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Geriatric cardiac anesthesia: Review

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In 2005, cardiovascular disease (CVDs) was the leading cause of death. It was responsible for 30% of all deaths, or about 17.5 million people, followed by cancer 7.6 million deaths , and chronic respiratory diseases 4.1 million deaths. By 2015 almost 20 million people will die from CVD. Life expectancy in the USA for 2007 is 78.0 years; in males it is 76.2 years and in females it is 80.97 years[1]. Increased life expectancy continues to increase the number of elderly patients subjected to anesthesia and cardiac surgery. The aging of the population and the decrease in adult mortality seen in the last decade will increase the average age of Americans between the years 2010 and 2030. During that time the population older than 65 years is expected to grow by 75% and, Americans over 85 years will be the most rapidly growing segment of the nation[2]. The implications of an aging population for the clinical practice of anesthesiology, surgery and critical care are well recognized[3].

There is no exact definition of «geriatric», «aged», «elderly» and «advanced age».

As aging is accompanied by a general decline in organ function, actual biological age is the result of the interaction between chronological age and concomitant diseases associated with changes in organ function. Chronological and biological age may differ considerably[4,5]. Chronological age is most commonly measured and is widely used in clinical practice. Medicare, the most important payer of health care for older adults in the United States, sets its current eligibility threshold at 65 years of age. Because the average life expectancy has dramatically increased, it is proposed to categorize older adults into the young-old (aged 65 – 74 years), the mid-old (aged 75 – 84 years), and the oldest-old (aged 85 years and above), with different levels of clinical risk among these groups[3-5].

Thorough preoperative assessment, optimal preparation, and identifications of the risk factors for perioperative morbidity and mortality in the geriatric population is critical. Age related changes in co-morbidities and altered pharmacokinetics and pharmacodynamics impacts every aspect of anesthetic management, monitoring, medication, postoperative care, and outcome. Current medical history and physical activity is a good predictor of postoperative outcome[3,5].

THE RISK FACTORS

Risk factors for adverse outcome following cardiac surgery are complex[5-13]. Rankin et al reviewed 409,100 cardiac surgical procedures from the database from the Society of Thoracic Surgeons) performed between 1994 and 2003[7]. Of these patients, 216,245 patients had isolated aortic valve replacement, with unadjusted mortality 5.7%. The primary causes of mortality were cardiac (60.3%) pulmonary (8.9%), neurologic (8.2%), infection (6.4%), and renal (3.3%). Nineteen variables independently influenced operative mortality. The most significant was emergency surgery (odds ratio, 2.11), followed by advance age (odds ratio, 1.88), and reoperation (odds ratio, 1.16). Of the preoperative comorbidities, the renal failure was the greatest risk factor for perioperative mortality while reduced ejection fraction was less important (odds ratio, 1.19). The most common perioperative morbidities were atrial fibrillation (27%), prolonged mechanical ventilation (14%), renal failure (7.1%), reoperation for postoperative hemorrhage (5.5%), and heart block (5.2%). In the discussion, the authors stated that the study produced many more questions than answers. Cardiac clinicians should redouble their efforts to emphasize earlier surgical indication to avoid urgent and emergency surgery. There are several reports informing the public about outcome data, for individual surgeons for specific surgical procedure. Some reports have been criticized for encouraging risk adverse behavior[8].

Strokes result in prolonged hospital stay and increased rate of disability, discharge to long-term care facilities,

and death after cardiac surgery. The incidence of perioperative stroke depends on the type and complexity of the surgical procedure. Cardiac and vascular surgeries are associated with higher risk compared with other operative procedures. About 45% of perioperative strokes are identified within the first day after surgery. Delayed strokes are often attributed to embolism, atrial fibrillation or coagulation disorders. The incidence of stroke varies according to surgical procedures: isolated coronary artery bypass surgery (1.4-3.8 %), isolated valve surgery (4.8 – 8.8%), double or triple valve surgery (9.7%), and aortic repair (8.7%). More strokes occur after emergency surgery than elective surgery. Boeken identified previous neurological events, advanced age, and the time of aortic cross-clamping as significant risk factors for neurological complications following coronary artery bypass surgery[9]. Despite advances in surgical and anesthetic techniques, improvements in monitoring and perioperative care, strokes have not decreased, reflecting the aging of the population and the increased number of elderly patients with coexisting conditions who undergo cardiac surgery[3-6,10-17].

Postoperative neuro-psychological and cognitive dysfunctions are recognized as a significant issue facing elderly patient . Cognitive dysfunction, following cardiac surgery, is the most common neurological complication, affecting more than 30% of patients. The finding of a relationship between early and long term cognitive complications need further clinical studies[5-8,17-19].

AGE RELATED CHANGES IN ORGAN SUBSYSTEMS RELEVANT TO CARDIAC ANESTHESIA

In general, skin begins to wrinkle and hair turns gray. Usually the process of aging decreases the volume of body fluid and increases fatty tissue, predisposing the elderly to gain weight. However, the very old (over 85 years) tend to decrease weight. Life style and habits, such as diet, exercise, cigarette smoking and alcohol use may also influence this aging process[2,3,5,10].

DENTAL

An experienced dental examination is critical in the geriatric population. Rotting teeth, oral infection and other dental pathology must be identified and addressed prior to elective surgery[20].

CENTRAL AND PERIPHERAL NERVOUS SYSTEM

Both the central and peripheral nervous systems are affected by aging. There is a decrease in the volume of the cortical gray matter and thalamus. In comparison, the white matter, volume of cerebrum, cerebellum, corpus callous, and pons remain fairly intact up to very old age. Aging increases intracranial cerebrospinal fluid volume with resultant non pathological low-pressure hydrocephalus. There is a substantial age-related decline in brain function with a variety of neurological impairments (deficit of memory, impairment in cognitive and intellectual function, sleep disturbances, deficit in sensory input, visual, taste, acoustic, smell; gait, mobility and psychiatric disorders.

The major central nervous system diseases in the elderly are: depression, dementia, delirium, confusion and Parkinson's disease. The aging of the autonomic nervous system is characterized by progressively limited capacity to adapt to stress and other changes. Reduced autonomic ability may influence how the geriatric patient to responds to anesthesia. There is evidence that activity of the parasympathetic nervous system decreases with age. Aging results in the reduction in vagal modulation of the heart at rest. This decreased responsiveness of the autonomic nervous system may influence the geriatric patients' response to acute hemodynamic challenges. Syncope and orthostatic hypotension are common in the geriatric and are worsened by the presence of diabetes[3,5-7,21-24].

Thermoregulation is effected by autonomic impairment and by a variety of chronic medications. The overall effect of their condition includes inappropriate heat production and conservation, increased heat loss, and reduced heat tolerance. As a consequence, the elderly are very vulnerable to hypothermia[3,5,17,25].

Pre – existing neurological deficits and a history of transient ischemic attack, stroke, seizure and Parkinson's disease should be specifically noted and documented, because neurological complications are frequent following cardiac surgery. Carotid angiography or duplex studies may be appropriate in selected elderly patients. Carotid angiography or duplex studies may be appropriate in elderly selected patients. Cerebral imagining using CT or MRI remains the gold standard for defining cerebral pathology In addition to the preoperative history and neurological assessment it is important to evaluate the degree of dementia, level of cognitive function and risk of stroke[2,5,10,17]. In many institutions pre and multiple postoperative neuropsychological and cognitive evaluations by an experienced consultant is routine[18,19,26-28].

RESPIRATORY SYSTEM

Age-related changes in the pulmonary system result in a decline of elasticity of all structures of the thorax. This decrease in elasticity decreases respiratory reserves and the area of alveolar gas exchange surfaces. These changes have mechanical, functional and anatomical consequences[2,5]. Residual volume

and functional residual capacity both increase with age at the rate of 5-10% and 1-3% per decade, respectively. There are reductions of the forced expiratory volume, a decrease in ciliary function, and force of cough. Pharyngeal sensitivity and motor function needed for swallowing are also diminished.

Many geriatric patients for cardiac surgery have a history of smoking and chronic obstructive pulmonary disease . A recent report from a large-volume institution found respiratory failure with prolonged intubations to be the most common complication after cardiac surgery in elderly. A preoperative chest radiograph documents the baseline appearance of the lungs, and allows for recognition of the deviated trachea and left main stem bronchus, which may complicate the placement of endotracheal tubes in general and double lumen endotracheal tubes in particular. Use of fiberoptic guidance may prevent tracheal trauma, since geriatric patients may have a fragile respiratory tract[3,5,10,29,30].

History of dyspnea, stridor, cough and hemoptysis should be defined during preoperative evaluation. Bacterial evaluation of sputum may influence perioperative antibiotic prophylaxis. Baseline arterial blood gas analysis and pulmonary function testing may predict post-operative ventilator dependence. Preoperative hoarseness may be due to recurrent laryngeal nerve palsy, which may predispose these patients to aspiration; rehabilitation should be considered at an early stage[3,5,17].

CARDIOVASCULAR SYSTEM

Most patients will have coexisting hypertension and both central and peripheral atherosclerotic disease; coronary artery disease with myocardial ischemia is common. Congestive heart failure as a result of systolic or diastolic dysfunction may be present. Detail preoperative cardiac studies should include resting ECG, stress tests, echocardiograms, cardiac catheterization, and other specific tests according to patients' exercise reserve, major and minor risk factors for perioperative adverse cardiac outcome, and proposed surgical intervention. The American College of Cardiology (ACC) and the American Heart Association (AHA) have developed detailed guidelines for cardiovascular evaluation[3,5,10,31-33].

Heart failure represents a clinical syndrome that can not be delineated by a specific diagnostic test, but is dependent on diagnosis by history and physical examination. The chief clinical components of heart failure are dyspnea, fatigue and fluid retention. In the elderly, atrial fibrillation is the most common sustained cardiac dysrhythmia.

The use of cardiac rhythm management devices in the geriatric population is common. When a patient presents with a device, the preoperative assessment should define the indication for device placement, determine the exact device placed and functionality, and finally define the patients' dependence on the device. Electromagnetic interference during surgical procedures should be defined and the availability of emergency pacing and defibrillation need to be identified. If perioperative electrocautery will be used, pacemaker dependent patients should have their pacemakers reprogrammed for asynchronous pacing; ICD should have their anti-arrhythmic functions programmed off[3,5,33-36].

RENAL SYSTEM

Renal mass diminishes with aging with renal blood flow decreasing approximately 10% per decade with a resultant decreases in glomerular filtration rate. By the eighth decade up to 30% of remaining nephrons are sclerotic. Even in the absence of renal disease, serum creatinine remains relatively constant during aging and thus serum creatinine levels may not accurately reflect renal dysfunction. The relationship between aging and chronic renal failure remain unclear. The elderly are at increased risk of developing hyperglycemia before the onset of end stage renal disease. This may be due to decreased in rennin synthesis and impairment of renin release. The aged kidney has difficulty in maintaining circulating blood volume and sodium conservation. Fluid homeostasis is complicated by alterations in thirst mechanism and antidiuretic hormone release, which frequently resulting dehydration. Metabolic acidosis in elderly patients is due to less efficient renal excretion of acid[3-6,10,37].

Hyponatremia is more common in the geriatric population, occurring in 10% of hospitalized patients. It may occur as a result of diuretic- induced renal dysfunction, age induced higher level of ADH secretion, or impaired ability of the aging kidney to remove free water. Other causes of hyponatremia include inadequate dietary sodium or increased sodium loss from vomiting or diarrhea in hospitalized elderly patients. Symptoms are commonly related to the central nervous system. Acute hyponatremia is usually associated with dehydratation and should be treated aggressively.

Total body potassium declines with age, but hyperkalemia is more common in geriatric population. The elderly are at increased risk of developing hyperglycemia before the onset of end stage renal disease. This may be due to decreased renin synthesis or impairment of renin release. Changes in serum potassium may result in dysrythmias[3,5,37,38].

Renal dysfunction is common after cardiopulmonary bypass, particularly when perfusion time is prolonged and multiple blood and blood products transfusion are required. Patients with aortic aneurysmal involvement of the renal arteries, those with preoperative renal dysfunction, and those with a history of congestive heart failure may be at the highest risk. Routine preoperative tests should include a measurement of blood urea nitrogen and creatinine, and it may be prudent to defer elective cardiac surgery until laboratory values have been normalized.

Preoperatively fluid management can have a great influence on postoperative renal malfunction. Intraoperative renal protective strategies, including diuresis with furosemide or mannitol, and low-dose dopamine, remain the subject of on-going clinical debate. An association between the use of aprotinin and renal dysfunction remains controversial[39-42].

HEPATIC SYSTEM

Aging has been shown to be associated with variety of changes in the hepatic function. No age-specific alteration in conventional liver chemistry such as serum billirubin, serum aminotranserases, hepatic alkaline phosphatase, and other liver tests are seen. Both hepatocyte mass and liver blood flow are reduced in the elderly. Proteins are produced by the liver, and many show slow changes with aging. A decrease in the serum albumin and an increase in alpha glycoprotein are commonly seen in the elderly[3,5,10].

ENDOCRINE SYSTEM

Aging alters endocrine function and changes may be very important for anesthetic management. Evidence for hyperthyroidism should be sought and elective cardiac surgery need to be postponed until a euthyroid state is achieved. Continuation of thyroid hormone replacement is recommended in patients with hypothyroidism. Parathyroid disease in elderly may cause alterations of calcium with resultant changes in ST segments and QT intervals or chronic hypokalemia. Diabetes is one of the known risk factors for adverse outcome in cardiac patients, particularly in the geriatric population. Management of hyperglycemia is very important not only during the perioperative period, but also during the postoperative care[3,5,17,43,44].

HEMATOLOGICAL SYSTEM

With aging hemopoetic mechanisms are depressed. Hemastatic competency is critical for all cardiac operation, but particularly in geriatric cases, where tissue fragility and atherosclerosis may cause increased bleeding. Coagulopathy is a common occurrence after any procedure with cardiopulmonary bypass and is particular troublesome with long cardiopulmonary bypass time or deep hypothermia. Before cardiac surgery, it is routine to discontinue antiplatelet medication and warfarin. Hematological and coagulation parameters should be optimized preoperatively. Blood conservation strategies, such as with antifibrinolytics, use of cell saver, preoperative autologous blood donation, hemodilution when appropriate, should be considered. According to recent reports, controlled hemodilution may influence outcome. The low perioperative hematocrit may cause organ hypoxemia and renal failure. Point of-care tests, thromboelastography, platelet count and other tests can be used to guide post perfusion transfusion of fresh frozen plasma, platelet or other clotting factors[3-5,10,40,45].

In patients where heparin was used prior to cardiac surgery, heparin induced thrombocytopenia (HIT) with severe complications may occur. In patients, where heparin induced thrombocytopenia is known, alternative anticoagulation should be used[46-48].

The clinical effect of antifibrinolytics is recently discussed[41,42].

Perioperative issues and intraoperative management.

Admission to the hospital on the day of surgery has become standard for most elective surgery, including the geriatric population. An immediate pre-operative assessment of the patient is mandatory to assure there have been no interval changes (such as dehydratation, fever, mental disturbance or other acute medical symptoms) from the time of the initial anesthetic evaluation. Perioperative administration of beta-blockers has been shown to reduce cardiac morbidity and mortality[3-7,49,50].

In addition to the routine monitors for cardiac surgery, it is prudent to establish continuous arterial pressure recording before induction of anesthesia. The pulmonary artery catheter is inserted on an individual basis. Additional pharmacological adjuncts for central nervous system protection e.g.,steroids and beta-blockers should be administered prior to induction of anesthesia. Antibiotics prophylaxis should be administered prior to skin incision[3,5,31].

Anesthesia and endotracheal intubation should be induced, performed, and maintained with consideration of the pharmokinetic and pharmacodynamic changes associated with aging. Hemodynamic stability should be maintained. Transesophageal echo is a useful monitor of cardiac function, may confirm supplement preoperative diagnostic information and to assist with the deairing of the cardiac chambers[3,5,10,17,31,36,51,52].

In general, an aggressive surgical approach after optimal preoperative preparation, offers benefit in the geriatric group of patients. The age should not be a deterring factor for indicated cardiac surgery. Additional clinical research in cardiac geriatric anesthesia (preoperative optimization of the patient, brain protection, improvements in surgical and perfusion techniques, prevention of complications, new discoveries in organ protections) will further improve outcome[3,10,31,50,52-54].

Ethical challenges in the geriatric cardiac patients face special medical ,social and economical issues. The basic principle of respect for patient autonomy requires that medical decision will be made by the patients . Physician can provide information and recommendation to the patient. Informed consent is an important legal document[3].

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