea and vomiting

Post-operative nausea and vomiting (PONV) is a well established complication of general anesthesia.⁵ PONV can cause a great deal of anxiety and discomfort for the patients leading to delayed discharge from post-anesthesia care unit (PACU) and poor patient satisfaction.^{57,58} Hence all elderly patients undergoing a surgical procedure should be thoroughly assessed for risks of PONV and those found to have moderate or high risk should receive prophylactic interventions.⁵

4.5. Post-operative Urinary tract infections

Urinary tract infections representing 32% to 40% of all nosocomial infections are among the most common postoperative complications. Elderly patients are more vulnerable especially owing to the prolonged immobilization and can result in heavy health care costs. A good nursing care and encouraging self voiding can help prevent this complication.^{59–63} A 2014 study conducted on 72 elderly female patients undergoing elective surgery, to determine the risk factors for urinary retention showed that the early removal of the urethral catheter (per 1-day indwelling period increase, OR 0.33, 95% CI 0.11–0.96, $P = 0.04$) and preoperative dementia and/or delirium (OR 10.4, 95% CI 1.21–89.2, $P = 0.03$) had significant correlations with postoperative urinary retention.⁶⁴

It is found that approximately 30% of elderly adults in the community fall every year.⁶⁵ Hence universal fall precautions are highly recommended in all elderly patients; however it should not interfere with early mobilization or delay ambulation. Good vision and hearing aids, scheduled toileting, early physical/occupational therapy and assistive walking devices all can help in preventing fall in elderly.

4.6. Post-operative Nutrition

Resuming oral diet at earliest with supplements if indicated maybe helpful. Maintaining adequate nutrition and wound care to minimize pressure ulcers in the postoperative setting should all be a part of the multicomponent interventions in the care of the elderly.⁵

5. Conclusion

Due to the increased incidence of adverse events in geriatric population a meticulous risk stratification of these patients undergoing various surgical procedures preoperatively may help guide decisions on adequate perioperative management as well as reduce untoward complications. Close collaboration between the surgeon, geriatrician and anesthesiologist is essential for a safe

anesthesia experience in these high risk patients as they all aim to create a safe environment in the operating room and post-operative unit with maximum efficacy.

6. Conflict of Interest

None.

7. Source of Funding

None.

References

1. Das SK. Situation analysis of the elderly in India. A Report. Officers of Social Statistics Division, Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India; 2011.
2. WHO—country cooperation strategy at a glance (India) . Available from: http://www.who.int/countryfocus/cooperation_strategy/ccsbrief_ind_en.pdf.
3. Etzioni DA, Liu JH, Maggard MA, Ko CY. The aging population and its impact on the surgery workforce. *Ann Surg*. 2003;238(2):170.
4. Palmer R. Geriatric assessment. *Med Clin North Am*. 1999;83:1503–23.
5. Mohanty S, Rosenthal RA, Russell MM, Neuman MD, Ko CY, Esnaola NF, et al. Optimal Perioperative Management of the Geriatric Patient: A Best Practices Guideline from the American College of Surgeons NSQIP and the American Geriatrics Society. *J Am Coll Surg*. 2016;222(5):930–47. doi:10.1016/j.jamcollsurg.2015.12.026.
6. Partridge JSL, Harari D, Martin FC, Dhesi JK. The impact of pre-operative comprehensive geriatric assessment on postoperative outcomes in older patients undergoing scheduled surgery: a systematic review. *Anaesth*. 2014;69:8–16. doi:10.1111/anae.12494.
7. Acheampong D, Guerrier S, Lavarias V, Pechman D, Mills C, Inabnet W, et al. Risk factors contributing to cardiac events following general and vascular surgery. *Ann Med Surg*. 2018;33:16–23. doi:10.1016/j.amsu.2018.08.001.
8. Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, et al. ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart association Task Force on practice guidelines. Developed in collaboration with the American College of Surgeons. *Society for cardiovascular Angiography and Journal of nuclear cardiology: official publication of the American Society of Nuclear Cardiology*. 2014;22(1):162–215.
9. Eagle KA, Brundage BH, Chaitman BR, Ewv GA, Fleisher LA, Hertzner NR, et al. Guidelines for Perioperative Cardiovascular Evaluation for Noncardiac Surgery: An Abridged Version of the Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *Mayo Clin Proce*. 1997;72(6):524–31. doi:10.4065/72.6.524.
10. Smetana GW, Lawrence VA, Cornell JE. Preoperative Pulmonary Risk Stratification for Noncardiothoracic Surgery: Systematic Review for the American College of Physicians. *Ann Intern Med*. 2006;144:581–95. doi:10.7326/0003-4819-144-8-200604180-00009.
11. Manku K, Bacchetti P, Leung JM. Prognostic significance of postoperative in-hospital complications in elderly patients. I. Long-term survival. *Anesth Analgesia*. 2003;96:583–9.
12. Lee HB, Ankrom M, Lyketso CG. Cognitive disorders: delirium, mild cognitive impairment, and dementia. *Psychiatry for Primary Care Physicians*. In: Goldman LS, Wise T, Brody D, et al., editors. 2nd Edn. Wise TN, Brody DS: Chicago: American Medical Association Press; 2004. p. 197.
13. Seitz DP, Gill SS, Gruneir A, Austin PC, Anderson GM, Bell CM, et al. Effects of Dementia on Postoperative Outcomes of Older Adults With Hip Fractures: A Population-Based Study. *J Am Med Dir Assoc*. 2014;15(5):334–41. doi:10.1016/j.jamda.2013.12.011.
14. Ansaloni L, Catena F, Chattat R, Fortuna D, Franceschi C, Mascitti P. Risk factors and incidence of postoperative delirium in elderly patients after elective and emergency surgery. *Br J Surg*. 2010;97(2):273–80. doi:10.1002/bjs.6843.
15. Rudolph JL, Jones RN, Levkoff SE, Rockett C, Inouye SK, Sellke FW, et al. Derivation and Validation of a Preoperative Prediction Rule for Delirium After Cardiac Surgery. *Circ*. 2009;119(2):229–36. doi:10.1161/circulationaha.108.795260.
16. Heruti RJ, Lusky A, Barell V, Ohry A, Adunsky A. Cognitive status at admission: Does it affect the rehabilitation outcome of elderly patients with hip fracture? *Arch Phys Med Rehabil*. 1999;80:432–6. doi:10.1016/s0003-9993(99)90281-2.
17. Bernstein GM, Offenbartl SK. Adverse surgical outcomes among patients with cognitive impairments. *Am Surg*. 1991;57:682.
18. Newman MF, Kirchner JL, Phillips-Bute B, Gaver V, Grocott H, Jones RH, et al. Longitudinal Assessment of Neurocognitive Function after Coronary-Artery Bypass Surgery. *N Engl J Med*. 2001;344(6):395–402. doi:10.1056/nejm200102083440601.
19. Azad N, Murphy J, Amos SS, Toppan J. Nutrition survey in an elderly population following admission to a tertiary care hospital. *CMAJ*. 1999;161(5):511–5.
20. Potter J, Klipstein K, Reilly JJ, Roberts M. The Nutritional Status and Clinical Course of Acute Admissions to a Geriatric Unit. *Age Ageing*. 1995;24(2):131–6. doi:10.1093/ageing/24.2.131.
21. Gibbs J, Cull W, Henderson W, Daley J, Hur K, Khuri SF, et al. Preoperative serum albumin level as a predictor of operative mortality and morbidity: results from the National VA Surgical Risk Study. *Arch Surg*. 1999;134(1):36–42.
22. Avenell A, Smith TO, Curtain JP, Mak JC, Myint PK. Nutritional supplementation for hip fracture aftercare in older people. *Cochrane Database Syst Rev*. 2016;.
23. Holmes J, House A. Psychiatric illness predicts poor outcome after surgery for hip fracture: a prospective cohort study. *Psychol Med*. 2000;30(4):921–9. doi:10.1017/s0033291799002548.
24. Heijmeriks JA, Pourrier S, Dassen P, Prenger K, Wellens HJJ. Comparison of quality of life after coronary and/or valvular cardiac surgery in patients ≥75 years of age with younger patients. *Am J Cardiol*. 1999;83(7):1129–32. doi:10.1016/s0002-9149(99)00028-4.
25. Carlisle JB. Pre-operative co-morbidity and postoperative survival in the elderly: beyond one lunar orbit. *Anaesth*. 2014;69:17–25. doi:10.1111/anae.12489.
26. Silveira MJ, Kim SYH, Langa KM. Advance Directives and Outcomes of Surrogate Decision Making before Death. *N Engl J Med*. 2010;362(13):1211–8. doi:10.1056/nejmsa0907901.
27. Sanders DP, McKinney FW, Harris WH. Clinical evaluation and cost effectiveness of preoperative laboratory assessment on patients undergoing total hip arthroplasty. *Orthop*. 1989;12(11):1449–53.
28. Barnett SR. Polypharmacy and perioperative medications in the elderly. *Anesth Clin*. 2009;27(3):377–89.
29. Liu LL, Leung JM. Predicting Adverse Postoperative Outcomes in Patients Aged 80 Years or Older. *J Am Geriatr Soc*. 2000;48(4):405–12. doi:10.1111/j.1532-5415.2000.tb04698.x.
30. Roy R. Choosing general versus regional anesthesia for the elderly. *Anesthesiol Clin North Am*. 2000;18:91–104.
31. Lim BG, Lee IO. Anesthetic management of geriatric patients. *Korean J Anesth*. 2020;73:8.
32. Seitz DP, Gill SS, Bell CM, Austin PC, Gruneir A, Anderson GM, et al. Postoperative Medical Complications Associated with Anesthesia in Older Adults with Dementia. *J Am Geriatr Soc*. 2014;62(11):2102–9. doi:10.1111/jgs.13106.
33. Covert CR, Fox GS. Anaesthesia for hip surgery in the elderly. *Can J Anaesth*. 1989;36(3):311–9. doi:10.1007/bf03010771.
34. Modig J. Beneficial effects on intraoperative and postoperative blood loss in total hip replacement when performed under lumbar epidural anesthesia. An explanatory study. *Acta Chirurgica Scand Supplementum*. 1989;550:95–100.

35. Shir Y, Raja SN, Frank SM, Brendler CB. Intraoperative blood loss during radical retropubic prostatectomy: Epidural versus general anesthesia. *Urol.* 1995;45(6):993–9. doi:10.1016/s0090-4295(99)80120-4.
36. Moller JT, Wittrop M, Johansen SH. Hypoxemia in the Postanesthesia Care Unit. *Anesth.* 1990;73(5):890–5. doi:10.1097/0000542-199011000-00016.
37. Kanonidou Z, Karystianou G. Anesthesia for the elderly. *Hippokratia.* 2007;11(4):175.
38. Gurgel ST, do Nascimento P. Maintaining Tissue Perfusion in High-Risk Surgical Patients. *Anesth Analgesia.* 2011;112(6):1384–91. doi:10.1213/ane.0b013e3182055384.
39. Hamilton MA, Cecconi M, Rhodes A. A Systematic Review and Meta-Analysis on the Use of Preemptive Hemodynamic Intervention to Improve Postoperative Outcomes in Moderate and High-Risk Surgical Patients. *Anesth Analgesia.* 2011;112(6):1392–402. doi:10.1213/ane.0b013e3181eeaae5.
40. Gregersen M, Damsgaard EM, Borris LC. Blood transfusion and risk of infection in frail elderly after hip fracture surgery: the TRIFE randomized controlled trial. *Eur J Orthop Surg Traumatol.* 2015;25(6):1031–8. doi:10.1007/s00590-015-1609-2.
41. Janssen TL, Alberts AR, Hooft L, Mattace-Raso FU, Mosk CA, van der Laan L, et al. Prevention of postoperative delirium in elderly patients planned for elective surgery: systematic review and meta-analysis. *Clin Interv Aging.* 2019;14:1095–117. doi:10.2147/cia.s201323.
42. Koch S, Spies C. Neuromonitoring in the elderly. *Curr Opin Anaesthesiol.* 2019;32(1):101–7. doi:10.1097/aco.0000000000000677.
43. Strøm C, Rasmussen LS, Steinmetz J. Practical management of Lim and Lee-Geriatric anesthesia in the elderly. *Drugs Aging.* 2016;33:765–77.
44. Pietraszewski P, Gaszyński T. Residual neuromuscular block in elderly patients after surgical procedures under general anaesthesia with rocuronium. *Anestezjologia Intensywna Terapi.* 2013;45(2):77–81. doi:10.5603/ait.2013.0017.
45. Frank SM, Beattie C, Christopherson R, Norris EJ, Perler BA, Williams GM, et al. Unintentional Hypothermia Is Associated with Postoperative Myocardial Ischemia. *Anesthesiol.* 1993;78(3):468–76. doi:10.1097/0000542-199303000-00010.
46. Frank SM, Fleisher LA, Breslow MJ, Higgins MS, Olson KF, Kelly S, et al. Perioperative maintenance of normothermia reduces the incidence of morbid cardiac events: a randomized clinical trial. *JAMA.* 1997;277(14):1127–34.
47. Grandison MK, Boudinot FD. Age-Related Changes in Protein Binding of Drugs. *Clin Pharmacokinetics.* 2000;38(3):271–90. doi:10.2165/00003088-200038030-00005.
48. Mörgeli R, Scholtz K, Kurth J, Treskatsch S, Neuner B, Koch S, et al. Perioperative Management of Elderly Patients with Gastrointestinal Malignancies: The Contribution of Anesthesia. *Visc Med.* 2017;33:267–74. doi:10.1159/000475611.
49. Spanjer MRK, Bakker NA, Absalom AR. Pharmacology in the elderly and newer anaesthesia drugs. *Best Pract Res Clin Anaesthesiol.* 2011;25(3):355–65. doi:10.1016/j.bpa.2011.06.002.
50. Steinmetz J, Rasmussen LS. The elderly and general anesthesia. *Minerva Anesthesiol.* 2010;76(9):745–52.
51. Manku K, Bacchetti P, Leung JM. Prognostic significance of postoperative in-hospital complications in elderly patients. I. Long-term survival. *Anesth Analgesia.* 2003;96(2):583–9.
52. 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(4):450–5. doi:10.1093/oxfordjournals.bja.a013468.
53. Qaseem A, Snow V, Fitterman N, Hornbake ER, Lawrence VA, Smetana GW, et al. Risk Assessment for and Strategies To Reduce Perioperative Pulmonary Complications for Patients Undergoing Noncardiothoracic Surgery: A Guideline from the American College of Physicians. *Ann Intern Med.* 2006;144(8):575–80. doi:10.7326/0003-4819-144-8-200604180-00008.
54. Lawrence VA, Hilsenbeck SG, Noveck H, Poses RM, Carson JL, et al. Medical Complications and Outcomes After Hip Fracture Repair. *Arch Intern Med.* 2002;162:2053–7. doi:10.1001/archinte.162.18.2053.
55. AGS Expert Panel on Postoperative Delirium in Older Adults. American Geriatrics Society Clinical Practice Guideline for Postoperative Delirium in Older Adults. American Geriatrics Society. <http://geriatricscareonline.org/ProductAbstract/american-geriatrics-society-clinical-practice-guideline-for-postoperative-delirium-in-older-adults/CL018>. 2014;.
56. Robinson TN, Raeburn CD, Tran ZV, Angles EM, Brenner LA, Moss M, et al. Postoperative Delirium in the Elderly. *Ann Surg.* 2009;249(1):173–8. doi:10.1097/sla.0b013e31818e4776.
57. Macario A, Weinger M, Carney S, Kim A. Which clinical anesthesia outcomes are important to avoid? The perspective of patients. *Anesth Analgesia.* 1999;89:652.
58. Gold BS. Unanticipated admission to the hospital following ambulatory surgery. *JAMA: J Am Med Assoc.* 1989;262(21):3008–10. doi:10.1001/jama.262.21.3008.
59. Kleven RM, Edwards JR, Jr R, Horan CL, Gaynes TC, Pollock RP, et al. Estimating health care-associated infections and deaths in US hospitals. *Public Health Rep.* 2002;122(2):160–6.
60. Gould CV, Umscheid CA, Agarwal RK, Kuntz G, Pegues DA. Guideline for prevention of catheter-associated urinary tract infections. 2009;.
61. Wald HL, Ma A, Bratzler DW, Kramer AM. Indwelling urinary catheter use in the postoperative period: analysis of the national surgical infection prevention project data. *Arch Surg.* 2008;143(6):551–7.
62. Saint S. Clinical and economic consequences of nosocomial catheter-related bacteriuria. *Am J Infect Control.* 2000;28(1):68–75. doi:10.1016/s0196-6553(00)90015-4.
63. Frencher S, Esnaola N, Nsqip A. *Chicago: Am Coll Surg.* 2009;.
64. Tobu S, Noguchi M, Hashikawa T, Uozumi J. Risk factors of postoperative urinary retention after hip surgery for femoral neck fracture in elderly women. *Geriatr Gerontol Int.* 2014;14(3):636–9. doi:10.1111/ggi.12150.
65. Gillespie LD, Robertson MC, Gillespie WJ, Sherrington C, Gates S, Clemson LM. Interventions for preventing falls in older people living in the community. Cochrane database of systematic reviews. 2012;9.

Author biography

Priyanka Das, Resident

Swati Sujeer, Resident

Kavya K, Resident

Shalini Subramanian, Consultant

Abhimanyu Kadapathri, Resident

Cite this article: Das P, Sujeer S, Kavya K, Subramanian S, Kadapathri A. Considerations in Geriatric Anesthesia - An overview. *Ann Geriatrics Educ Med Sci* 2020;7(2):47-52.