

Geriatric Anesthesia

Bhavna Kakkar*

Department of Anesthesia and Critical Care, Maulana Azad Medical College and Lok Nayak Hospital, New Delhi, India

*Corresponding author: Bhavna Kakkar, Department of Anesthesia and Critical Care, Maulana Azad Medical College and Lok Nayak Hospital, New Delhi-110002, India, Tel: +91-8527686660, E-mail Id: bhavna.kakkar@gmail.com

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Abstract

Elderly people comprises a growing proportion of population. They have higher prevalence of co-morbidities which include heart disease, diabetes, hypertension, cerebrovascular disease, renal dysfunction which require careful evaluation during pre-anesthetic checkup. They have decreased adrenergic responses to stressor events and have poor compensatory responses to hypovolemia. They are also prone to post-operative pulmonary complications owing to poor protective reflexes and impaired chest wall compliance. The immune system is impaired, making them susceptible to surgical site infections. They are at increased risk of post-operative delirium and confusion. They require less dosage of opioid analgesics, sedatives, local anesthetic dosages, to achieve a desired effect. This brief review focusses on physiological changes of ageing, its perioperative implications and anesthesia management.

Keywords: Anesthesia management; Ageing;

Introduction

Ageing is characterized by degenerative changes in structure and function of organs and tissues, there is gradual loss of skeletal tissue mass, increase in body fat, reduction in total body water, and decline in albumin levels. Elderly population are highly sensitive to anesthetic drugs and require less medications to achieve the desirable effects and avoiding untoward side effects. [1] In the elderly, decreased skin elasticity increases the risk of injury from the use of various adhesive tapes. Adding a thin layer of cotton batting wrap before applying the noninvasive blood pressure cuff may be a simple but effective maneuver for the prevention of neurovascular complication. Thinner layer of subcutaneous fat, which predisposes elderly patients to the potential for pressure sores. Protecting elderly patients' bony prominences, padding with pillows and arm-support devices should be ensured [2-5].

Literature Review

In the cardiovascular system, they have decreased beta adrenergic receptors response and there is stiffening of myocardium, arteries and veins. There is increased sympathetic and decreased parasympathetic activity, increased conduction abnormalities and defective ischemic preconditioning. Elderly population are prone for atrial and ventricular ectopic, and cardiac conduction defects owing to fibrotic infiltration in cardiac conduction pathway system. Elderly population depends on frank starling mechanism for maintenance of their cardiac output and they require adequate and diastolic volume to generate contractile strength of ventricles. These people have diastolic dysfunction and reduced vascular compliance, therefore they have poor compensatory mechanism for hypovolemia and importantly they tolerate exaggerated transfusion poorly. The left ventricle becomes more dependent on atrial kick and requires an increase in left atrial pressure to preserve diastolic filling. Unfortunately ageing also diminishes the ability to maintain filling pressures, and veins act as

reservoir of blood to maintain central blood volume, and ventricular filling at an adequate level. With age, veins also stiffen, thereby creating a situation in which there is more dramatic changes in venous pressure and cardiac filling with modest change in venous blood volume. Ageing also diminishes preconditioning of ischemia (brief period of myocardial ischemia prevents or lessens the adverse effects of more prolonged ischemic period) [2,3].

In the respiratory system, there is increase in stiffness of chest wall, and decrease in stiffness of lung parenchyma, because of loss of elastin, with advancing age, increasing the work of breathing. Elderly are at increased risk of post-operative pulmonary complications. Small airways do not have enough inherent stiffness and depends on surrounding tissues to remain open, as the tissues lose its compliance, greater lung inflation is required to prevent smaller airway collapse. Closing capacity therefore increases with age and exceeds the functional residual capacity by 65 years of age, and eventually exceeds tidal volume at latter ages. FEV1 declines by 8% to 10% per decade owing to reduced lung compliance. Partial pressure of oxygen declines further with age because of shunt and ventilation-perfusion mismatch. Most important predictor of adverse pulmonary outcome depends on the site of surgery, and type of anesthesia technique. Diminished laryngeal protective reflexes, declining hypoxic and hypercarbic drive, reduced respiratory muscle strength, and an increased ventilation-perfusion mismatch are all potential contributors to this increase in morbidity. Additionally, apnea and hypoventilation following administration of narcotics and sedatives are more common in the aging population [4,5].

Renal mass and blood flow declines with age by 20% to 25%, but serum creatinine remains constant owing to decrease in muscle mass. Decrease in GFR is approximately 1 ml/min/year after the age of 40 years. Elderly population are at risk of both dehydration, as sensation of thirst declines and fluid overload owing to impaired handling of sodium, reduced aldosterone production, inability of tubules to concentrate well and diluting capacity of nephrons. They are also at risk of acute renal failure owing to reduced renal blood flow and decline in nephrons concentrating ability. [5]

Liver mass declines by almost 40% by the age of 80 years, there is modest reduction in metabolism of phase I drug and bile secretion with age. The effects of opioids, muscle relaxants metabolized by liver and other drugs cleared by hepatic metabolism are prolonged in elderly [4].

Geriatric people have a decline in nervous tissue mass, density of neurons, concentration of norepinephrine and dopamine receptors along with neuro-transmitters is also reduced. At 80 years of brain has typically lost 10% of its weight. Response time and learning is more difficult and above the age of 80 years, many patients have significant cognitive impairment. Requirement of both local and general anesthetic agents is reduced. They take time to recover from the effect of general anesthesia and may be more disoriented in the post-operative recovery room. They may also have varying degree of post-operative delirium, as they are highly sensitive to central anti cholinergic agents.

Pharmacology

The pharmacokinetic effects of ageing depend on the drug used. Acidic drugs bind to albumin, and the circulating levels of albumin declines with age, on the other hand, level of alpha 1 acid glycoprotein increases. Total body water is decreased, leading to overall reduction in central compartment and sudden increase in blood concentration of drug can be seen when a bolus of drug is given. There is also prolonged action of drug as there is greater volume of distribution of drug owing to increase in body fat stores. Metabolism of drug is also altered by the effect of ageing on organ function especially-liver and kidney. Drug action is usually prolonged in them, and they generally require smaller dosage for the same clinical effects. Decreased cardiac output leads to slow onset of drug action followed by prolonged action secondary to delayed clearance (i.e., barbiturates, benzodiazepines). Inhalational drugs: MAC (Minimum Alveolar Concentration) declines with age, almost 6% per decade, which parallels loss of neurons and decreased cerebral metabolism. Receptor sensitivity, alteration in ion channels and synaptic activity is also responsible for similar effects [3].

Opioids: Elderly require lesser dosage of opioid agents. Sufentanyl, fentanyl and alfentanil are twice potent in elderly as compared to adult population owing to altered sensitivity of brain to opioids. As the central compartment is reduced in geriatrics infusion rates should be reduced and titrated to effect.

Neuromuscular drugs: Metabolism of drugs which depend on liver and renal blood flow is reduced, thereby prolonging the duration of effect. Metabolism of atracurium and cis-atracurium is unaffected by age, as they are metabolized by Hoffman degradation.

Preoperative evaluation

Elderly have associated co-morbidities like hypertension, diabetes, atherosclerosis, degenerative joint and bone diseases, etc. and risk of anesthesia is related to the associated co-morbidities. It is imperative to determine the physical status and physiological reserve during pre-operative anesthetic evaluation. Pulmonary complications are the leading cause in post-operative morbidity of these patients, it is important to optimize the same. Also, it is important to determine the cognitive status of an elderly patient at this juncture. They require lower dosage of pre-medication, opioids should only be reserved in intolerable pain. Anti-cholinergic are usually not required because of senile atrophic changes in salivary glands. However, H2 antagonists should be provided to reduce the risk of aspiration. Metoclopramide

can also be given but one must be cautious of extra-pyramidal side effects.

Intraoperative anesthetic management

Advanced age is not a contraindication for regional or general anesthesia. Regional anesthesia has its own benefits, that it decreases the incidence of deep venous thrombosis, improves blood flow, provides adequate pain relief and may be beneficial for the patient, more importantly, patient maintains spontaneous airway and pulmonary functions are intact depending on the level of blockade. The hemodynamic effects of regional anesthesia are associated with reduced blood loss in lower limb surgeries as well. Basic principle of drug use includes smaller dose than young adults, and efficacy becomes more apparent when the Practitioner is patient enough to allow more time for the drug to achieve its peak effect. Short-acting intravenous drugs and volatile anesthetics with lower partition coefficients provide the advantage of more rapid elimination, brisk emergence, and reorientation to the patient's surroundings, and potentially lower incidence of confusion and delirium during recovery. For induction, a given blood level of Propofol causes a greater decrease in brain activity but the dramatic fall in blood pressure can be seen, to avoid the same, attempts should be done to reduce the amount of Propofol with the use of adjuncts like opioids and combining it with etomidate. Maintenance of normothermia is important as hypothermia is related to increased oxygen demand and chances of myocardial infarction and hypoxemia. Prolonged elimination of anesthetic agents and slower postoperative awakening also can occur because of poorly controlled intraoperative heat loss. Interventions available for protecting from hypothermia include increasing operating room temperature, using warm blankets or other warming devices to cover patients, administering heated anesthetic gas mixtures, and infusing warmed intravenous fluids.

Preoperative investigations

Preoperative testing is done to know the baseline parameters, and depending upon the associated co-morbidities and postulated surgery.

Complete blood count (CBC): It is generally reasonable to get complete blood count, which include hemoglobin, total leucocyte counts and platelet count. Hemoglobin 8.5-10 g/dl is usually considered adequate for surgery, depending upon the co-morbidities, anticipated blood loss, and type and duration of surgery involved. Etiology of anemia should be looked for by getting blood indices, peripheral smear, upper and lower gastrointestinal endoscopy and to correct any nutritional deficiency of iron, folate, vitamin B12 and proteins.

Blood urea and serum electrolytes: elderly patients may be dehydrated, they may be on various anti-hypertensive medications such as diuretics, ACE inhibitors, ARBs, and may have associated co-morbidities such as long-standing diabetes, hypertension, chronic kidney impairment, therefore it is essential to get the values of creatinine, urea, creatinine clearance and serum electrolytes.

Coagulation profile: PT, APTT are usually only indicated in known bleeding disorders or deranged liver, or in those who have history of bleeding. In some of the major surgeries such as neurosurgical/spinal/heart surgeries, even small amount of bleeding can be catastrophic, so one might prefer to get baseline coagulation profile in selected subsets.

Urine analysis: Elderly patients have high chances of symptomatic bacteriuria and may have indwelling urinary catheters, therefore it is mandatory to get baseline urine routine microscopy done in them.

Chest X-ray: Chest X-ray is recommended in patients who have known cardiopulmonary disease and who are found to have abnormalities on systemic examination.

Electrocardiogram/Echocardiogram: Electrocardiogram/Echocardiogram is indicated in elderly patients with cardiac disease, associated risk factors/co-morbidities such as hypertension, diabetes, elevated cholesterol, triple vessel disease etc.

Options of Geriatric Anesthesia

Options available for anesthesia management include Monitored anesthesia care (MAC), Regional and General Anesthesia. Decision is based on the type and nature of surgery, patient's choice and patient's co-morbidities.

Monitored anesthesia care (MAC)

Sedation can be provided during local or regional anesthesia to increase patient's comfort for proposed surgery, helps overcome anxiety and prevents sympathetic surges. There is overall patient's satisfaction and co-operation during the surgery. The routine standard monitoring implies same as is done during general anesthesia. Anesthesiologist administering the same should be well versed with the side effects of the agent, should not over sedate the patients, should have control over the airway in case unintentional general anesthesia occur because of over dosage.

Regional anesthesia

Regional anesthesia is the preferred mode and is often employed in elderly owing to possible depression of cardiovascular and respiratory

function associated with general anesthesia. Patient maintains their own consciousness, permitting early recognition of cognitive dysfunction or onset of ominous symptoms such as chest pain in ongoing angina, or identifying TURP syndrome early manifestations. Although literature suggests little if any difference between regional and general anesthesia in elderly population. Impairment of cognitive dysfunction has also been reported and seen after regional procedures. Regional anesthesia itself is challenging in these patients owing to calcified spinous ligaments, fractures, osteoporotic bones, vertebral collapse and fractures, kyphosis etc. Larger bore spinal needle is preferred to avoid risk of post dural puncture headache and gentle epidural needle should be placed to avoid risk of dural puncture during epidural anesthesia. The added advantage of neuraxial anesthesia include avoidance of airway instrumentation, patient maintains his/her own airway, there is decreased risk of DVT, decreased blood loss, post-operative analgesia can be provided through epidural catheter. One must be cautious of age related autonomic changes, cardiovascular abnormalities, sudden hypotension after sympathetic blockade, bradycardia, and increased chances of urinary retention in the post-operative period. While giving local anesthetics, one must not forget that they have decrease in latency time, reduced CSF volume, increased CSF density, which may cause greater diffusion of drug. Demyelination of nerve fibers is secondarily responsible for higher blockade; therefore, one must reduce the amount of local anesthetics [5,6].

General anesthesia

Geriatrics are very sensitive to anesthetic agents. Lower concentration of drug is required to achieve a desired effect and effect is usually prolonged. Gradual titration of drug to dosage effect is usually required, boluses must always be avoided. One must be cautious of hemodynamic surges. Intravenous drugs may have longer circulation time and delayed onset of effect.

Drug	Usual Dose	Dosage Adjustment
Propofol	1.5-2.5 mg/kg	20% to 30% reduction in dosage
Thiopentone	2.5-5 mg/kg	30% reduction
Etomidate	0.3-0.4 mg/kg	0.2 mg/kg. Most cardiac stable.
Midazolam	0.2-0.3 mg/kg	75% reduction in dose may be required in age >85 years. Titrated dosage is usually preferred
Isoflurane	1.2%	MAC reduced by 6% per decade
Sevoflurane	1.8%	MAC reduced by 6% per decade
Desflurane	6%	MAC reduced by 6% per decade
Morphine	0.1-0.15 mg/kg	50% reduction is required
Fentanyl	1-2 micrograms/kg bolus	50% reduction
Remifentanyl	0.5-1 micrograms/kg	50% reduction in bolus and 33% reduction in infusion is required

Table 1: Anesthetic dosage adjustment in geriatrics.

Ambulatory elderly anesthesia

Ambulatory or day care surgery has an added advantage in elderly subsets, as they are discharged same day from the hospital, they're into

their familiar zone, have reduced fear, apprehension, are mobile sooner and have reduced risk of post-operative delirium and confusion, post-operative surgical site infections. Cataract, hernia repair, TURP

surgeries are amongst the commonly performed day acre surgeries in them. Discharge criteria, Aldrette scores and PADS score apply same for them.

Analgesia

Elderly are particularly sensitive to opioid analgesics and their use in higher dosage should be avoided. One should carefully titrate the drug dosage effect relationship and include a prophylactic bowel softener such as docusate or stimulant laxative if these patients are on chronic opioid therapy for pain. Regional techniques for analgesia should be encouraged and advocated to improve pain control and improve patient’s satisfaction scores. Peripheral nerve blocks are useful especially in orthopedic surgeries and provides better pain scores, reduced use of opioids, wakefulness and decrease side effects, better

return of gastrointestinal function, and overall reduced risk of cardiovascular complications.

Induction of anesthesia

Adequate pre-oxygenation is mandatory, followed by titrating the effect of anesthetic drugs to effect is required. ED 50 of inhalational anesthetic drugs falls linearly with age, concurrent administration of opioids, midazolam and induction agents such as Propofol and thiopentone increases the depth of anesthesia. One should anticipate hypotension owing to effects of drugs and prepared to treat the same. Dosage adjustment of various drugs have been summarized in Table 1. Rapid sequence induction may be required in emergency scenario, in diabetics and gastro-esophageal reflex disorders.

Enhanced recovery after anesthesia	Description
Background	Risk assessment
	Optimization of pre-existing organ dysfunction
	Education
	Reduction of surgical site infection
Pre-operative	Cardiovascular risk stratification-surgery type/functional status/ age/ASA
	LEEs Index: CHF/DM/IHD/Surgery type
	Cardiopulmonary exercise testing
	Smoking cessation
	No prolonged fasting-2 hr clear liquid/6 hours solid
	Antibiotics
	Thromboprophylaxis
Intraoperative	Standard anesthesia protocol and monitoring
	Avoid PONV
	Avoid pain-use of thoracic epidural
	Short acting opioids to be preferred
	Avoid hypoxia and hyperoxia
	Reduce surgical site infections-hand hygiene/antibiotics/avoid hyperoxia
	Glycemic control/fluid balance/avoid over-hydration
Post-operative	Nsaids+COX+paracetamol
	Open abdominal surgery-TEA/TAP/intra venous lidocaine
	Laparoscopic surgery-TAP/Intra Venous Lidocaine
	Avoid post op delirium-use short acting agents/avoid sedatives/BZDs/long fasting hours

Table 2: Enhanced recovery after anesthesia in elderly-summary.

Airway management

They have limited neck mobility, owing to arthritic changes. They have difficult mask ventilation owing to absence of multiple teeth. Goal of pre-oxygenation may not be reached because of increase in closing

capacity. They are prone to sleep apnea owing to reduction in upper airway tone placing them at increased risk of pulmonary complications. Intubation should be rapid, gentle and atraumatic.

Risk factors for PONV in elderly

Nausea and vomiting is amongst the most common complication of general anesthesia, and patients can be extremely nervous and anxious about the same in the preoperative period, and is also a causative factor for prolonged stay of patient in hospital, also poor patient's satisfaction in the post-operative anesthesia care unit. Risk factors of PONV should be assessed in all elderly patients, and those at moderate-high risk for PONV should receive prophylactic medications for the same. The anesthesiologists should be aware of post-operative

nausea-vomiting prophylactic and treatment strategies and should appropriately administer them weighing the potential risk and benefits of the drugs. Use of 5HT3 antagonists such as ondansetron should be avoided or used cautiously to avoid QT prolongation. Corticosteroids use should be avoided in patients at high risk of post-operative delirium. Transdermal scopolamine should be avoided as it has strong anticholinergic properties and increases the risk of delirium, confusion and constipation. Prochlorperazine is avoided to avoid anticholinergic side effects [6].

Procedure	Enhanced Recovery Protocol	Conventional Protocol (Key Differences)
Pre-operative	Provide complete information about the protocol and take an informed consent.	Overnight starvation.
	Advice given regarding exercise, smoking and alcohol cessation.	No carbohydrate drink.
	Optimize any pre-existing co-morbidity and minimal starvation (6 hrs. for solids and 2 hrs. for liquids).	Mechanical bowel preparation.
	100 g oral carbohydrate drink.	Parenteral hydration (to compensate for bowel preparation)
	Avoid mechanical bowel preparation.	
	Pre-operative antibiotic	
Operative	Epidural anesthesia (0.125% bupivacaine, continuous infusion) along with spinal or general anesthesia.	Done under spinal or general anesthesia.
	Arterial/Central lines inserted only if unavoidable.	Routine use of Nasogastric tubes, abdominal drain and urinary catheter.
	Goal directed fluid therapy.	
	Maintain optimal oxygenation.	
	Avoid hypothermia.	
	Minimal tissue handling.	
	Elective use of nasogastric tubes, abdominal drains and urinary catheters	Liberal hydration
Post-operative	Maintain supplemental oxygen.	No emphasis on PONV prophylaxis.
	Strict post-operative nausea and vomiting prophylaxis.	No enforced mobilization.
	Early enforced mobilization.	Removal of nasogastric tube and abdominal drain delayed till markers of bowel motility are observed.
	Early enteral nutrition.	Oral or Enteral nutrition given once bowel motility is restored
	Removal of epidural catheter by day 2.	
	Ensuring adequate analgesia after epidural catheter removal.	
	Early removal of all tubes, drains and catheters	
	Post discharge	Ensure 30-day follow-up including: Phone call at 48 hours
7th day clinic visit o any emergency visit		

Table 3: Comparison of eras and conventional protocol.

Target fluid therapy

Generally fluid administration should take in account the physiology of ageing, duration of surgery, use of anesthetics agents and

blood and third space losses. Appropriate use of intravenous fluids in elderly is important to avoid ill effects of fluid administration on already compromised physiological reserves of geriatric population.

Goal directed, or fluid restrictive strategies are preferred over fixed volume strategies to avoid volume overload [6].

Enhanced recovery after surgery and anesthesia I elderly

Enhanced recovery programs involve changes in every step of the patient care process, from the referral from primary care through to the post-operative phases and follow-up. Most of the evidence for ERPs comes from colorectal surgery, although these components apply equally for other applications such as gynecological, urological or orthopedic surgery [7]. The ERP aims to reduce these detrimental effects by reducing surgical stresses and reducing or preempting the metabolic changes that occur. The ERAS has been summarized in Tables 2 and 3.

Post-operative care

Analgesia is the major goal. Failure to achieve the same is associated with adverse outcomes, including sleep deprivation, respiratory impairment, ileus, tachycardia, hypertension, and insulin resistance. Epidural analgesia is well known to provide superior analgesic as compared to intravenous agents resulting in earlier return of bowel function, nutrition and earlier mobilization. If a patient had a surgery with major fluid requirement, it is important to look for signs of fluid overload like rales, dyspnea, tachypnea, orthopnea after 48-72 hours in post-operative period, when third space fluid tends to mobilize. A timely administration of diuretic may be helpful in preventing pulmonary edema in these patients. Most surgical morbidity and mortality, including myocardial ischemia, cerebrovascular events, renal insufficiency, pneumonia, and delirium, occur in the postoperative period.

Minimizing post-operative pulmonary complications

In order to minimize the post-operative pulmonary complications, anesthesiologists should prefer avoidance of general anesthesia as far as possible depending upon the nature of surgery, should maximally use epidurals for pain relief, avoid the usage of long acting opioids and muscle relaxants, use laparoscopic surgeries especially in bariatric elderly population of subsets, ensure adequate recovery of neuromuscular function before extubating, maintaining normothermia, monitoring core temperature in surgeries lasting more than half hour duration, use of warming blankets, warm fluids for surgical washes and intravenous replacement, replacement of third space losses and blood losses, deep breathing exercises, propped up position and use of incentive spirometry.

Venous thromboprophylaxis

Elderly people are prone to risk of venous thromboembolism owing to their age, immobilization, fractures off and on, due to fragile bones, varicose veins, inflammatory bowel disease, increased risk of cancer/therapy, recent surgery, severe infection, cardiovascular diseases, hypercoagulable state etc.

Prevention and treatment of pressure ulcers in elderly

Possible risk factors for pressure ulcers in elderly include hypothermia, use of cardiopulmonary bypass, longer period of intraoperative hypotension, prolonged duration of surgery, massive blood loss, intraoperative blood transfusion, use of vasopressors and inotropes, moribund or ASA III patients etc. health care teams should

assess for risk of pressure ulcers in elderly patients in the post-operative period and they should implement interventions to prevent and treat the same.

Discussion

Post-operative delirium

Risk factors for post-operative delirium: Age >65 years, chronic dementia, poor vision, hearing impairment, presence of infection and severe illness especially when admitted in ICU are significant risk factors for post-operative delirium. Screening tools such as CAM (Confusion Assessment Method) are used to start early treatment for delirium at risk patients.

Delirium prevention strategies: Include education about multicomponent of delirium, multidisciplinary approach involving health care workers, and family caregivers, and interventions include cognitive reorientation, daily physical and occupational therapy, presence of a family member at bedside of patient, early mobility, physical rehabilitation, nutritional and fluid requirements to be met adequately, appropriate pain management, adequate oxygenation, preventing and treating constipation, minimize the use of Foley catheters, periodic removal of ECG leads, compression devices and last but not the least sleep enhancement techniques by means of appropriate sleep hygiene, avoidance of light, sound environment and non-pharmacological methods.

Conclusion

Post-operative delirium is acute state of confusion, characterized by an acute onset of disorientation, impaired attention and cognition, disturbances in perception from situation of misinterpretation to overt hallucinations, and disorganized thinking. Risk factors include advanced age, low baseline cognitive function, depression, dementia, general debility including dehydration. Additional stress factors can include the drugs which acts on CNS e.g. narcotics, benzodiazepines and drugs with anticholinergic side effects. Other factors include sleep deprivation, dehydration, unfamiliar surroundings and perioperative blood loss. Once identified, management focusses on reversible factors, such as concurrent medications, pain management, better sleep environment. In case patient become more agitated, haloperidol up to 1.5 mg can be given. Even haloperidol is also reserved for patients, who undergo high risk major surgeries to avoid severity of post-operative delirium.

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