Introduction

According to recent studies, the elderly population of the United States has been growing rapidly since 1980 at a rate of 21%\(^1\). By the year 2040, the percentage of the population who will be older than 65 years of age is estimated to reach up to nearly 20% of the total population\(^2\). Even though the elderly population is growing rapidly, there is little literature discussing the mortality factors in older patients, whose trauma mortality rates are much higher than those for the under-65 age group\(^1-3\). A study found the mortality rate for all grades of injury to be about 10% higher in the 70 years and older age group when compared with the 20 to 70 years age group\(^4\). Another research paper also found the older group to have higher case fatality and complication rates and longer hospital stays when compared with non-elderly trauma patients in 111 United States and Canadian trauma centers\(^5\). Two previous studies found that the mortality in the elderly group was twice as high as that in the younger group (28% vs. 12%; 27% vs. 14%). The elderly group had higher pulmonary and infectious fatality complications\(^2,6\). Deaths in elderly trauma patients were significantly higher than in the younger patient group,
whether in the surgical intensive care unit or after discharge.

Trauma in the elderly population is frequent and is associated with significant mortality, owing not only to mechanism-related factors, but also to those complicated population factors including increasing age, decreasing physical reserves, underestimation of injury severity, preexisting comorbidity, and insufficient ability for systemic compensation. The purpose of this review article is to recognize the mortality factors in the elderly population. Richmond et al. showed that the mortality was nearly 10%, with a mean age of 77.5 years old in patients who suffered a serious injury. Among them, injury severity, total number of injuries, complications, and increasing age were all predictors of mortality, and the presence of preexisting medical conditions increased over threefold for the risk of comorbid complications. Another study demonstrated that late mortality occurred after admission and was associated with a trauma score of ≤7, hypotension (systolic blood pressure, <90 mmHg), hypoventilation (respiratory rate, <10 breaths/min) or a Glasgow coma score (GCS) score of 3, especially in elderly patients. A retrospective study from a chart review demonstrated that mortality correlates closely with the injury severity score (ISS), the GCS score, systemic complications, and a need for general surgery in elderly patients. Other mortality factors reported were GCS score ≤7, age ≥75 years, presence of head injury, shock, and sepsis. Geriatric trauma patients (age, ≥65 years) consume disproportionate amounts of health care resources, but their late mortality is high and their long-term outcome is poor. A previous study showed that the mortality in trauma patients older than 70 years was affected by factors including mechanism of injury, body region affected, ISS, shock, and prehospital GCS, with a high mortality rate of up to 15%.

A previous study reported factors of pedestrian–motor vehicle mechanism, initial blood pressure of less than 150 mmHg, acidosis, multiple fractures, and head injuries, all of which predicted mortality in 60 patients who were older than 65 years and suffered blunt multiple traumas, excluding burns and minor falls.

Physical Reserves and Mortality

Mortality may be caused by decreased physiologic reserves that accompany aging, with a higher incidence of preexisting medical problems in the geriatric patient, thus making accurate diagnosis not easy to achieve in elderly trauma patients.

A study reported that geriatric problems require special thinking early in the process, as one-third of the patients who appeared “stable” in the resuscitation area with a “normal” blood pressure and heart rate died within 24 hours from cardiac arrest. Age-related insufficient cardiac output, which causes a state of hypoperfusion, with hard-to-identify metabolic demands and lower maximum heart rate with a higher peripheral vascular resistance, makes the cardiovascular system reserve unable to respond, rendering diagnosis of shock more difficult. Some studies reported that it is easy to under-compensate when shock occurs in the elderly, leading to inadequate oxygen delivery and thereby creating an “oxygen debt”. Thus, the consequences are a poor outcome and higher mortality rates. The physiology of aging restrains the ability of elderly trauma patients to respond to stresses of injury perfectly. The ability of cardiac output remains stable at rest, but is greatly blunted at stress as patients age. The physiologic reserves of elderly patients cannot tolerate the load that the stress of the injury or critical illness causes, because most of their systems have less functional capacity than their younger counterparts, especially in relation to their cardiopulmonary system.

Scalea et al. found that there were significantly different mortality rates between severely elderly trauma patients with higher peripheral vascular resistances and lower cardiac outputs, and those with higher peripheral vascular resistances but without lower cardiac outputs. The authors noted that the limited compensatory mechanisms of elderly patients might lead to the wrong cognitive state of a perfusion deficit because of a decreased cardiac output.

Mechanism and Mortality

Slip-and-fall and pedestrians–vehicle accidents are the most common reasons of mortality for elderly trauma patients. With slip-and-fall injuries excluded, the overall mortality rate in the elderly was 18.1%. However, Zietlow et al. also found that 31% of the 1,931 trauma patients were ≥65 years old, with a 23% mortality rate in that group, which had predominant causes of injury being linked to falls (59%) and motor vehicle crashes.
Finelli et al.\(^\text{6}\) demonstrated that 46% of the elderly patients had simple falls, resulting in a mortality rate of only 11.7%, compared with a 33% mortality rate after pedestrians were struck and a 21% mortality rate after motor vehicle crashes.

### Age and Mortality

The importance of advanced age is a well-recognized risk factor for adverse outcomes following trauma. Previous studies showed that mortality increases from the age of 40 years\(^\text{21}\). Morbidity and mortality increased in geriatric trauma patients when compared with their younger counterparts, excluding the “minor” or “mimic” injuries in the elderly\(^\text{22,23}\). Morris et al.\(^\text{24}\) found that mortality, defined as in-hospital death, began to increase at age of 45 years in patients with moderate injuries (ISS 9–24). Pelicane et al.\(^\text{1}\) demonstrated statistically significant differences in age between elderly non-survivors and elderly survivors.

Knudson et al.\(^\text{9}\) reported a 1.33-fold increased risk of death associated with an age older than 75 years. A more recent study compared early and late mortality and found that age was a significant predictor of late mortality\(^\text{25}\). Another study demonstrated that age was significantly predictive of both early (<24 hours) and late (>24 hours) mortality. Age of ≥65 years was associated with a 4.64-fold increased risk of late mortality\(^\text{14}\). van Aalst et al.\(^\text{11}\) demonstrated that a poor outcome was particularly significant in the 75.5 years and older group, after following blunt geriatric trauma patients for 3 years. Battistella et al.\(^\text{26}\) enrolled 279 geriatric trauma patients older than 75 years into their study and found that the associated mortality rate was 23% and the mean ISS was 9.4.

### Preexisting Conditions (PECs) and Mortality

For the elderly trauma population, it is hard to clearly separate PECs and age factors related to mortality because of the higher frequency of PECs with increasing age.

Morris et al.\(^\text{21}\) examined the hospital discharge data for trauma patients in California and found that PECs were important predictive factors for mortality, which were independent of age (<65 years). The effect of PECs on mortality became less important in patients older than 65 years, perhaps because at this age, chronologic age becomes the predominant predictor of mortality. In this study, the added presence of PECs does little to increase trauma mortality rates\(^\text{21}\). Milzman et al.\(^\text{27}\) reported increased mortality in 8,000 elderly trauma patients with PECs, compared with those without PECs.

The presence of preexisting disease has been shown to increase the mortality rates of middle-aged patients with moderate ISS, but it appears not so important in patients older than 65 years. Milzman et al.\(^\text{27}\) demonstrated that the mortality rates of trauma patients with preexisting disease aged 65 to 74 years and 75 years and older were 13.9% and 30.1%, respectively, compared with 11.1% and 27.9% for patients without preexisting disease from the respective age groups. A more recent study examined risk factors for mortality among a group of 9,424 trauma patients aged 67 and older, who were discharged from acute care hospitals within the state of Washington in 1987, to predict the outcome, and it was found that not only the number of PECs, but also the severity of the PECs can affect the mortality rate. It was found that patients with PECs were anywhere between 2.0 and 8.4 times as likely to die within 5 years of injury compared with those without PECs, depending upon the number and severity of PECs\(^\text{28}\). Several studies confirmed the value of PECs as predictive factors for poor outcome and mortality in geriatric trauma\(^\text{15,17,29,10}\).

### Arterial Base Deficit, Serum Lactate and Mortality

Both arterial base deficit and serum lactate can help identify “occult shock” and a subgroup of elderly patients needing intensive monitoring and resuscitation for early determination of admission. Measurement of the arterial base deficit is helpful in detecting the extent of shock and the adequacy of resuscitation in elderly trauma patients\(^\text{31–33}\).

The geriatric population may have the same normal range of base deficit as the younger group, whether they have severe injuries or not\(^\text{34}\). A study showed that elderly patients with severe base deficits (over −10) had a high mortality of 80%. The geriatric trauma mortality was still markedly elevated at 60% in patients with only moderate base deficits (−6 to −9). Even a “normal” (2 to −2) base deficit carried a mortality rate of 24%.\(^\text{35}\)\(^\text{35}\)
However, a normal base deficit (2 to −2) in patients 55 years and older with significant injury (ISS ≥ 16) was less of a negative predictive value than in the younger cohort (40% vs. 60%)34.

In addition, an elevated serum lactate level has also been implicated in occult hypoperfusion, and the rate of clearance directly correlates with mortality35. Elderly patients are less able to compensate for occult hypoperfusion. Lactic acidemia level of more than 22 mg/dL (>2.4 mmol/L) for longer than 12 hours is associated with an increased mortality36.

**Injury Scores and Mortality**

ISSs are useful in predicting mortality in young patients, but they have not been as effective in the elderly population37. van der Sluis reported on a series of 121 trauma patients aged 60 and over, all with an ISS of >16, and found that no patient with an ISS of ≥50 survived in this series25. Many studies showed that ISS did not accurately predict mortality in elderly patients1,13,17,19. The mortality rate for patients with an ISS of >18 was 37%, compared with only 4% in patients with an ISS of ≤1819. ISS is probably the most widely correlated with geriatric trauma outcome. Trauma patients with an ISS of >20 were most likely to die, especially if they were more than 75 years old38.

An ISS is severely limited in its prognostic capability, owing to significant delays in obtaining sufficient data to calculate the score. In a study of 94 blunt trauma victims aged 65 years or older, Carrillo et al.39 found that mortality correlated well with the combination of APACHE II and ISS, better than with APACHE II or ISS alone. All patients with an APACHE II of >15 and an ISS of >30 accounted for only one-third of all deaths in this series39.

**Complications and Mortality**

Recently, two studies reported that higher mortality cases had a higher incidence of cardiac and septic complications and respiratory complications in elderly trauma patients, when comparing elderly survivors with non-survivors38,40. There are several findings identifying cardiac, infectious and pulmonary complications of non-survivors as independent predictors of poor outcome following geriatric trauma. In a study of 456 trauma patients aged 65 years and older, Smith et al.41 reported a 5.4% mortality rate for those patients with no complications, 8.6% for those with one complication, and 30% for those with more than one complication. A previous study demonstrated that it is actually of importance to decrease complications, which contributed to mortality in 32% of all deaths. Among them, 62% of deaths were related to multiple organ system failure1.

**GCS and Mortality from Head Injury**

Traumatic brain injury is much worse in geriatric patients than in their younger counterparts. Vollmer et al.42 found that the mortality rate for younger patients with severe brain injuries and a GCS of <8 was 38%, but was 80% for patients older than 55 years. Age, starting at 45 years, was a significant predictor of death and vegetative outcome62. When the outcome of patients with acute subdural hematomas was examined in another study, the authors found that mortality was 18% in patients between the ages of 18 and 40 years, but 74% in patients older than 65 years43. Admission GCS is used as a potential predictor of poor outcome from geriatric head injury in geriatric patients. “Low” admission GCS is clearly associated with poor outcomes in elderly head-injured patients. In a study by Reuter44, there was an 87% mortality rate in elderly patients (age >60 years) with traumatic intracranial hemorrhage and an admission GCS of <8. Zietlow et al.20 studied elderly patients with multisystem injuries and found a GCS of <8 to be a predictor of mortality, and van Aalst et al.11 had a similar finding of a GCS of <7. Rozelle et al.45 found that elderly trauma patients with subdural hematomas had poor long-term outcomes if their GCSSs were less than 7. A study by Cagetti et al.46 found that there was almost 100% mortality for patients aged 80 years and older with a GCS of <11.

A more recent study reported that head-injured patients aged 70 years and older with a GCS of <9 had a 90% mortality rate47. However, in a similar study for head-injured patients aged 80 years and older, outcome was poor even when the patients had “low” GCS scores in the 3 to 6 range48. Some studies found the GCS scores of elderly patients with head injuries were usually attributed to delays, hence the underestimation of the risk of severity. The reason may be small intracranial hemorrhage occupying the additional space left
by atrophied brain and then compressing the brain tissue, so the clinical symptoms cannot be presented immediately. This is the reason why, for elderly trauma patients, the GCS score must be closely and aggressively followed for at least 24 hours or more after injury, so as to differentiate the range of GCS managed from the younger age groups. Ross et al. noted a nearly 100% 6-month elderly trauma mortality rate among those who had a persistent GCS of less than 8 at 72 hours following admission.

Ethics, Aggressiveness and Mortality

Aggressive decision to perform general surgery rapidly for elderly trauma patients decreases their mortality. There are circumstances when the need for aggressive treatment for elderly trauma patients is delayed, as the physician and patient or family member(s) may hesitate and, in turn, reject the type of treatment. Most of them may choose only vital support for reason of age of the patient. The ethical issue of appropriateness of elderly trauma care in declining hospitals is a challenge to a physician in relation to both resources and finances. Outcomes in elderly trauma can be maximized by a more aggressive approach, rather than one which is expectant. There exists good outcome benefit from early diagnosis and decisions, by which the physicians have the ability to diagnose and manage the injury of elderly trauma patients quickly. Survival of these patients has shown to improve by early (the first 1–2 hours) aggressive and invasive monitoring.

Advanced age alone should not be the reason to abandon the chance of an operation for any injury. Many articles noted that elderly patients had higher mortality rates for both operative and nonoperative management of splenic injuries. Albrecht et al. reported a high failure rate of 33% in elderly patients who received the nonoperative method, but who actually had higher grades of splenic injury and free intraperitoneal fluid levels. It was a potential reason why older patients had higher mortality. It may be because of an increased splenic fragility and their decreased physiologic reserves associated with their advanced age.

The Eastern Association for the Surgery of Trauma study group postulated that successful nonoperative management of blunt splenic injuries could be predicted by hemodynamic stability, grade of splenic injury, and GCS, but never in regard to patient age.

Conclusion

Risks increase with age. As several studies have shown, elderly patients have higher complication and mortality rates than their younger counterparts, if they sustained major trauma. Although advanced age is a risk factor for poor outcomes in trauma patients, better outcomes in elderly trauma patients can be improved by an experienced physician, with the intensive monitoring, aggressive management, and comprehensive care provided by the experienced trauma team. Among the injured elderly patients, some studies found that over 80% can return to their original activities before injury, if given aggressive resuscitation and follow-up care.

A high ISS (>30), post-injury GCS status, and hemodynamic function can affect elderly trauma mortality. Injuries in elderly trauma patients are typically multi-systemic and life-threatening. The potential pitfalls of mortality in older trauma patients have always existed, and prediction is not fully captured if it is only determined by the standard ISS or GCS results. There needs to be more aggressive management and more previous geriatric considerations to avoid the pitfalls of mortality. It has been suggested that special geriatric considerations should be in place for elderly trauma patients to bring about better outcomes and long-term functional survival in geriatric trauma patients. A geriatric consultation service could be an important addition to the interdisciplinary trauma team. Further efforts are needed to evaluate proper aggressive resuscitation criteria for elderly patients.

References


