Perioperative management of the elderly trauma patient

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This article reviews the physiology and pathology associated with ageing and the impact these may have on the perioperative and anaesthetic care of the elderly trauma patient. The current literature on this subject is summarized and, based on this, recommendations are made for perioperative management.

Trauma is the leading cause of death in the first four decades of life, and consequently is frequently thought of as a disease of the young. However, trauma affects all ages. During 1994 and 1995, those over the age of 65 years formed 15.8% of the population of England and Wales and 34% of the hospital admissions resulting from trauma (Surti, 1997). The geriatric population is expected to continue to grow throughout most of the Western world (Butler, 1997; Raleigh, 1997). This, coupled with the increasing mobility of this group, makes it likely that the elderly proportion of the trauma population will be more significant in the future.

The pattern of trauma, response to injury and outcome in the elderly patient is quite different than in the younger patient (Demarest et al, 1990; Schwab, 1992). It is assumed this difference is because of the general reduction in reserve and increased comorbidity found in the elderly. However, there are few studies of perioperative resuscitation and anaesthetic management in trauma that directly examine the geriatric patient (Demaria et al, 1987; Scalea et al, 1990; Santora, 1994; Shapiro et al, 1994). In addition, the geriatric population is heterogeneous with widely varying degrees of comorbidity. Much of the rationale underpinning current practice has been extrapolated from knowledge of alterations in physiology with age and the management of younger trauma patients.

This article summarizes the current literature on trauma in the elderly and examines age-related pathophysiological processes that may be important during resuscitation and perioperative management of the elderly trauma patient.

EPIDEMIOLOGY

Frequently those over the age of 65 years are arbitrarily defined as geriatric. There is no consensus in the literature on what constitutes the elderly patient or which factors are predictive of outcome after trauma. Most reviews indicate that mortality rates for a given injury severity score are higher in the elderly patient (Demaria et al, 1987; Santora, 1994; Zietlow et al, 1994). However, a small number of studies conclude that aggressive care can improve survival after trauma in this group (Demaria et al, 1987; Scalea et al, 1990; Shapiro et al, 1994).

In common with other groups of patients, no severity scoring system currently employed allows differentiation of those patients who could benefit from aggressive care from those who have a high probability of death regardless of level of treatment. Those trauma scoring systems that are used in the general population are less reliable in the elderly population and studies of their accuracy show conflicting results (Phillips et al, 1996).

Falls, usually on flat surfaces or from one or two steps, are the most common mechanism of injury in the elderly, and their incidence increases directly with age (Koski et al, 1996). Falls that result in hospitalization could be the result of coexisting pathologies in 25% of cases (Cummings et al, 1995). Data from the USA indicate that in the 65–75-year age group, the incidence of trauma following motor vehicle accidents is greater than that resulting from falls. In the UK hip fracture is the most common injury precipitating hospitalization in the elderly, but recent work suggests that trends in this country may also be following the American pattern (Raleigh, 1997). The elderly are involved in road traffic accidents as pedestrians more commonly than any other age group.

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It has been documented that mortality rates are higher in the elderly than the young for similar trauma, and this increases with age (Oreskovich et al, 1984; Schwab, 1992; Lonner and Koval, 1995). In the elderly, death occurs more often from multiple organ failure, whereas in the young irreversible brain injury is more frequently the fatal injury (Scalea et al, 1990). This has been related to the reduction in physiological reserve that occurs with ageing and the increasing incidence of comorbidity.

PATHOPHYSIOLOGY

Cardiovascular system

Studies in trauma patients indicate that an oxygen debt is incurred. Those patients able to mount an appropriate hyperdynamic cardiovascular response to repay this debt have the best survival and lowest incidence of multisystem failure (Horst et al, 1986; Scalea et al, 1990). The reduction in reserve and increased incidence of cardiovascular pathology found in the elderly patient may limit an adequate response, and so contribute to the increased incidence of multisystem failure and mortality following a given injury.

Table 1 lists the effects of ageing of the cardiovascular system. There is a reduction in myofibril numbers and an increase in the connective tissue content of the heart. This causes an age-related reduction in myocardial contractility and cardiac index (Muravchick, 1997), which may explain the exaggerated cardiodepressant effects of anaesthetic agents. The myocardial conducting system becomes fibrosed, and particularly in the perioperative period, the incidence of abnormal conduction and arrhythmias is increased. Thickening and calcification of the heart valves is common, particularly on the left side. Only 7% of the resulting murmurs are significant.

Atherosclerosis is common but not invariable with increasing age. There is a high incidence of coronary, cerebral and peripheral vascular disease. Silent ischaemia and infarction are more common in the elderly, and perioperative mortality following acute myocardial ischaemia increases with age (Muravchick, 1997). In the USA coronary artery disease and hypertension are the most common comorbidities found in the elderly.

TABLE 1.
Effects of ageing on the cardiovascular system

Cardiovascular changes	Clinical implications
↓Myofibril numbers and ↑connective tissue content	↓Myocardial contractility and ↓cardiac index
↑Incidence of hypertension	Polypharmacy, ↑cardiac morbidity
↑Incidence of peripheral, cerebral and coronary vascular disease	↑Incidence of mortality from silent infarction and arrhythmias

Respiratory system

Table 2 lists the effects of ageing on the respiratory system. Changes in the connective tissue of the lung result in loss of alveolar surface area and changes described as ductectasia (Muravchick, 1997). A decline in lung elastic recoil also contributes to reduced lung volumes. Anaesthesia results in an increase in the alveolar–arterial oxygen difference compared with younger patients. Ventilatory responses to hypercarbia and hypoxaemia are blunted, resulting in obtunded clinical signs of respiratory distress. Frequently a higher inspired concentration of oxygen is required.

Respiratory muscle strength and stamina are decreased and mucociliary activity is impaired, resulting in a reduced ability to clear secretions and compensate for respiratory insults. Respiratory disease is commonplace so it is not surprising that this group are at an increased and prolonged risk of pulmonary complications in the perioperative period. Careful assessment and prompt intervention is required to reduce the impact of infective respiratory complications.

Central nervous system

Changes in the cellular composition of the brain occur with ageing, but the precise relationship of this with functional deterioration remains unclear. Brain size and weight decrease, with loss of cerebral and cerebellar cortices (*Table 3*). Cerebrospinal fluid volume increases to fill the enlarged ventricles. Frequently there is an accelerated reduction in cerebral blood flow over the age of 70 years, which has been linked to a measurable reduction in intelligence (Muravchick, 1997).

The rate of cerebral atherosclerosis may be implicated in this, but it is unclear which areas

TABLE 2.
Respiratory changes with ageing

↓Alveolar surface area
↓Lung elastic recoil
↓Responses to hypoxaemia and hypercarbia
↓Muscle strength
↓Ciliary activity

of the brain are most affected. Neurotransmitter production is decreased and destruction increased, leading to deficiency states that may manifest as Parkinson's or Alzheimer's disease. Anaesthesia may be induced and maintained with smaller volumes and concentrations of anaesthetic agents. The precise mechanism of this change is unknown but may be caused by pharmacodynamic or pharmacokinetic changes.

Cognitive, sensory, motor and autonomic functions all decline. The reduction in sensory acuity results in reduced interaction with surroundings and impaired plastic learning ability. This is an important factor in trauma epidemiology and may make assessment of the patient in the perioperative period difficult. It also contributes to prolonged rehabilitation following injury.

Renal and hepatic function

Vascular supply to the kidney reduces after the middle years. This is accompanied by a loss of renal tissue and reduction in glomerular filtration. These changes seem to be linked as the glomerulotubular balance remains intact (Muravchick, 1997). Alteration of metabolism and excretion of drugs causes slower elimination of many agents and unpredictable responses to a given dose. There is decreased ability to regulate fluid balance and handle fluid challenges (*Table 3*).

Hepatic perfusion is reduced, and it is this rather than a decline in enzyme function that results in changes in the metabolism of pharmacological agents. Many drugs cleared from the circulation by the liver have altered pharmacokinetics. Reduced protein intake rather than reduced production leads to a fall in plasma protein levels. This may result in increased levels of the unbound fraction of a drug with high protein binding, leading to increased toxicity. This has implications for many drugs used in the perioperative period.

Locomotor system

Increased bone fragility, high rates of osteoporosis and arthritic disease, combined with cardiovascular changes result in reduced exercise tolerance and mobility in the geriatric population (*Table 3*) (Muravchick, 1997). A reduced ability to compensate for balance problems means that geriatric patients are at an increased risk of falling. These same functional changes are implicated in poor rehabilitation following other trauma.

ASSESSMENT AND MANAGEMENT OF THE ELDERLY TRAUMA PATIENT

History taking can be difficult in patients with chronic cognitive impairment or who have a risk of acute confusional states. A relative may provide useful information but silent disease must be considered and suspected in all cases.

General principles of assessment and management of trauma must be applied. All patients should undergo a primary survey — assessment of airway, breathing and circulation — with the immediate management of any life-threatening problems that are identified. It is important to bear in mind that, because of reduced physiological reserve, the elderly patient may not respond in the expected manner to hypoxaemia, hypercarbia and hypovolaemia (Muravchick, 1997). Frequent reassessment of response to treatment is essential during this period and will provide more useful information than single recordings.

After completion of the primary survey and resuscitation a full secondary survey follows. As with younger patients spinal immobilization is appropriate to prevent further injury, but the risk of pressure ulceration may be increased in this group if peripheral circulation is poor. Careful assessment and removal of spinal boards at the earliest opportunity is advocated.

There is even greater need for supplemental oxygen therapy in a population who suffer greater effects of oxygen debt, and in whom the detection of respiratory compromise is difficult. The widespread use of beta-blocking and calcium channel-blocking agents (and other agents) interfere with expected responses to hypovolaemia. As a result it is easy to underestimate the degree of fluid loss and injury. In addition, the body is less able to compensate, resulting in further decreases in oxygen delivery to body tissues. It is for these reasons that many authors advocate the early and liberal use of invasive haemodynamic monitoring in the elderly trauma patient (Scalea et al, 1990; Shapiro et al, 1994; Zietlow et al, 1994; Shabot and Johnson, 1995).

TABLE 3.
Ageing effects on other systems

System	Effect
CNS	↓ Brain size and weight
	↑ Cerebrospinal fluid
	↓ Cerebral blood flow
	↓ Neurotransmitter production
Renal and hepatic	↓ Renal tissue
	↓ Glomerular filtration rate
	↓ Renal perfusion
	↓ Hepatic perfusion
Locomotor	↑ Bone fragility
	Impairment of balance
	↑ Joint disease

Some small studies have shown that the elderly multiple trauma population has a low cardiac output state that is not revealed by non-invasive monitoring. Aggressive management with fluids and vasoactive agents based on parameters measured with invasive monitoring, instituted at an early stage, can improve mortality in these patients (Scalea et al, 1990; Schwab, 1992; Lonner and Koval, 1995; Sinclair et al, 1997).

Reversal of this low flow state, with resultant increase in oxygen delivery, may be the key point of management if outcome is to be improved. Reduction in mortality for all trauma patients using invasive monitoring has been shown by the Pulmonary Artery Catheter Consensus Conference; however, the effect on the elderly patient group in particular remains to be defined because of lack of evidence (Kirkton and Civetta, 1997; Participants, 1997). There is also recent work using oesophageal Doppler ultrasound to guide fluid resuscitation in elderly hip fracture patients. This relatively non-invasive monitoring of cardiac blood flow appears to allow more effective resuscitation than non-invasive parameters; however, the study was small (Sinclair et al, 1997) and further work is required.

Radiological assessment, particularly of the cervical spine, may be more difficult in the elderly patient. Interpretation may be complicated by the effects of ageing as well as previous pathology. The benefit of previous films for comparison is obvious when diagnosing spinal or chest injury, as difficulties may arise differentiating acute from chronic changes.

It is always important to provide adequate analgesia for the patient. In the elderly trauma patient care is required because altered physiological and metabolic response to parenteral analgesics increases the risk of adverse effects. The use of intravenous opioids in small boluses supervised by qualified personnel provides the safest and most rapid method of analgesia. Other analgesics, such as non-steroidal anti-inflammatory agents, should be used cautiously in a population with reduced renal reserve and potential dehydration and hypovolaemia.

ANAESTHETIC MANAGEMENT

The principles of anaesthetic assessment and management are the same for all patients. However, geriatric assessment and management is notoriously difficult because of the many problems outlined above. Even after apparently minor trauma many of these patients fall into a high-risk category because of comorbid problems and lack of physiological reserve. Any limitation of exercise tolerance should be assumed to be the result of reduction of cardiovascular or respiratory reserve until proven otherwise. As discussed previously, this may mean instituting and acting on information from invasive monitoring in elderly patients with relatively minor trauma at an earlier stage in the perioperative course (Shabot and Johnson, 1995).

Airway problems are to be anticipated in patients with reduced mobility of the cervical spine, which may make tracheal intubation difficult. Ventilatory difficulties will be more frequent because of altered lung mechanics, with decreased compliance of both the lung and chest wall. The increase in alveolar–arterial oxygen difference produces slower onset and offset of therapeutic effects of volatile agents, leading to increased risk of inappropriate depth of anaesthesia and adverse cardiovascular effects.

Changes in drug metabolism present challenges in perioperative management. Slower metabolism and reduced excretion of agents such as barbiturates and opioids produce unpredictable responses. These patients may have a slow circulation time and a contracted volume of distribution because of both physiological and pharmacological factors. Dose requirement is easily overestimated. Cautious use of small increments and patience may prevent iatrogenic cardiovascular and respiratory events.

Elderly patients frequently take other medications. Iatrogenic interactions may compound hypovolaemia and myocardial depression resulting from trauma and anaesthesia. Local anaesthetic techniques may be employed to minimize the prolonged effects of anaesthetic agents into the postoperative period. The reduced requirement for opioid analgesics in the postoperative period with improved pain control may facilitate rapid mobilization, which has been shown to improve outcome in elderly trauma patients.

CONCLUSION

The number of elderly patients hospitalized following trauma is significant and likely to grow as this group form a greater proportion of the population. With increasing mobility into later years there is likely to be an increase in more severe trauma. The elderly form a physiologically distinct group of patients with a higher rate of mortality than their younger counterparts for a given level of trauma.

The general principles of trauma management remain applicable but the response observed to both injury and treatment may not reflect the physiological derangement. There is some indication that invasive monitoring at an early stage, guiding aggressive management, can improve mortality

rates. It is possible that this management may improve the low cardiac output state seen in the elderly trauma patient, and so reduce the high incidence of multi-organ failure in this population. There is a requirement for further investigation of these effects since the resource implications of this strategy are significant and much of the work reports on outcome in the American population, which may not be comparable to our own.

These patients should be regarded as high risk and great care must be taken in assessment of both the physiological reserve of the patient and coexisting pathology. HM

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KEY POINTS

- The number of trauma patients who are elderly is significant, and is likely to increase as the elderly population increases and becomes more mobile.
- The elderly patient has a higher mortality than the younger patient for the same level of trauma.
- The response to trauma is modified by the physiological changes of ageing and concurrent pathophysiology.
- There are few studies looking specifically at the elderly trauma patient but there is some evidence that increased use of invasive monitoring may allow more effective resuscitation.
- These patients should be regarded as high risk, requiring careful preoperative assessment, anaesthetic management and postoperative care.