Review Article

Geriatric Trauma

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Abstract

Age associated decrease in physiological reserve may lead to varied responses to trauma in the elderly population. In this article, we have reviewed the salient features of geriatric trauma including anatomic, physiologic, and pharmacologic changes with aging, as well as associated co morbidities affecting the outcome of the elderly trauma patients. Moreover, the patterns of common injuries, pre-hospital and emergency department evaluation, initial resuscitation, and anesthetic managements of these patients have been discussed. Recent advances having an impact in the care of the elderly injured patients are discussed with the hope that this will assist the trauma clinicians to become more caring towards the senior citizens.

Keywords: Trauma, Geriatric, Elderly, Injury

(Journal of The Indian Academy of Geriatrics, 2017; 13:32-40)

INTRODUCTION

Currently, life expectancy in elderly population is longer than ever before in India due to improved knowledge regarding medical management in this group of patients. According to 2011 census of India, the proportion of total population belonging to the age group 65 years and above is 7.5%.[1] and the projected population by 2025 is 12%.[2] Presently, geriatric population is more active than previous generations of elderly, using rashly driven public vehicle, even many driving into their 80's and pursuing a variety of activities that increase their exposure to traumatic injury.

Unintentional injury is the 5th leading cause of death among geriatric age group in the U.S.[3] Age 65 years or older is associated with a 2.46 fold increased likelihood of early (< 24 hours of injury) mortality and 4.64 fold increased risk of late (> 24 hours of injury) mortality.[4] However, more favorable long-term outcomes, with up to 85% of survivors function independently at home as long as 6 years postinjury.[5] Thus, advanced age should not be used as the sole criterion for limiting treatment in the geriatric trauma patients. Instead, with a thorough understanding of the pathophysiology of aging, trauma care team can contribute significantly in resuscitation and management of the traumatized victims, thereby reducing the morbidity and, mortality in this age group.

METHODS

A thorough Pub Med and Medline search was performed for all publications with the key words trauma, injury, geriatrics, and elderly. Complete manuscripts were studied. Only those that reported on human subjects in English language were included. Publications included review articles, guidelines, prospective randomized trials, and retrospective studies in last 25 years. Case series and case reports were excluded.

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Physiological changes with aging

Aging can be defined as an universal and progressive physiologic process characterized by declining end organ reserve, decreased functional capacity, increased imbalance of homeostatic mechanism and increased incidence of pathologic processes.[6] Even relatively fit older persons have reduced physiological reserve compared to their younger counterparts. For each 1 year increase in age over 65 years, the odds of dying in trauma victims increases by 6%.[7]

Cardiovascular

Progressive stiffening of arterial tree with aging leads to systolic hypertension and eventually ventricular hypertrophy.[8] Hypertrophy slows diastolic relaxation. The left ventricle becomes more dependent on the left atrium in order to preserve diastolic filling. This phenomenon, called diastolic dysfunction, increases in severity with age.[9] Since elderly trauma patients have decreased response to ß receptor stimulation, the ventricles depend more on adequate end-diastolic volume to generate enough contractile strength.[10] Furthermore, veins stiffen with age and any reduction in venous blood volume can cause change in cardiac filling.[11] Thus, hypovolemic shock is less tolerated in the elderly.

Respiratory

Aging leads to decreased strength of the respiratory muscles, progressive loss of alveolar surface area, impaired nervous control of ventilation, and a reduction of the elastic recoil of lung tissue combined with stiffening of the chest wall.[12] The end result is increase in closing capacity and ventilation perfusion mismatch.[13] These changes coupled with reduction of alveolar surface lead to decline of resting arterial oxygen tension with age.[14] The chest becomes more barrel shaped with flattened diaphragm. The diaphragmatic efficacy is also impaired by a significant age-related loss of motor neurons. There is impaired mucociliary clearance of bacteria, reduced cough reflex and strength, increased oropharyngeal colonization with gram-negative bacteria and higher risk of aspiration. All these make elderly trauma victims more prone to nosocomial and ventilator-associated pneumonia.[15]

Central Nervous system

There is gradual cortical atrophy and reduction of brain volume with aging.[16] Subdural space is increased as the atrophied brain pulls away from the tightly adherent dura to the skull. This puts the parasaggital and branching veins under tension and more susceptible to rupture.[17] Assessment of Glasgow Coma Scale (GCS) may be difficult due to the presence of dementia or impairment of hearing. Since the increased subdural space can accommodate more blood volume before the physiology of pressure-volume relationship gets altered, an elderly trauma victim may remain asymptomatic at the time of initial assessment after traumatic brain injury.[18]

Renal

There is progressive reduction in renal mass with diminution of glomerular filtration rate.[19] Corresponding reduction in muscle mass means that serum creatinine is not a good surrogate marker of renal function. Hence, "normal creatinine" in an elderly patient may actually reflect a significant reduction in renal function. The ability of the aged kidney to handle sodium and water homeostasis is reduced particularly during acute injury. Urine output is less reliable marker of renal perfusion in the elderly.

Metabolic, Endocrine & Thermoregulation

Decreased secretion of insulin and increased resistance to it leads to glucose intolerance in the elderly.[20] Hyperglycemia is a poor prognostic factor in traumatic brain injury.[21] Cold environment, exposure and large volume of resuscitation with cold fluids make elderly traumatized victims prone to hypothermia owing to their reduced ability to vasoconstrict and shiver in response to cold.[22]

Immune System

An elderly trauma victim is more susceptible to develop multiple organ failure due to reduction in cell mediated immunity and antibody response to stimuli.[23]

Musculoskeletal & Skin

Older individuals are more vulnerable to the risk of fracture especially hip and distal forearm even after minor trauma than their younger counterparts primarily due to osteoporosis which is a common feature of aging.[18] Skin becomes more fragile and prone to breakdown in patients on immobilization after trauma.[24]

Pharmacologic alterations with aging

Both pharmacokinetic and pharmacodynamic changes are involved in the altered impact of drugs on the elderly.[25]

Lean body mass decreases with age as does total body water, while total body fat tends to increase. The combination of decreased total body water and redistributed cardiac output tends to decrease the size of the central compartment, potentially increasing peak concentrations even though steady state volume increases due to increased body fat.

Both aging and anesthesia decrease liver blood flow, and thus decrease the maintenance dose of the anesthetic agent. Renal blood flow is inversely correlated with age, and there is a progressive decrease in the glomerular filtration rate with aging.

Receptor sensitivity for specific drugs is highly variable with age, which has an impact on the requirements for essentially all the drugs used by anesthesiologists. Need for anesthetic drugs may be altered due to the presence of various injuries and co morbidities.

Preexisting medical conditions and drug therapy

Use of beta blocker for treatment of hypertension and coronary artery disease in elderly trauma victims is associated with higher mortality.[26] Tachycardia in response to hypovolemia may be absent in patients with beta blocker therapy and thus resuscitation may be delayed.

Older individuals with traumatic brain injury (TBI) using warfarin, aspirin, and clopidogrel for treatment and prophylaxis of cardiovascular diseases require close monitoring even without depressed Glasgow Coma Score (GCS) or overt neurologic symptoms. Warfarin therapy is strongly associated with worse outcome in head injury patients.[27]

Mechanisms of injury

Falls remain the leading causes of both fatal and nonfatal injuries in persons older than 65 years in the United States in 2013.[28] Elderly persons who fall have high injury rate (up to 71 per cent), high admission rates (up to 57 per cent) and mortality (up to 25 per cent).[29,30] The most common injuries are fracture(femoral neck, upper extremities and pelvis), soft tissue injuries and lacerations.[29]

Traffic accidents due either to motor vehicle collisions (MVC) or pedestrian hit by automobiles (PHBA) are the second most common mechanism of injury in the elderly. Mortality is greater than 25 per cent among the victims of over the age of 65 years in case of PHBA.[31]

Domestic fire accounts for 86 per cent of thermal injuries in older patients.[32] Mortality is high with burns of even 10-39 per cent body surface area in elderly burn victims.[33]

Predictors of Morbidity and Mortality

Age

Elderly patients have increased morbidity and mortality rates after trauma. They are more likely to have underlying medical conditions that limit their physiologic response to injury. However, age itself is an independent predictor of poor outcome even when controlled for comorbidities and injury severity score.

Comorbidities

Certain pre-existing medical conditions increase the risk after trauma significantly. They are cirrhosis, coagulopathy, ischemic heart disease, chronic obstructive pulmonary disease, and diabetes.[34] Other conditions found to increase the risk of death significantly include renal disease and malignancy.[35]

Elderly trauma victims generate poor physiologic response to injury due to their limited physiologic reserve. However, advanced age should not be used as the sole criterion for denying or limiting treatment.[34,35]

Other physiologic factors associated with poor prognosis (mortality rate > 80 per cent) are hypoventilation (respiratory rate<10),[36] hypotension (systolic blood pressure < 90 mm Hg),[34] a Trauma Score<7,[36] a Glasgow Coma Score (GCS) < 8,[35] a base deficit of > -3[37] and elevated venous lactate level[38] during triage adversely affect outcome and are associated with increased mortality in elderly trauma victims.

Prehospital Triage

For reasons described above, outcome is better for the elderly trauma patients when they are transferred promptly to high volume trauma

centres[39] and are treated by dedicated trauma care team.[40]

The manual of American College of Surgeons Committee on Trauma (ACS – COT) suggests that patients older than 55 years of age should be considered for transport to trauma centre irrespective of their severity of injury.[41]] Unfortunately, elderly trauma patients are frequently under triaged despite satisfying triage criteria.[42,43]

MANAGEMENT

Initial Assessment and Resuscitation

Airway and breathing

Tracheal intubation, if considered, should be undertaken early. Otherwise, an elderly trauma victim will progress to respiratory arrest more rapidly than a younger patient. Airway management in the elderly includes special considerations. Laryngeal reflexes are obtunded in the elderly. Edentulous patients may not be able to keep their airway patent in supine position. Blood, foreign body, and resultant tissue edema from direct airway injury can physically obstruct the airway. Moreover, fracture of first and second cervical vertebrae are common in the elderly.[44] Manual-in-line stabilization and rapid sequence intubation with cricoid pressure remain the safest and most effective way to control the airway.

Circulation

As discussed earlier, elderly trauma victims may not develop tachycardia in response to hypovolemia due to the decreased responsiveness of the aging myocardium to circulating catecholamine and the effect of ß-blocker which is a frequent therapeutic measure in the elderly. Therefore, normal heart rate may not indicate cardiovascular stability in the geriatric trauma victims.

The elderly are often hypertensive. The diagnostic parameters of severe hemorrhage (class 3 or 4) i.e. systolic blood pressure (SBP) less than 90 mmHg and heart rate more than 120 per minute as described in the Advance Trauma Life Support (ATLS) guidelines of the American College of Surgeons may not be applicable in the elderly population. It has been proposed that in case of older injured patients the minimum acceptable SBP should be 120 mm Hg for ages 50 to 69 years and 140 mm Hg for ages 70 years and above in trauma victims.[45]

Traditionally, injured patients have been resuscitated with intravenous crystalloids and/or colloids to restore blood pressure and organ perfusion. However, since early 2000, several deleterious consequences of aggressive resuscitation of trauma victims with large amount of crystalloids have come in forefront, for example, cardiac and pulmonary complications,[46] hypothermia,[47] coagulation disturbances,[48,49] immunological and inflammatory mediator dysfunction.[46] and multiple organ damage.[50] High volume crystalloid resuscitation of 1.5 L or more was an independent risk factor for mortality particularly in the elderly (age≥ 70 years) trauma patients.[51] Resuscitation with colloid instead of crystalloid may lead to decreased serum lactate levels, less renal injury, and better tissue resuscitation after penetrating trauma.[52] Early use of fresh whole blood,[53] if available, or plasma, RBC, and platelets in the ratio 1:1:1[54] should be instituted to prevent development of trauma-induced coagulopathy.

Arterial blood gases (ABGs) should be considered mandatory early during resuscitation, since they may reveal base deficit or serum lactate concentrations which are the other markers of perfusion. While an increased base deficit is an indicator of hypoperfusion, a normal base deficit (2 to -2) does not rule out serious underlying pathology.[37] Determination of venous lactate levels and appropriate intervention may improve hemodynamic instability and outcome of geriatric trauma patients particularly those with unrecognized hypoperfusion.[38]

Monitoring

Central Venous pressure, used traditionally to guide resuscitation, is a good approximation of right atrial pressure and right ventricular filling. However, due to changes in venous tone, intrathoracic pressure, and compliance of the ventricles in critically ill trauma victims, CVP may not be a good indicator of fluid responsiveness in this group of patients.[34]

Early aggressive management by putting pulmonary artery catheter and optimizing hemodynamic parameters including cardiac index and oxygen delivery has been shown to improve survival in blunt multiple trauma victims in geriatric population. [55,56]

In the last decade, a number of non-invasive methods of monitoring specially the fluid responsiveness of a trauma patient have been developed. These are pulse pressure variation (PPV), and systolic pressure variation (SPV) derived from analysis of the arterial waveform, as well as the

stroke volume (SVV) derived from pulse contour analysis and the variation of the amplitude of the pulse oximeter plethysmographic waveform. Although there is no specific trial targeting geriatric trauma patients, a number of studies have demonstrated these monitoring to be highly predictive of fluid responsiveness in the critically ill when compared with CVP and indices of left ventricular end diastolic area (LVEDA) and volume[57] in mechanically ventilated patients. In spontaneously breathing patients, passive leg raising (PLR) has been proposed for this purpose.[58,59]

Anesthetic Management

Inhalational anesthetics: Requirement of anesthetic agent is less to around 30% due to reduction of minimum alveolar concentration. Both induction of anesthesia and emergence from it are slower. However, onset is more profound.[60]

Intravenous anesthetics: The doses of etomidate, thiopentone, and midazolam should be reduced to prevent hypotension[61] which is more marked when the patient is hypovolemic.

Ketamine has reduced clearance in the aged and should be used with caution to avoid hallucinations, seizures, and mental disturbance.

Opioids: The requirement of morphine, fentanyl, alfentanil, and remifentanil is reduced by 50% due to increased opioid sensitivity of the ageing brain as well as altered pharmacokinetics.[62]

Muscle relaxants: There is no reduction of the intubating dose.[63] However, time taken to achieve adequate muscle relaxation is generally delayed. Duration of action of non depolarizing muscle relaxants may be prolonged. Therefore, larger dose of antagonizing agent (neostigmine) are needed because muscle relaxants have prolonged duration of action.[63]

Local anesthetics: Dose requirement is less both in spinal and epidural anesthesia; although age seems not to influence the duration of them.

Common Serious Injuries in the Elderly

Hip fracture

Almost 70% of the patients with hip fracture will be of American Society of Anesthesiologists (ASA) grade 3-4[64]; 35% have one co-morbidity, 17% have two and 7% have three or more.[65] Mortality among hip fracture patients has remained unchanged over the last two decades with a 30 day mortality of 8.4% and 1 year mortality of up to 15-30%.[64]

The timing of hip surgery may play a significant role in the morbidity and mortality. Meta- analyses indicate that delaying surgery beyond 48 hours from admission is associated with prolonged hospital stay and increased morbidity and mortality.[66,67] Moreover, early surgery is associated with reduced pain. Therefore, early interdisciplinary communication between orthopedic surgeons, geriatricians, and anesthesiologists to optimize less fit patients before surgery is of utmost importance.[68] Regional anesthesia is associated with 29% reduction in mortality and 25% reduction in pulmonary complications in a large retrospective study.[69] Furthermore, blood loss, deep vein thrombosis, and incidence of delirium would be decreased with regional anesthesia.

Post operative early ambulation, daily physiotherapy and good pain relief with regular paracetamol and/or nerve block technique improve outcome.[68]

Traumatic brain injury (TBI)

The age-adjusted rate of hospitalization for non-fatal TBI in older adults (>65 years) is 155.9 per 100,000 population, whereas in general population it is only 60.6.[70] TBI is most often caused by falls and pedestrian-motor collisions.[71]

Elderly patients who sustain minor head trauma have a high risk of significant intracranial injury despite no history of altered level of consciousness, or neurological deficit. Therefore, Computed Tomography (CT) scan of head is recommended in even with history of minor head trauma despite absence of neurological symptoms and signs. Mortality rates with severe TBI range from 30-80% significantly higher than those reported in younger patients.[72]

Autoregulation of blood flow to the brain is impaired following TBI and more so in the elderly. Maintenance of Cerebral Perfusion Pressure (CPP) should be aimed in the management of TBI. Current guidelines recommend maintaining CPP at a minimum of 60 mmHg.[73] Aggressive treatment is needed for initial 72 hours in elderly patients who have head trauma. However, further aggressive therapy is unlikely to benefit these patients if significant improvement is not seen within this period.[34]

Rib Fracture

Elderly patients with 3-4 rib fractures have an incidence of pneumonia (31%) and mortality (19%) and those with more than 6 rib fractures had 33% mortality and 51% occurrence of pneumonia.[74]

Multiple rib fracture causes inadequate ventilation due to pain resulting in atelectasis of alveoli, poor oxygenation and respiratory failure. Therefore, early aggressive chest physiotherapy and mobilization of the elderly patient are of top priority. Non invasive ventilation with continuous positive airway pressure mask (CPAP) has been shown to reduce the incidence of infection in multiple rib fracture patients.[75] Epidural analgesia, by improving pain control and respiratory function, might improve morbidity and mortality rates compared to other forms of analgesia especially in the elderly.[74] Therefore, it should be considered early in the management of multiple rib fractures.

CONCLUSION

Geriatric population is rapidly expanding throughout the world. Trauma remains a significant cause of morbidity and mortality in this population. Medical professionals responsible for the management of elderly trauma victims should have a thorough understanding of the anatomic, physiologic, and pharmacologic changes with ageing. Presence of preexisting medical conditions puts the geriatric trauma victims at increased risk of morbidity and mortality. Elderly people when traumatized are more likely to present in shock than their younger counterparts. The vital signs of an elderly trauma victim can be deceptively normal despite having occult hypoperfusion. Clinicians must possess high index of suspicion regarding the actual extent as well as severity of trauma while attending an elderly traumatized patient. Early resuscitation, low threshold for instituting invasive and non invasive monitoring as well as early diagnosis of the exact nature of injury is of paramount importance. Despite these facts, the geriatric trauma patients are frequently undertriaged. Doses of anesthetic medications should be adjusted appropriately according to the age and physiological status of the patient. Airway can be difficult and early intervention is recommended. Hip fractures are one of the most common injuries in the elderly. Surgical intervention of these fractures as early as possible is desired to minimize morbidity and mortality. Regional anesthesia for hip fracture surgery has been shown to improve early postoperative morbidity. Elderly people are at high risk of suffering from significant intracranial injury even after minor head trauma. Maintenance of cerebral perfusion pressure at an adequate level is the primary objective in the management of traumatic brain injury. Multiple rib fractures put elderly patients at significant risk of developing pneumonia and its inevitable consequences. Early aggressive physiotherapy and good pain relief with the institution of epidural analgesia are recommended.

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