

## ISSUES IN GERIATRIC ANAESTHESIA

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Elderly individuals represent the fastest growing segment globally. In America, the expectancy for aged above 65 years is reported to be 18.9 years, 11 years and 7 years at 75, 85 and 90 years respectively.<sup>1,2</sup> In India, according to the Census, Registrar General of India, 2001 the elderly population since independence had increased from approximately 18.2 millions to 75.9 millions in 2001. The projected figure is likely to rise further by another 12.6% to almost 150 millions (projected figure World Demographic Estimate of population, United Nations, New York, 1988).<sup>3,4</sup>

This shift in demographics, especially in the developing countries like India, has created additional challenges for the medical personnels, as more than 50% of this older group will definitely need one or two surgeries in their life time.<sup>2,5</sup>

Although there has been advances in health care, pharmacology and technology, the chronological age is not considered a contraindication for any surgical intervention but the greater number of patients presenting with age related or coexisting diseases, definitely carry high risk of postoperative complications. In a study of abdominal operation in USA, the mortality rates for patients aged 80-84 years, 85-90 years and those above 90 years, was projected to be 3%, 9% and 25% respectively.<sup>4,5,6</sup>

Improvements in anaesthesia and surgical techniques have considerably reduced surgical mortality in general population but anaesthesia related mortality in older patients is still quite high. Anaesthesiologists, thus, need to prepare themselves for the new challenges and for this they must be fully aware of the potential alterations due to the age related reduced physiological reserves and the additional impact of the associated comorbidities.

This paper will consider the various age related physiological alterations and their implications on the anaesthetic management in the perioperative period in order to minimise the additional stress on the various organ systems.

The functional capacity of organs reduces with ageing, resulting in decreased reserves and ability to endure stress. Risk factors of ageing further multiply due to the coexisting disease. Additional risk factors in the elderly are major surgery, urgency of operation, ASA physical status and poor nutritional status. (table1)<sup>7</sup>

**Table-1 : Risk factors for postoperative mortality in elderly surgical patients**

ASA physical status	III or IV
Surgical procedure	Major and /or emergency procedures
Coexisting disease	Cardiac, pulmonary, diabetes mellitus, liver and renal dysfunction
Functional status	1- 4 METs
Nutritional status	Poor, albumin < 35%, anaemia
Place of residence	Alone or with family
Ambulatory status	Confined to bed

Various issues involved in geriatric surgical patients are the major organ involvement affecting their physiological reserves, preoperative assessment, perioperative care involving airway management, pharmacokinetics and drug administration, implications of anaesthetic drugs and techniques and the postoperative complications.

### Perioperative care

Number of age related diseases affect the various organ systems which will have implications on the perioperative outcome. The anaesthesiologist must possess adequate knowledge about the various coexisting diseases, their preoperative optimization and perioperative care.

### The important systems to be considered are:

- Cardio vascular system
- Respiratory system
- Hepato renal systems
- Central nervous system
- Musculo skeletal system and airway management

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### Cardiovascular system (CVS)

Physiological changes in the CVS are related directly to stiffening and decreased distensibility of systemic arteries and cardiac wall. Age related changes include.<sup>6,7</sup>

- Decreased cardiac output and stroke volume
- Reduced arterial elasticity and peripheral sclerosis
- Decreased size of sino atrial and atrioventricular nodes
- Increased sympathetic nervous systems activity and
- Sclerosis of the coronary arteries.

Cardiac output declines by 1% per year and is responsible for delayed absorption, onset of action and elimination of medications.<sup>8</sup> Since the elderly are unable to increase their cardiac output by increasing their heart rate because of the relative “hyposympathetic state”, due to declining receptor functions, they depend on their stroke volume increased intrinsically by increased preload (venous return) or extrinsically by sympathetic innervation. As the later is reduced in aged heart so cardiac output mainly depends on adequate preload to maintain cardiac output and blood pressure.<sup>10</sup>

Decreased elasticity of vessels results in increased peripheral vascular resistance, elevation of systolic blood pressure and left ventricular hypertrophy. Sclerosis of conduction system along with previous ischaemic events may result in conduction defects arrhythmias and sick sinus syndrome. Response to induction agents results in exaggerated effect on blood pressure. Elderly patients also have age related decrease in the heart rate, in response to exercise mainly due to a drop in the number of atrial pacemaker cells.<sup>9</sup> There is also a diminished response to atropine.

### Anaesthetic Implications

Should hypotension occur during induction of anesthesia it is managed in younger heart by a and b agonists, in addition to fluid management but as there is a decrease b - response in elderly with retained a response, selective a agonist such as metaraminol should be the drug of choice, in place of a/b agonists.<sup>11</sup>

Ventricular relaxation in hypertrophied heart is more energy and oxygen dependent. Mild degree of hypoxemia in the aged due to the declining partial pressure of oxygen, may, therefore, result in prolonged relaxation, higher diastolic pressure with diastolic dysfunction. As early diastolic filling is also impaired in the aged, maintenance

of preload becomes more dependent on the atrial click at the end of diastole. Loss of atrial contribution to preload can further lead to cardiac dysfunction. Diastolic dysfunction is responsible for almost 50% of the cases of heart failure. As there is no specific drug treatment for diastolic dysfunction, control of ventricular hypertrophy and hypertension should be the aim.<sup>12,13</sup>

### Pulmonary system

With advancing age there is progressive decline in the functional capacity of the respiratory system. This may decrease the ability to deliver more oxygen to the tissues. The prominent changes noticed in elderly are:<sup>12,14,15</sup>

Progressive decrease in chest wall compliance because of the structural changes in the rib cage, making the lungs more difficult to ventilate.

Changes in the respiratory mechanics and lung volumes because of the progressive decrease in the strength of respiratory muscles resulting in decline in maximum inspiratory and expiratory force.

Loss of elasticity will lead to increased alveolar compliance with collapse of small airways and subsequent alveolar hypoventilation, air trapping leading to ventilation perfusion mismatch.

### Dynamic lung volumes and flow rates are limited as seen by:

Forced vital capacity decreases by 14 -30 ml/year and forced expiratory volume at 1 sec is reduced by 23 - 32 ml/years after 60 years of age.

Ventilatory responses to hypoxia and hypercarbia fall by 50% and 40% respectively due to declining chemo receptor function at the peripheral or central nervous system level.<sup>16</sup>

There is a progressive decrease in T cells functions, mucociliary clearance and decrease in swallowing functions which predisposes the aged to higher incidence of aspiration.

### Anaesthetic Implications:<sup>5,7,11,12</sup>

Elderly patients adapt to the age related decline in physiological reserves until times of stress of surgery and anaesthesia. Loss of facial contours as a result of alveolar bone resorption and loss of dentition, may make the anaesthesia mask fit with difficulty.

Decreased number of alveoli with increased size may impair gas exchange. Blood oxygen content decreases 10% - 15% but carbon dioxide levels remain unchanged.

At rest the elderly patients have to work harder during respiration because of less compliant chest wall. An aged patient will thus struggle to adapt to hypoxia because of the limited capacity. Similarly respiratory challenge puts them at a greater risk of perioperative hypoxemia.<sup>11</sup>

Ventilatory response to hypoxemia and hypercapnia are decreased in the elderly so arterial blood gas monitoring will be more reliable sign in assessing the respiratory functions than the simple clinical signs of pulse rate, respiratory rate or blood pressure.<sup>16</sup>

Administration of premedication may increase elderly patient's risk for aspiration. Anti aspiration prophylaxis must be strictly observed with administration of sodium citrate, cimetidine hydrochloride and gastro prokinetics, metoclopramide hydrochloride.

Cervical arthritis may restrict the neck movements and make these patients prone to vertebro basilar arterial insufficiency.<sup>17</sup>

Postoperatively, age associated muscular weakness will reduce their ability to cough forcibly and remove secretions effectively. Thus chances of postoperative pulmonary complication are quite high. Combination of residual affects of anesthetics, prolonged effect of neuromuscular blocking agents and postoperative pain, can significantly contribute to these respiratory complications.<sup>9</sup>

Arozullah multifactorial risk index predicting postoperative pulmonary complication has been found to be most useful as the analysis covers procedure related risk factors in addition to the functional, nutritional status, age and coexisting pulmonary diseases.<sup>17</sup>

### Renal System<sup>5,18,19</sup>

Renal functions decrease with age. Physiological changes that accompany ageing are:<sup>18</sup>

Decreased renal mass (between 25 – 85 yrs) as evidenced by the decreases in glomeruli and nephrons by almost 40%. Renal blood flow falls by about 50% after 40 years of age.

Diminished renal blood flow due to reduced in cardiac output being the main reason for diminished renal functions.

The fall in glomerular filtration rate (45% by 80 years of age) is reflected by decline in creatinine clearance of 0.75 ml/min/year. Serum creatinine, however, is not

affected because of the simultaneous reduction in the lean muscle mass. Estimation of creatinine clearance by Cockcroft and Gault formula can be a better guide to assess excretion of drugs:<sup>21</sup>

$$\frac{(140 - \text{age in years}) \times (\text{weight in kg})}{72 \times \text{serum creatinine in mg/dl}}$$

The results need to be adjusted in very sick patients and females.

There is a marked decline in a subjective feeling of thirst but its cause is not well understood. Alterations in chemo-receptor functions in the hypothalamus may be responsible, as these do not respond to elevation in serum osmolality. Volume overload thus can occur because of the decrease in and functional impairment of the diluting segment of nephrons or associated elevation of antidiuretic hormone in the postoperative period.<sup>19</sup>

Decreased renal function is responsible for prolonged action of relaxants (doxacurium chloride, pancuronium bromide). Decreased tubular function and renin – aldosterone responsiveness affect fluid, acid base and electrolyte alterations, resulting in impaired conservation of sodium and decreased exertion of potassium. They are more prone to renal insufficiency, dehydration and renal failure.

### Practical aspects of fluid and electrolyte therapy<sup>21</sup>

“Rule of thumb” useful for assessment and treatment of fluid and electrolyte disturbances in elderly surgical patients is as follows:-

1. Water loss of 2kg or more is significant.
2. Elderly patients have higher risk for a given percent of saline depletion because of their limited homeostasis reserve.
3. In younger patients 4 L of saline are least before clinical signs of depletion are visible and 4 L saline are given before oedema develops. In elderly there is no such comparable estimate so monitoring of vital signs should be stressed.
4. Recommended rate of fluid administration depends on the type of fluid lost.

In water depletion, rapid replacement might result in cerebral oedema so half the deficit is infused in 24 hrs and the rest half in the next 24 - 48 hrs.

In case of volume depletion, benefits of rapid repletion may be partly offset by the risk of fluid overload.

### **Hepatobiliary System:**<sup>5,22</sup>

Decrease in number of hepatocytes with compensatory hyperplasia of cell size and proliferation of bile duct is seen with increasing age. Hepatic blood flow falls by approximately 1% per year to about 40% beyond 60 years.<sup>5</sup>

Several changes seen in the aged affect drug pharmacokinetics. These changes include decreased gastric motility, increased gastric pH, decreased hepatic blood flow and liver mass with reduced hepatic microsomal enzyme function.<sup>22</sup>

Delayed emptying time results in delayed medication absorption and high incidence of aspiration.<sup>5</sup>

Decline in hepatic blood flow due to atherosclerotic changes and decrease in microsomal enzyme activity, affect medications therapy for the drugs solely depending on liver for their metabolism and excretion e.g. fentanyl citrate, vecuronium bromide. Drugs requiring microsomal oxidation (phase I reaction) before conjugation (phase II reactions) are metabolised slowly, while those requiring only conjugation may be cleared normally. Drugs depending on hepatocytes such as warfarin, may produce exaggerated effects due to increased sensitivity of the cells. Increased incidence of cholelithiasis is reported in aged patients above 90 years.<sup>5,22</sup>

### **Body Composition:**<sup>5,8</sup>

There is a gradual increase in body fat, a decrease in lean muscle mass and strength, due to selective loss of muscle fibres and changes in growth hormone. Decreased activity and muscle mass is responsible for decreased energy expenditure by as much as 15% per year but magnitude of oxygen consumption and energy requirement after a period of stress is much less reflected in elderly as their BMR is low. With reduced exogenous energy supplementation, endogenous protein stores are mobilized and protein energy malnutrition may be seen specially during stress or infection.

### **Nervous system**

Age related changes in the nervous system effect cognitive, motor, sensory and autonomic functions due to neuronal damage, cerebrovascular diseases, reduced blood supply and degenerative diseases.<sup>23</sup>

Elderly patients easily enter into a state of confusion following stress of infection, dehydration, hypotension or by anaesthetic/surgical procedures. Simple steps like fluid maintenance, prophylactic antibiotic therapy and balanced surgical care reduce these incidences postoperatively.<sup>24</sup>

Autonomic dysfunction can pose potential problems resulting in blunting of the physiological compensatory response to hypotension and thermoregulation. The elderly are more prone to hypothermia. Shivering will increase further oxygen demand in elderly beyond their respiratory and cardiac capacity. Greater risk of hypothermia in elderly is observed, due to prolonged effect of anaesthetic following delayed hepatic and extrahepatic degradation and elimination (propofol). The elderly, must always be kept warm during the perioperative period.<sup>8,25</sup>

Postoperative delirium may be the manifestation of unrecognized preexisting disease, intraoperative or postoperative events or preoperative cognitive impairment, poor nutritional status, polypharmacy and advancing age.

Impairment of cognitive functions gradually increased with age. Cognitive dysfunction as presurgical condition or post operative complication can interfere with surgical outcomes.

The prevalence of baseline cognitive deficits is 1.5% in 65 – 70 yrs, doubles every 5 yrs thereafter, reaching 25% for those above 85 years. So preoperative assessment of cognitive impairment should be routine in all patients above 70yrs. Several simple methods of evaluation in elderly are available like Folstein Mini Mental status test or three item recall test.<sup>5,52</sup>

In 15-50% of elderly patients, postoperative cognitive dysfunction (POCD) and postoperative delirium (PD) are notable adverse postoperative outcomes. In view of this high incidence, a frank discussion with the patient and/or family member should be carried out and written informed consent obtained. Preoperative baseline cognitive status must be recorded for comparison with postoperative events.<sup>5,26</sup>

### **Pharmacokinetics in the aged:**<sup>10,11,27</sup>

#### **Drug distribution is altered because of number of reasons:**

- i. A reduction in total body water
- ii. An increase in body fat increasing the volume of distribution of lipophilic drugs like propofol, benzodiazepines, opioids - prolonging their half life and effects.<sup>10</sup>
- iii. Decrease in plasma proteins will allow larger unbound proportion of drugs with higher protein binding property like propofol, lidocaine and fentanyl.<sup>11</sup>
- iv. An increase in arm brain circulation time makes IV administered drugs take longer time to have its effects and must be given slowly and small bolus doses.

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### Preoperative Evaluation

Preoperative assessment plays a significant part in reducing postoperative complications. Knowledge of patients' physical status will guide the assessment of type and severity of the comorbid disease, type of monitoring required, preoperative optimization and give indications of postoperative complications.

Detailed medical history, physical examination, laboratory investigations and an assessment of surgical risk should be focussed during preoperative evaluation.

### Informed Consent<sup>37</sup>

The patient, family members or legal guardian should be apprised of the surgical intervention and possibilities of likely complications. Decisional capacity is a prerequisite for providing legally and morally sufficient informed consent. Elderly patient may not be fully aware of gravity of the intervention planned so, a close relative should be involved for obtaining detailed informed consent. Patients' mental acuity, cognitive status must be considered and documented.<sup>28</sup>

### History and Nutritional status<sup>5,9</sup>

Complete history of prior medical and surgical conditions and a detailed medication list should be noted as elderly are usually under multiple drug therapy.

As nutritional deficiencies are common in elderly, it should be accurately assessed. Complete blood count showing anemia, serum albumin level less than 3.2g/dl and cholesterol level less than 160mg/dl has been shown to be risk markers for adverse postoperative outcome.<sup>30</sup>

Body mass index of less than 20kg/m<sup>2</sup> in a frail elderly may be suggestive of increased morbidity due to delayed wound healing. Preoperative nutritional supplements should be considered.<sup>29</sup>

### Physical Examination

Although the elderly patients have a long medical history they normally do not try to give their details, considering it to be an inevitable consequence of old age. The physical examination should include detailed information regarding hydration, nutrition, blood pressure, pulse irregularities and systemic examination.

Assessment of preoperative mental status is critical as it normally reflects on the postoperative cognitive status. Preoperative dementia is an important predictor of poor surgical outcome.

### Preoperative investigations

Even a healthy elderly patient should undergo various test that will help determine the parameters of the patient's health and include.

- Full blood count: haemoglobin, lymphocyte count
- Urea, electrolyte and creatinine will give indications regarding renal functions as they gradually deteriorate with increased age. Creatinine clearance is an important index.
- Blood glucose and cholesterol because of high incidence of diabetes mellitus and atherosclerosis.
- Albumin levels and coagulation profile
- Electrocardiogram (ECG) should be ordered in all patients above 60 years, regardless of whether there is a history of cardiac ailment.
- Radiograph chest and pulmonary function tests in a patient with chronic obstructive pulmonary disease.
- Cardiology reference should invariably be sought.

### Systemic Evaluation

Preoperative evaluation of older patients should be directed towards identifying physiologic deficits and comorbid conditions that may increase the chances of postoperative complications. Perioperative plans can then be designed to minimize these deficits. However, complete detailed analysis should cover evaluation of functional, cognitive and nutritional status in addition to evaluation and optimization of the associated disease.

### Cardiovascular: <sup>5,31,32,33</sup>

Cardiac complications are among the most serious postoperative problems. The strongest predictors of adverse outcomes are recent myocardial infarction (MI), uncompensated congestive heart failure (CHF), unstable ischaemic heart disease and certain cardiac arrhythmias.<sup>7</sup>

Perioperative cardiac evaluation is done according to the American College of Cardiology (ACC) and American Heart Association (AHA) task force guidelines. The step-wise approach according to the clinical predictors, risk of operative and functional capacity has been proposed.<sup>32,33</sup>

- Major predictors are unstable coronary symptoms, decompensated CHF, significant arrhythmias and severe valvular disease; Intermediate predictors are mild
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angina pectoris, prior MI, compensated CHF, diabetes mellitus and minor predictors are advanced age, abnormal ECG rhythm other than sinus, low functional capacity, history of stroke and uncontrolled hypertension.

- Functional assessment: Assessment of the functional status is one of the most important means to predict postoperative outcome. American Society of Anaesthesiologists (ASA) physical status classification has been most reliable and accurate predictor of surgical mortality. In addition assessment of functional capacity is based upon energy expenditure. Activities required for 1-4 metabolic equivalents (METs) include daily routine work or walking 1-2 blocks on level ground while 4-10 METs include climbing stairs, walking up the hill, running, playing golf, squash or tennis.<sup>34</sup>
- Surgical procedures are categorized as high risk (major emergency operations, aortic or peripheral vascular surgery, prolonged procedures) with large fluid shifts or blood loss status). Intermediate risk procedures (Carotid endarterectomy, head and neck, orthopaedic, thoracic abdominal and prostate surgery) and low risk surgical procedures (endoscopies, skin and breast operations, cataract surgery).

All the patients are risk stratified and optimized according to the guidelines and cardiac condition.

#### a) Hypertension:<sup>33,35</sup>

In case of mild to moderate hypertension and no associated metabolic or cardio vascular abnormalities, the surgery should not be delayed. Antihypertension medications should be continued during the perioperative period and diastolic blood pressure of over 110 mm Hg requires control before surgery.

#### b) Congestive Heart Failure<sup>36</sup>

CHF is a major risk factor. In patients above 65 years, heart failure patients undergoing major noncardiac surgery carry very high morbidity and mortality where as coronary artery disease (CAD) without CHF carry same mortality as in general population. CHF and clinically significant arrhythmias require detailed evaluation and control prior to elective, noncardiac surgery.

A history of chronic congestive heart failure is an established predictor of adverse perioperative cardiac events. b type natriuretic peptide (BNP) is released into circulation when ventricular myocytes are overstretched. Level of

BNP depends on severity of the disease. Low levels (BNP < 100 pg/ml) needs CHF diagnosis to be ruled out while levels above 500 pg/ml needs urgent treatment of CHF.<sup>38</sup>

If digoxin is being selected as the drug of treatment for CHF serum level concentration between 0.5-0.8ng/ml are recommended. Concentrations greater than 1.0ng/dl do not provide any added benefit rather may be associated with higher mortality. Therefore, serum digoxin level must be tested in elderly taking digoxin 0.25mg daily.<sup>36</sup>

#### c) Arrhythmias:<sup>11</sup>

By the age of 80 years, sinus node cells are reduced to almost 10% thus increasing the risk of bradycardia and sick sinus syndrome. Prolonged P – R interval and decreased number of purkinje cells delay the conduction time in the A-V node. Incidence of atrial fibrillation (AF) is too high in geriatric population. Therefore, evaluation is done to rule out the presence of atrial clot. Perioperative therapy and anticoagulation therapy should be considered. Idiopathic degeneration disease may be responsible of various degrees of heart block and cardiologist must be involved if preoperative pacing is required.

#### d) Diastolic Dysfunction:<sup>37</sup>

Diastolic dysfunction has been found to show an increasing incidence with increasing age, even if ECG findings or ejection fraction are recorded normal. In patients with diastolic dysfunction, cardiac output does not increase with stress and CHF may be precipitated with atrial fibrillation or even minimal infusion. As no specific treatment exists, the diastolic dysfunction is managed by control of hypertension with diuretics, renin – angiotensin axis blockade and b blockade; control of heart rate with calcium channel blockers, b blockers, or digoxin in patients with atrial fibrillation; maintaining sinus rhythm with amiodarone, cardio version; preventing myocardial ischemia with b blockers, statins, aspirin, oxygen and reducing left ventricular hypertrophy.<sup>38</sup>

#### e) Coronary stents

The elective surgery should be delayed by 2 wks (preferably 4- 6 weeks) in patients who have had recent percutaneous coronary intervention (PCI). Two weeks allows the dissipation of antiplatelet therapy effects (clopidogrel or ticlopidine) and six weeks for endothelialization of injured lumen. Discontinuing the antiplatelet therapy, specially in eluted stents, for surgery increases the likelihood of perioperative myocardial infarction. Atleast aspirin should be continued if the surgery is unavoidable.<sup>39</sup>

#### f) Contrast induced nephropathy:

It is one of the common causes of acute renal failure in patients undergoing coronary angiography specially those with diabetes mellitus or preexisting renal insufficiency. An infusion of an isotonic solution of sodium bicarbonate from 1 hour before and until six hours after radio contrast exposure prevents or attenuates the renal damage.<sup>38</sup>

#### Diabetes Mellitus:<sup>6</sup>

Hyperglycemia with or without diabetes increases morbidity and mortality in patients with myocardial ischaemia. American Diabetic Association (ADA) recommends that hypoglycemic therapy is aimed at to keep pre prandial blood glucose levels between 80 – 120 mg/dl, bed time concentration between 100 – 140 mg/dl and haemoglobin A1C levels less than 7%. There are ample evidences that tight blood sugar control with insulin infusion, maintaining blood glucose between 80–150mg.dl intraoperatively and following ADA guidelines will minimise mortality and improve perioperative outcome.<sup>38</sup>

As the stress of surgery will increase hyperglycemia, it is important to start insulin regime on patients with type 2 diabetes mellitus after discontinuing the oral hypoglycemic regimes during the preoperative preparation.

It is recommended that sulfonyl ureas and metformin be discontinued the night before and on the day of surgery because they predispose the patients to lactic acidosis (metformin) especially during hypovolemic state and to myocardial ischaemia (sulfonyl ureas) if significant haemodynamic stress, hypertension or hypotension with tachycardia occur during surgery and anaesthesia.<sup>40</sup>

#### Pulmonary disease:<sup>5,14,17</sup>

Problems can be reduced if it is remembered that the perioperative opioid dose required for an elderly patient is much less than that for the younger adult. Short or intermediate acting neuromuscular blocking drugs are preferred and antagonists to reverse residual neuromuscular blocking drug effects are routinely used. In additions steps should be taken to reduce the incidence of likely postoperative pulmonary complications (PPCs) by a combination of adequate analgesia, early mobilization and supplemental oxygen for atleast 12 hours postoperatively or as indicated by pulse oximetry. Patients with active pulmonary disease (bronchial asthma, COPD) should undergo vigorous preoperative management and optimization before subjecting them for surgery.<sup>6,12,41</sup>

#### Smoking:<sup>38</sup>

Adverse effects of smoking include functional anaemia from carboxyhemoglobin, increased airway complication due to hyper reactive airway, bronchospasm, atelectasis, increased cardiopulmonary complications. Longer period of abstinence of more than 8–10 weeks will reduce the perioperative complications.

#### Intraoperative management

Intraoperative management is directed towards limiting the surgical stress and avoiding events that further deteriorate compromised reserves. No specific technique is universally approved for elderly patients but several interventions can improve the outcome.<sup>52</sup>

#### i. Preoperative evaluation and preparation

Preoperative administration of b blockers or clonidine.<sup>42</sup> According to revised cardiac risk index(RCRI) study of 782969 patients, one point each was allotted to intrathoracic, intraabdominal, suprainguinal vascular procedures, ischaemic heart disease, cerebrovascular disease, renal disease and diabetes mellitus. In patients with RCRI of 3 or 4, b blockers clearly reduced the risk, RCRI of 2 showed beneficial effects and in patients with RCRI of 0 or 1, their use was not beneficial or rather harmful but still it is suggested that, perioperative coverage of b blockers in geriatric patients be continued till the study gives clear cut verdict.<sup>5,7,38</sup>

Patients with CAD, peripheral vascular disease or soft cardiac risk indicators (age > 60 yrs, diabetes, hypertension, hypercholesterolemia and cigarette smoking) are advised b<sub>1</sub> selective agents like atenolol, a week prior to surgery, continued for at least 30 days postoperatively and then tapered or withdrawn slowly to avoid rebound phenomenon. If patient is unable to take b blocker (bradycardia, hypotensions 2<sup>nd</sup> or 3<sup>rd</sup> degree heart block, uncompensated CHF), clonidine, an α<sub>2</sub> – adrenergic receptor agonist should be the choice.<sup>7</sup>

#### ii. Perioperative administration of b blockers and statins:<sup>7,38,43</sup>

Evidence is now accumulating that in case of acute coronary syndromes the patients should receive b blockers along with the inhibitors of 3-hydroxy 3 methyl glutaryl coenzyme. A reductase, an enzyme involved in synthesis of cholesterol. Statins have been given to protect against plaque rupture and MI. Adverse effects of statins should be noted. ACC/AHA have defined four syndromes involving muscles associated with the use of statins: statin myopathy,

myalgia myositis and rhabdomyolysis. These syndromes should be sought for during preoperative evaluation and documented

### iii. Aspirin and aspirin withdrawal:

Aspirin is commonly administered as part of the treatment of several vascular diseases. The dose of aspirin depends on the disease involved. Low dose aspirin inhibits the cyclooxygenase activity of prostaglandin H synthase I (CoxI) and higher dose effects Cox I and Cox II. The beneficial effects of low dose aspirin is by blocking the synthesis of thromboxane A<sub>2</sub> but not prostacyclin. Antiplatelet effects of aspirin can only be reversed through the regeneration of new platelets (life cycle 9 days) or platelet transfusion. It is no longer routine to discontinue aspirin therapy preoperatively, particularly when administered to patients with known coronary artery disease with a dose less than 75mg per day.<sup>12,44</sup>

### Preoxygenation

Although four deep breaths of 100% oxygen within 30 seconds is an acceptable technique to preoxygenate in younger adult patients, it is not as satisfactory in geriatric patients because desaturation occurs faster in older patients. The time to peak relaxation following neuromuscular blockade is delayed with increasing age and the elderly are more prone to have a cardiac event from desaturation. A technique that seems to provide maximum oxygenation in the shortest period requires eight deep breaths of 100% oxygen within 60 seconds with an oxygen flow of 10 L per minute.<sup>45</sup>

### Induction of Anaesthesia:<sup>6,15,22</sup>

Considerations for administration of general anaesthesia in elderly are:

Aggressively preoxygenate,<sup>45</sup> ED 50 equivalent for inhalational anaesthetics falls linearly with age therefore, the dosage of drugs effecting CNS need be reduced, anticipate drug synergy. Concurrent use of propofol, midazolam opioids, increase the depth of anaesthesia. Hypotension is very common so the dosages of these agents should be titrated. Short acting drugs should be selected, stimulation of tracheal intubation does not offset hypotension in elderly patients.

Peak effects of drugs administered is delayed: midazolam 5 mins, fentanyl 6-8 min, and for propofol 10 minutes. To minimize the depth and duration of hypotension, the dosages are adjusted downwards to 1.0-1.5 mg/kg lean body weight (LBW) for propofol

without opioid supplementation and 0.5-1.0mg/kg when opioids are given simultaneously specially when low dose ketamine and midazolam are also included.

Aspiration prophylaxis : Use of aspiration prophylaxis and rapid sequence intubation (RSI) should be practiced routinely, specially in patients with diabetes mellitus or oesophageal reflux disease and emergency procedures.

Anticipate prolonged duration of neuromuscular drugs that undergo organ based clearance. Intermediate acting agents become longer acting with increasing age (except atracurium and cisatracurium), decreasing body temperature, diabetes and obesity (if dose is calculated on total body weight) and result in increased density of neuromuscular blockade. Dose of anticholinesterase inhibitors should also be reduced accordingly and patients strictly observed in the post-anaesthesia care unit (PACU) for any sign of recurarization.<sup>66</sup>

Non-steroidal anti-inflammatory drugs (NSAIDs) for postoperative pain relief should be given in reduced doses to avoid complications such as gastritis, acute renal failure NSAIDs should be avoided in elderly patients with preoperative deranged renal functions (raised urea/creatinine levels) or if the patient is hypovolemic.<sup>34</sup>

Inhalational agents : The minimum alveolar concentration (MAC) of all inhalational agents is reduced by about 4-5% per decade above 40 years of age. Therefore, elderly will require less volumes of inhalational anaesthetics to reach the same level of unconsciousness as in younger patients. Less insoluble inhalational agents such as sevoflurane and desflurane, undergo minimal metabolism and are mostly excreted unchanged by the lung. There is a strong perception that it is better to administer sub MAC concentrations of potent inhalational agents and to use  $\beta$  blockers to control hypertension than to use supra MAC concentrations. Maintain the bispectral index between 50 - 60 rather than 45.<sup>7,47</sup>

Thoracic epidural anaesthesia and local anaesthetics reduce MAC and MAC awake by as much as 50%. Lower concentrations of inhalational agents are required during combined epidural - general anaesthesia for endotracheal tolerance and prevent intraoperative awareness. Emergence may be prolonged if same MAC inhalational agent concentration is maintained during CSE/general anaesthesia.<sup>7,15</sup>

### Regional Versus General anaesthesia:<sup>15,34,53</sup>

Concerns with the geriatric patients regarding regional anaesthesia are:

- Increased sensitivity to local anaesthetics, Increase risk of persistent numbness, nerve palsies and neuralgic complications, increased duration of block, higher level of block, greater degree of hypotension and bradycardia even with similar dose as in younger adults, Dramatic reduction in sedation requirement with central neuraxial block is observed.<sup>49</sup>

Regional anaesthesia blocks the stress response to surgical stimulus provided nutritional status and normothermia are maintained. It also limits central sensitization, reduces the requirement of postoperative opioid analgesics and improve pulmonary, cardiac and renal outcomes while reducing the incidence of thromboembolic complications. The review by Rodgers et al observed, reduction in 30days mortality and deep vein thrombosis (DVT) in regional group.<sup>49,50</sup>

### Hypothermia:

In general surgery can cause hypothermia due to environmental factors and anaesthesia induced inhibition of normal thermoregulatory mechanisms. Elderly are more at a higher risk of becoming hypothermic because of anaesthetic induced altered thermoregulatory mechanisms and their low basal metabolic rate. Intraoperative hypothermia is found to be an independent cardiac risk factor for postoperative cardiac events in elderly. Therefore, in elderly patients every effort should be made to prevent heat losses. Steps to prevent hypothermia are:<sup>6</sup> Prepping preoperatively and cleaning postoperatively with warm solutions, using warming systems, warming IV fluids, keeping the environmental temperature warmer, Covering the patients with blankets before and after the surgery.

### Fluids<sup>5, 6, 19, 20</sup>

Managing appropriate intravascular volume is essential by avoiding over and under fluid administration. Because of the increased after load presented by stiffened vascular system, decreased inotropic or chronotropic responses and impaired vasoconstrictor responses, the elderly depend on adequate preload. Elderly are also prone to dehydration because of illness, use of diuretics, preoperative fasting and lack of thirst response. Liberal oral intake of fluids up to 2 – 3 hours preoperatively, and adequate maintenance fluid therapy while withholding diuretic therapy preoperatively can avoid sudden hypotensive events soon after induction of anaesthesia.<sup>6</sup> Over hydration should also be avoided in elderly compromised heart because they are more prone to systolic failure, poor organ perfusion and reduced GFR.<sup>20</sup>

Central venous or pulmonary artery catheters to measure central blood volume specially in those elderly who are likely to have large blood volume losses or fluid shifts is an essential intraoperative monitoring. Central venous pressure in the range of 8 – 10 and pulmonary artery pressure of 14 – 18 mm Hg is necessary to maintain adequate cardiac output.<sup>20</sup>

### Postoperative Management

Increased incidence of postoperative morbidity and mortality has been reported. Pedersen et al found that morbidity and mortality in the first 24 hours and over the next six postoperative days was twice and 10 fold more frequent than seen intraoperatively.<sup>51</sup>

Age related changes in respiratory mechanics and control of respiration accentuated by pain, anaesthetics induced effects, fluid shifts and atelectasis put these patients more prone to respiratory complications.<sup>7</sup>

Alterations in pharyngeal functions, diminished cough reflex, aggravated by the effects of anaesthetics, pharyngeal instrumentation and site of surgery, can increase the chances of postoperative aspiration in the elderly. Focusing on appropriate reversal of neuromuscular blocking drugs, use of nasogastric tubes, restoration of pharyngeal and laryngeal reflexes, gastrointestinal motility and early ambulation with advancement of feeding after surgery can minimise the adverse incidences of postoperative aspiration.<sup>34,54</sup>

Acute pain management is very important in the elderly surgical patients as the postoperative pain can produce most harmful effects. Inadequate pain control can increase morbidity and mortality in the elderly because of the associated comorbidities like ischaemic heart disease, decreased ventilatory reserve, altered drug metabolism, effects and excretion.

For acute postoperative pain, IV morphine titration using the similar protocol of the elderly (> 70 years) and younger patients appears safe. Two to three milligrams of IV morphine every 5 minutes for visual analog score of greater than 30 has been shown to provide adequate pain relief. Short acting opioids fentanyl or sufentanyl and intensive pain management strategies by intermittent boluses or patient controlled analgesia (PCA) parenterally or by central neuraxial blockade has been found to be most beneficial in high risk elderly patients or low risk elderly patients undergoing high risk surgery by reducing the stress response to surgery and early ambulation.<sup>15,46</sup>

Postoperative delirium and or POCD affects 5 – 50% of elderly patients. The onset of delirium typically presents

after 24 – 72 hours postoperatively and persists for about a week, prolonging hospital stay and reducing the functional reserve further. Cognitive dysfunction has also been observed very frequently with transient or prolonged memory impairment. No single cause has been found to be responsible for triggering delirium or POCD as narcotics, sedatives, anticholinergic, infection, general or regional anaesthetic techniques, all have been blamed. Hospitalization, pain, sleep deprivation and an unfamiliar environment may be the contributing factors.<sup>55,56</sup>

Therefore, a broad based multidisciplinary approach to plan perioperative management in the elderly surgical patients shall be most helpful. This can serve as a foundation for organizing comprehensive evidence based geriatric perioperative care and might be beneficial in preventing postoperative complications specially cardiac, pulmonary or delirium/cognitive dysfunction, significantly.

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