

The elderly and general anesthesia

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ABSTRACT

Due to the aging population, the number of elderly patients taking advantage of healthcare services is increasing. A general physical decline of all organ systems and a high frequency of chronic disease accompanying aging. Comorbidity and polypharmacy are therefore common in the elderly. Hence, the administration of general anesthesia to the elderly can be a very challenging task. This paper aims to highlight some of the important issues presented to the elderly undergoing surgery and to suggest some strategies for management.

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An increasing number of elderly patients are taking advantage of healthcare services due to the aging population, and this number is likely to grow in the future.¹ Anesthesia for elderly patients provides various challenges in the perioperative setting, and a recent study found an increased risk of anesthesia-related mortality in patients with advancing age.² This paper is intended to emphasize some of the important issues that may be presented to the elderly undergoing anesthesia. Even though the concept of term “elderly” is probably well known, there is no strict definition of the exact age at which this final part of the life cycle commences. Moreover, the average life expectancy differs in various regions of the world and will possibly differ among cultures.³ In this paper, our focus will be on patients above 60 years of age.

Preoperative considerations

Informed consent

Informed consent should always be obtained in the preoperative consultation, but at times it

can be challenging with elderly patients. With advancing age comes an increased risk of dementia,⁴ but other concerns such as hearing impairment can pose an equal challenge to communication. It should always be determined if the patient is able to comprehend, retain, and process the information presented before giving consent, and the physician should ensure that any sensory deficit the patient might have is corrected prior to the consultation.⁵ In cases of significant dementia, a family member or another representative should be consulted regarding decision-making regarding treatment.

As an anesthesiologist, one must also expect to contribute to decision-making in the “do not resuscitate” orders in the operating room and in the end of life discussions in the Intensive Care Unit.⁶

Comorbidities

Aging is accompanied by a general physical decline due to a progressive loss of function of all organ systems. Furthermore, people tend to become less active with advancing age, and a considerable proportion of elderly patients are like-

ly to acquire chronic disease. For example, the prevalence of hypertension and congestive heart failure is increasing,⁷ and advancing age is a dominant risk factor for hypertension, cardiovascular mortality, and diabetes.⁸ Several functional changes, such as loss of cardiac contractility, a decreased number of myocytes in the heart,⁹ respiratory deterioration in terms of a decreased vital capacity, an increased residual volume, increased lung compliance, and a decrease in the expiratory flow have been described.¹⁰ Furthermore, both renal and hepatic mass decrease with age. Therefore, there is a difference between older and younger populations in the clearance and the volume of distribution of numerous drugs.^{11, 12} Due to the slower elimination from the central compartment in the elderly, the dosage of thiopental and propofol should be reduced with advancing age.^{13, 14}

Consequently, these comorbidities may potentially raise some concerns in relation to anesthesia and surgical procedures. Sometimes, such considerations require further examination and/or treatment in order to preoperatively optimize the patient's medical condition to the best possible state under the circumstances. Even though age is an independent risk factor for poor perioperative outcome, it seems difficult to separate age from the increased occurrence of comorbidity in the elderly. It also seems that the patient's overall preoperative status is a better predictor of perioperative complications than the specific anesthetic management.¹⁵

Other preoperative risk assessments

Older people have diminished neck mobility, and advancing age is an independent predictor of experiencing a difficult intubation in patients with a cervical spine motion limitation.^{16, 17} The maximum range of head and neck movement is easily assessed by a method described by Wilson *et al.*, in which the patient is asked to fully extend the head and neck with a pencil placed vertically on the forehead. The examiner can then evaluate if the neck movement is greater than 90° when the head and neck are fully flexed by evaluating the displacement of the pencil.¹⁸

However, predicting a difficult laryngoscopy and a thereby challenging tracheal intubation is

optimally based on several variables, including previous difficulties in airway management, mouth opening, Mallampati classification, and, obviously, neck mobility.¹⁹

Elderly patients have vulnerable teeth, and dental injuries seem to be more common in the older age groups.²⁰ Therefore, it is advisable to use a mouthguard, even though intubation conditions can be impaired as a consequence of the narrowed space. Removable dental prostheses should be taken out to provide optimal conditions for intubation, but it may be an advantage to leave them in situ during induction in order to improve mask ventilation.

Depending on the preoperative risk assessment, the anesthesiologist should consider the possible advantages and disadvantages of regional anesthesia techniques for the specific operation, which can be applied either in combination with or as a substitution for general anesthesia.

Polypharmacy

The presence of several diseases is often synonymous with polypharmacy. It has been estimated that one in four elderly patients are prescribed at least three different drugs; among those hospitalized, as many as eight drugs are taken.²¹ Obviously this draws a concern for adverse drug interactions in the perioperative period. It is relevant to reevaluate the prescribed medications before the surgery. Patients should be encouraged to either bring the drugs or, better, to show their medication list at the preoperative consultation. Therefore, the clinician can decide if any prescribed medication should best be avoided preoperatively, thereby reducing the chance of any potential drug-related problems. For example, some opioids can interact with anti-Parkinson drugs and induce muscle rigidity.²² However, it is very difficult to provide any simple recommendations, and sometimes one should seek advice from experts such as geriatricians or clinical pharmacists if time allows for it, as in elective surgery.

Premedication

Presumably, there are several traditions among different regions and countries in regards to the administration of premedication. The beneficial

effects of a routine use of premedication in the elderly are not evident, and a conservative approach is most likely preferable due to the side effects of drugs and the potential interactions as above mentioned.²³ However, if symptoms such as irritability, anxiety, and agitation are remarkable, it can occasionally be necessary to implement medications such as anxiolytics, for example short-acting benzodiazepines. Once in a while, paradoxical reactions to benzodiazepines occur, and although the mechanism is unclear, it has been suggested to be secondary to advancing age.²⁴ The decision to administer preoperative analgesics in the elderly should be similar to that in younger patients, taking the dose adjustment into account.

Perioperative interventions

Thermoregulation

It is important to maintain normothermia in surgical patients because hypothermia is associated with increased blood loss and transfusion requirements, a higher rate of wound infections, and increased in-hospital mortality rates.²⁵⁻²⁷ Elderly surgical patients are particularly at risk of experiencing hypothermia due to their age-related diminished thermoregulatory control; furthermore, anesthesia impairs the patient's ability to regulate body temperature.²⁸ Active heating systems, such as forced air warming and maintenance of proper temperature in the operating room, are some of the preventive measures that can be easily implemented.

Fluid regimen and red blood cell transfusion

Fluid regimens should be based on the specific disease and procedure rather than on the age of the patient. For several years, it has been an ongoing discussion whether to use a "restrictive" or a "liberal" fluid therapy. A clear answer to such a complex issue is probably not achievable, and comparison among studies is difficult because they lack consensus in the methodology used.²⁹

For the elderly, as well as for other patients, it should be realized that the lower limit of the exact blood hemoglobin concentration required for the delivery of adequate tissue oxygen is not known. Old age in itself does not mandate whether or

not a blood transfusion should be performed. In general, such transfusion strategies aim at specific diseases or conditions rather than age. The transfusion of red blood cells is independently associated with longer hospital lengths of stay, increased complications, and increased mortality. In critically ill patients, recent guidelines state that a restrictive transfusion strategy (to transfuse when hemoglobin < 7 g/dL) is just as effective as a liberal transfusion (to transfuse when hemoglobin < 10 g/dL) approach, provided that the patient is hemodynamically stable and does not have myocardial ischemia or infarction. Still, it may be used for patients with evidence of acute hemorrhage and hemodynamic instability.³⁰ Preventive measures must be taken in order to reduce surgical blood loss. Procedures such as controlled hypotension, minimally invasive procedures, lowered venous pressure, autologous blood transfusion, and pharmacological interventions with antifibrinolytic agents, recombinant factor VIIa, tranexamic acid, desmopressin, and erythropoietin have all been successfully used to some extent, although most measures are not very well documented.³¹ The harmful effects associated with each procedure should be considered simultaneously. For example, controlled hypotension involves a risk of cardiovascular morbidity.³² When determining the optimal transfusion strategy and the preventive measures of blood loss, an extended monitoring, such as venous oxygen saturation and cardiac output monitoring, will often be helpful.³³

Choice and dosing of anesthetics

All general anesthetics can be used in elderly patients, but the dose should be carefully and patiently adjusted according to the response. Elderly patients display a huge variability in sensitivity to many drugs, especially hypnotics, but generally these patients will need much lower doses than younger and middle-aged patients. It is not uncommon for the elderly to receive excessive doses of anesthetics that lead to an undesired prolongation of recovery and to hemodynamic depression. An important factor contributing to this error is the longer onset time, which may lead to an unnecessary supplementation to the induction dose. The

elderly are less able to compensate for profound vasodilation due to a diastolic cardiac insufficiency; the decrease in blood pressure can be concerning, especially in the patients who have significant stenoses of the coronary or carotid arteries. Hence, it is common practice to administer vasopressors and fluids to maintain a mean arterial blood pressure at a level corresponding to no less than 20-25% of the baseline. Unfortunately, fluid overload and increased myocardial oxygen consumption may result in such cases where low blood pressure is triggered by an overdose of anesthetics.

There are several explanations supporting the statement that most elderly will need smaller doses of anesthetics than younger patients. The elderly population is pharmacokinetically characterized by a lower volume of distribution. In addition, some drugs, such as remifentanyl, have a much smaller volume of distribution. The same dosage per kg given to the elderly will, therefore, result in a higher plasma concentration than if given to a younger age group, and delivery to the effect compartment will be delayed.

Another principal explanation for the required dose reduction is the pharmacodynamic increase in sensitivity, which means that the same concentration produces a larger response.

The dosage of hypnotics can be guided by the depth of anesthesia monitors based on the spontaneous electro-encephalogram (EEG), including products such as the BIS, the entropy monitor, the Index of Consciousness (IOC), and the auditory evoked potentials (AEP). The principle behind the AEP has a physiological basis because it is the middle-latency component of the EEG response to sound stimulation that is analyzed. Profound hearing impairment can alter this auditory response, which is an important issue in the hearing-impaired elderly.

Depth of anesthesia monitoring can sometimes reduce the recovery time and consumption of anesthetics, but very few elderly have been included in those studies. Although not yet documented, one may expect that the benefit in elderly patients would be even greater due to the large variability.

Hypnotics

The same effect on level of consciousness may be achieved with lower plasma concentrations of

hypnotics in the elderly. Hence, the generally recommended induction dose of thiopental and propofol can usually be reduced by 30-50% in elderly patients. The initial decrease in plasma concentration of both induction agents is caused by the slower distribution to peripheral compartments in the elderly, who subsequently will display a hemodynamic depression more often and for a longer time period than a younger patient would.³⁴

Maintenance of intravenous anesthesia with propofol in the elderly should be adjusted on the basis of the response to the induction dose; most of these patients will need no more than 50% of the dosage given to young subjects. An interesting new technique may aid in titrating propofol because the end-tidal concentrations of the drug can be measured during anesthesia by proton transfer reaction mass spectrometry (PTR-MS). The PTR-MS allows for detection of extremely low gas concentrations, and the results have been in agreement with plasma concentrations.³⁵

The propofol infusion can be controlled by various algorithms that can be incorporated in the infusion pumps when a desired target blood concentration is chosen. These target control infusions may be useful, but there are important differences between the algorithms. The Marsh model does not correct for age; on the other hand, the Schnider model takes age into account. However, a recent study of the elderly failed to show a better correlation between the Schnider effect site prediction and the BIS value than the correlation exhibited by the Marsh model.³⁶ A study of the administration of propofol based on BIS found more hemodynamic stability and reduced total amounts of anesthetics associated with closed loop administration than with manual titration based on BIS.³⁷ Despite several differences among the advantages and disadvantages of the various algorithms, the topic is new and evolving, and clinical consequences are not necessarily easily predictable.³⁸

For induction of anesthesia in emergency patients, it may be prudent to use etomidate or ketamine because these drugs cause very little hemodynamic depression, and there seems to be no major differences between the two agents.³⁹ Ketamine may be associated with significant

adverse psychological effects, but a recent study found that administration of ketamine actually resulted in less cognitive dysfunction.⁴⁰

Two new hypnotics with attractive pharmacological properties are under development. Similar to remifentanyl, they both undergo rapid elimination by esterases that are independent of organ function. One is a benzodiazepine, and the other is an etomidate-analogue.^{41, 42}

Opioids

Most opioids cause less circulatory depression than the hypnotics, and they effectively reduce the necessary dose of other anesthetics. Sensitivity becomes somewhat greater and clearance becomes lower with increasing age. Still, the initial dose of fentanyl and alfentanil should probably not be much lower than that administered to younger patients, but recovery may be delayed if a supplementary dose is given near the end of the procedure.

Remifentanyl is rapidly metabolized by esterases, which is a theoretical advantage in geriatric anesthesia. In spite of this, remifentanyl must be given cautiously to elderly patients because of a low volume of distribution, a lower clearance, and a much greater sensitivity.⁴³ Hemodynamic depression with hypotension and bradycardia occurs more often with remifentanyl than with other opioids.⁴⁴ Small bolus doses of remifentanyl can be given, but they are not recommended in the elderly frail patient. A study of volunteers demonstrated a profound effect of bolus doses on healthy subjects over 60 years of age, in which significant respiratory depression occurred more frequently even after small doses.⁴⁵ The infusion rate of remifentanyl in patients above 60-70 years of age should probably be no more than 30-40% of the dose administered to younger patients because of the risk of increased drug potency and the decreased elimination rate associated with advanced age. An infusion rate between 0.1 and 0.3 µg/kg/min has been used in studies of elderly, and that dosage has seemed to be appropriate, although some hemodynamic depression has occurred.⁴⁶⁻⁴⁸

Volatile anesthetics

Inhalational anesthesia offers some advantages in elderly patients. Titration is usually easy, and

the monitoring of end-tidal concentrations provides the anesthesiologist with important knowledge about the depth of anesthesia. It should, however, be taken into account that there is some variation among the elderly. The potency of all volatile agents increases with age, and the minimum alveolar concentration is around 30% lower in an 80-year-old patient than in a 20-year-old patient. It is favorable that the elimination of inhalational agents can be controlled by ensuring adequate ventilation.

Neuromuscular blocking agents

Neuromuscular blocking agents (NMBA) are used to provide muscle relaxation in order to achieve optimal conditions for tracheal intubation and for surgery. In this way, the dosage of other drugs and hemodynamic depression can be reduced. There are, however, important drawbacks such as the risk of residual curarization. Not only is it unpleasant, but it may also impair swallowing and pulmonary function. There seems to be a lack of knowledge regarding the appropriate use of NMBA and neuromuscular monitoring, and more anesthesiologists now perform tracheal intubation without NMBA.^{49, 50} Tracheal intubation is definitely possible without NMBA, but adequate depth of anesthesia must then be assured, for instance with propofol and remifentanyl, if laryngeal morbidity and inferior intubation conditions are to be avoided.^{51, 52}

The elimination of some NMBA, such as rocuronium, is dependent on hepatic or renal function that leads to a pronounced variability in the duration of action.⁵³ Cisatracurium, in contrast, is eliminated predominately by the organ-independent Hofmann degradation. A new drug, sugammadex, may allow a very rapid reversal of neuromuscular block caused by rocuronium or vecuronium. The dose depends on the depth of the neuromuscular block that can only be reliably assessed by objective neuromuscular monitoring. In the elderly, this monitoring seems even more important because of the concomitant medications that may interact with the NMBA.⁵⁴

Now it is possible to obtain full neuromuscular recovery only a few minutes after an intubation dose of rocuronium.⁵⁵ Satisfactory intubation conditions can be obtained only 60 seconds after a 0.9-

1.2 mg/kg dose of rocuronium, but the intubation conditions are probably not as good in comparison to succinylcholine for rapid sequence intubation.⁵⁶

Postoperative considerations

Pain assessment and management

Pain is common in the postoperative setting, but unfortunately it is often neglected in older people. Age-related factors such as dementia and altered nociception make the elderly highly vulnerable to inappropriate pain management, and the assessment of pain is difficult in the elderly. The use of visual or numeric scales is problematic because older people can have trouble understanding these tasks, especially the cognitively impaired. Furthermore, the ability to report pain may be impaired. Recently, an alternative has been developed called the Mobilization-Observation-Behavior-Intensity-Dementia (MOBID) pain scale, which is based on observation of behavior during rest and movement. The MOBID scale evaluation can often reveal pain that occurs during mobilization that is not determined with the traditional bedside assessment.⁵⁷ The MOBID scale can be used for determining pain in demented patients.⁵⁸

Complications

Two of the main complications that occur in the elderly undergoing surgery are delirium and postoperative cognitive dysfunction (POCD).

Delirium is characterized by a fluctuating change in cognition with a severe disturbance in attention and thinking and an affected level of consciousness. The clinical detection of delirium can be performed using the confusion assessment method (CAM).⁵⁹ The incidence of delirium among the elderly surgical population is around 40%, and the most important risk factors are increasing age and dementia. Other risk factors include side effects of drugs, dehydration, sensory deprivation, and anxiety.⁶⁰ The treatment of delirium is primarily focused on identification of precipitating factors rather than administering medication, which should only be used to treat severe cases. Whereas the consciousness is modified in delirium, it remains unaffected in POCD

because it is a more subtle cognitive disorder. POCD usually involves a decline in memory, concentration, and information processing and is often unnoticed when patients are discharged from the hospital because detection of it requires neuropsychological testing.⁶¹ Advancing age is also an important risk factor for POCD, and the incidence is 25% in patients above 60 years of age one week after major non-cardiac surgery; it occurs less frequently after minor surgery and in the outpatient setting.^{62, 63} The etiological factors for POCD are, for the most part, unknown, but the condition probably has a multifactorial origin. Even though both delirium and POCD are largely reversible, they are both associated with higher mortality and morbidity rates.^{64, 65}

Conclusions

In conclusion, general anesthesia in the elderly can be very challenging. Several mental and physiological differences are apparent with advancing age and the frequent co-existence of diseases. In order to optimize the treatment of the growing elderly population, it is necessary to be aware of such differences.

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