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Baishideng Publishing Group Inc

7901 Stoneridge Drive, Suite 501, Pleasanton, CA 94588, USA

Telephone: +1-925-2238242

Fax: +1-925-2238243

E-mail: editorialoffice@wjnet.com

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Severe trauma in the geriatric population

Juan Antonio Llopart-Pou, Jon Pérez-Bárcena, Mario Chico-Fernández, Marcelino Sánchez-Casado, Joan Maria Raurich

Juan Antonio Llopart-Pou, Jon Pérez-Bárcena, Joan Maria Raurich, Servei de Medicina Intensiva, Hospital Universitari Son Espases, 07120 Palma de Mallorca, Spain

Mario Chico-Fernández, Servicio de Medicina Intensiva, UCI Trauma y Emergencias, Hospital Universitario 12 de Octubre, 28041 Madrid, Spain

Marcelino Sánchez-Casado, Servicio de Medicina Intensiva, Hospital Virgen de la Salud, 45071 Toledo, Spain

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Correspondence to: Juan Antonio Llopart-Pou, MD, PhD, Servei de Medicina Intensiva, Hospital Universitari Son Espases, Carretera Valldemossa, 79, 07120 Palma de Mallorca, Spain. juanantonio.llopart@ssib.es
Telephone: +34-87-1205974
Fax: +34-87-1909721

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Abstract

Geriatric trauma constitutes an increasingly recognized problem. Aging results in a progressive decline in cellular function which leads to a loss of their capacity to respond to injury. Some medications commonly used in this population can mask or blunt the response to injury. Falls constitute the most common cause of trauma and the leading cause of trauma-related deaths in this population. Falls are complicated by the widespread use of antiplatelets and anticoagulants, especially in patients with brain injury. Under-triage is common in this population. Evaluation of frailty could be helpful to solve this issue. Appropriate triaging and early aggressive management with correction of coagulopathy can improve outcome. Limitation of care and palliative measures must be considered in cases with a clear likelihood of poor prognosis.

Key words: Geriatric trauma; Elderly patients; Severe trauma; Triage; Outcome

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Core tip: Geriatric trauma constitutes an increasing problem. These patients have a limited response to injury. Falls constitute the most relevant mechanism of injury. Specific problems in this population include frailty, under-triage and the combination of traumatic brain injury and use of anticoagulants. Early aggressive treatment and palliative care in cases with a clear likelihood of poor prognosis must be considered.

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INTRODUCTION

In spite that different cutoff levels have been suggested, 65 years represents the most commonly accepted age to consider a patient as an elderly or geriatric patient^[1,2]. In the following years, it is expected that people over 65 years will represent up to one-fifth of the world population^[1,3] and almost 39% of trauma admissions by 2050^[4]. This will constitute a major problem worldwide, but especially in developed countries with higher life expectancy.

Geriatric trauma constitutes an increasingly recognized problem^[1-4]. Although the number of articles dealing with this topic showed a 6-fold increase in the last 25 years^[3], the optimal management of these patients remains to be determined. A specific ad-hoc Geriatric Trauma Committee was constituted by the American Association for the Surgery of Trauma^[2]. In summary, participants concluded: Geriatric trauma was an increasing problem with increased secondary hospital admissions; elderly trauma patients were usually under-triaged; outcome was better when patients were admitted in higher level trauma centers^[2].

Trauma patients aged > 65 years present different comorbidities that imply a higher risk of death and severe disability^[5], in spite of having similar severity scores that younger patients^[6,7]. Hospital costs are also increased, even in low-energy traumas^[1]. In our environment, patients aged > 65 years represent up to 20% of trauma patients admitted to intensive care units^[8]. Therefore, specific skills and an evidence-based approach in the management of this population are required.

In this review we will focus on the characteristics of elderly patients, the mechanisms of injury, the areas of controversy and specific strategies to improve outcome.

PHYSIOLOGICAL CONSIDERATIONS AND EFFECT OF MEDICATIONS

Aging results in a progressive decline in cellular function which leads to a loose of their capacity to respond to injury^[4]. Impaired adaptive and homeostatic mechanisms are associated to a diminished physiological reserve^[4] and, therefore, an impaired response to a physical insult^[4,9]. In addition, comorbidities are commonly associated with an increased use of medical treatments that can also affect the response to injury^[1,3,4].

Specifically, the following conditions are present^[1,4,10].

Brain

Elderly patients are more likely to present baseline neurologic deficits, such as dementia, stroke, hearing and visual loss and less pain reporting^[1,4]. All of this

results in gait instability and therefore, in patients prone to low-energy or ground-level falls. Additionally, the use of some medications such as antipsychotic or antidopaminergics can mask symptoms and precipitate falls^[1].

Cardiovascular

Most elderly patients can present hypertension, cardiovascular disease and impaired sensitivity to catecholamines. In addition, they are receiving chronic medications that can affect heart rate and blood pressure^[1,3,4], blunting the response to injury in hemodynamically compromised patients^[1].

Respiratory

Respiratory function is compromised in elderly patients through different mechanisms, such as decreased functional residual capacity, impaired mucociliary clearance of bacteria and reduced cough and reduction in compliance^[1,4]. These factors result in increased work of breathing and a higher risk of respiratory failure and need of mechanical ventilation, ventilator associated pneumonia and intensive care unit stay^[4,11]. Steroids, usually administered in patients with chronic obstructive pulmonary disease can affect wound healing, induce adrenal impairment and have deleterious effects in patients with traumatic brain injury^[1,12].

Kidney

There is a fall in glomerular filtration rate and renal tubular function in elderly patients, limiting the ability to tolerate large-volume resuscitation^[4]. Additionally, patients with low glomerular filtration rate are prone to develop contrast induced nephropathy^[10].

Skeletal

These patients usually present osteoporosis^[1]. Osteoporosis and tendency to fall increase the incidence of hip fractures, which is the most common cause of traumatic injury in elderly patients, mainly in women^[4]. Aging bones are more easily fractured with minor trauma^[10].

Coagulation: Elderly patients are usually taking antiplatelets or anticoagulants which clearly can affect outcome, especially in patients with traumatic brain injury^[1,3,4,7]. The widespread use of novel anticoagulants might complicate the management and outcome in this setting^[13,14].

MECHANISMS OF INJURY

A recent study showed a linear association between different patterns and intensity of injury and aging^[7]. As age increased, low-energy traumas complicated with the use of antiplatelets and anticoagulants were more prevalent, as well as being run-over. High-energy traumas, such as motor vehicle collision under the abuse of toxic substances were less frequent as age increased^[7].

Falls

Constitute the most common cause of trauma and

the leading cause of trauma-related deaths, even in low-energy cases^[2,3]. The morbidity and mortality seems correlated with frailty^[15] and age constitutes the strongest, but not unique, predictor of mortality^[16]. A recent systematic review identified six risk factors appearing in more than one study that could be used to predict falls in the geriatric population: Previous fall, living alone, walking aid, depression, cognitive deficit and use of > 6 medications^[16].

Motor vehicle collision

This mechanism accounts for up to one-quarter of patients with geriatric trauma^[1], with 26.8% in the 66-75 years group and 14.4% in patients older than 75 years^[7]. Elderly patients are more likely to present severe injuries caused by low speed vehicles and have a doubled mortality rate than younger counterparts^[1,10].

Blunt vs penetrating trauma

Elderly patients usually undergone blunt rather than penetrating trauma, which accounts for less than 5% of the cases^[7,17]. Most of the cases of penetrating trauma rely on self-inflicted injuries mediated by chronic illness and depression.

CLINICAL FEATURES

In brain injured patients, aging is strongly associated to significant epidural or subdural hematomas even when presenting with mild symptoms^[18]. In this setting, the Glasgow Coma Scale is an unreliable clinical tool, and the repeated use of computed tomography of the head becomes essential to rule out increased intracranial pressure^[19]. When anticoagulants are used there should be a low threshold to repeat brain imaging, even in cases without any clinical neurologic change^[1,19]. If the elderly patient with traumatic brain injury is taking warfarin, there is a significantly increased risk of fatal intracranial hemorrhage. Therefore, such patients benefit from rapid correction^[19].

Elderly patients are at a significantly increased risk of high cervical spinal cord injuries (C1-C2) as a result of degenerative changes and stiffening of the lower cervical spine^[20]. In this scenario, early spinal evaluation and appropriate spine immobilization are of paramount importance to avoid secondary devastating injuries.

Chest trauma is most likely to be blunt and secondary to motor vehicle accidents. It carries a significant risk of morbidity, even in patients with isolated rib fractures^[21]. The risk of mortality after a rib fracture is proportional to the number of fractured ribs and may serve as a predictor of trauma severity and risk of complications^[22]. The most common complications include pneumonia and pulmonary contusions^[21]. Pneumonia following a rib fracture can be a devastating complication in these patients with limited respiratory function. It is essential to aggressively manage rib fractures, including, when indicated, optimized analgesia and epidural anesthesia and/or rib fixation for pain control^[23].

Abdominal trauma has similar characteristics in elderly patients than in younger counterparts, but its management is controversial in elderly patients. A conservative approach can be used, but elderly patients seem to fall to a non-operative management more frequently than younger patients^[24]. However, risk must be well-balanced since mortality after laparotomy increases with age and higher lactate levels^[25]. In this scenario, a recently developed geriatric emergency surgery score using 5 clinical variables could be helpful in predicting 1-year mortality and assist in preoperative counseling^[26]. However, this score has to be specifically validated in elderly trauma patients yet.

Pelvic fractures in the elderly have a higher incidence of complications and mortality than in the younger population. Specifically, the pattern of injury is different with a higher incidence of lateral compression fractures, which are associated to secondary bleeding requiring angiography for bleeding control^[27]. Therefore, these patients should be promptly treated, since associated mortality is high^[27]. In patients with initially stable pelvic fractures, advanced age along with injury severity, mental status, prolonged mechanical ventilation, and/or in-hospital blood product administration were predictors of mortality^[28].

Osteoporosis is the main contributor factor to skeletal injuries in elderly trauma patients, especially in women. Fractures in the geriatric population are associated to a high morbidity and mortality and diminished quality of life^[29]. Forearm and hip fractures are the most common^[10]. Elderly patients have a high mortality following a hip fracture. It is mandatory that these patients receive coordinated care including early surgical repair balanced with medical optimization and appropriate rehabilitation. Evidence suggests that a dedicated orthogeriatric team approach to these patients may improve functional outcomes, but its effects on mortality are not clear^[30,31].

SPECIFIC AREAS OF INTEREST AND POTENTIAL STRATEGIES TO IMPROVE OUTCOME

Under-triage

Consensus exists that elderly trauma patients are usually under-triaged to trauma centers^[1,2,10]. Different underlying causes have been described, such as low-energy mechanisms of injury, unconscious age bias, unreliability of vital signs, the use of medications that can blunt the physiologic response to injury and, until recently, the lack of specific triaging scores^[1,10,32]. This is especially surprising if we take into consideration that age itself is a strong determinant of higher mortality in trauma patients^[7] and that when aggressive treatment is initiated, the outcome difference between younger and older patients decreases^[33]. Elderly patients have a decreased mortality if they are transferred to trauma centers with a high volume of elderly trauma patients^[34]. To solve under-triage, different authors

suggested advanced age to be the sole criteria for referral to level I trauma centers and activation of the trauma team in the presence of traumatic injuries, since this led to reduced odds of mortality when controlling for severity in before-and-after studies^[35,36]. Taking into consideration the evidence available, under-triaging of elderly trauma patients can be considered as a form of ageism.

Another potential strategy is the use of alternative parameters for triage purposes, since conventional scores, the Revised Trauma Score and the Injury Severity Score did not perform well in this population. To this purpose, different alternatives such as a different cutoff for systolic blood pressure in 110 mmHg (due to the high percentage of patients with hypertension in this population)^[37], as well as the values of the shock index, modified shock index and age shock index^[38,39] were analyzed with improved but not optimal results. Specific geriatric criteria could increase the sensitivity in identifying the need of a trauma center^[40], but with limited impact of the number of elderly patients transferred to trauma centers and mortality^[41,42]. The recently developed Geriatric Trauma Outcome Score^[43], which uses the values of Age, Injury Severity Score and the need of transfusion in the initial 24 h in a dichotomized form can be of outstanding interest for establishing the odds of mortality, but of limited interest for triaging purposes.

Frailty

Age itself could not be an accurate indicator of the ability of the elderly patient to respond to injury. In addition, as previously explained, traditional vital signs and severity scores do not perform well in this specific population. Here the concept of frailty arose. Frailty syndrome is considered as decreased physiologic reserve in multiple organ systems which leads to an impaired ability to withstand physiological stress^[3]. Therefore, frail patients are at a higher risk for a variety poor outcomes following injury^[44].

Among the different tools developed, the most interesting is the Trauma-specific Frailty Index. This modified 15-component scale was validated in 200 patients and was useful in planning discharge disposition of elderly trauma patients^[45]. In a follow-up study with 250 patients with median Injury Severity Score 15 and mean age 77.9 years, forty-four percent of the patients had frailty. These patients were more likely to have in-hospital complications and adverse discharge disposition. All patients who died had frailty^[44]. This index was also superior to traditional signs or scores^[46]. It is therefore reasonable that the use of this index may help in planning the process of care of geriatric trauma patients.

Traumatic brain injury and anticoagulation

In patients with traumatic brain injury, there is a clear relationship between age and mortality and poor outcomes. One meta-analysis of 5600 severe head-injured patients confirmed the strength of this association, expressed as an odds ratio per 10 years of age of 1.39

(95%CI: 1.3-1.5) for death and 1.46 (95%CI: 1.36-1.56) for unfavorable outcomes in multivariable analyses, reaching 6-mo mortality 72% in patients aged > 65 years^[47]. In a more recent report, elderly patients with moderate to severe brain injury had an overall in-hospital mortality rate approaching 30%. Most interestingly, no patient with an admission Glasgow Coma Scale score less than 9 had good outcomes; the mortality for that subgroup was 80%^[48]. Therefore, concerns about futility arise in this setting.

This picture is complicated by the common use of anticoagulants in elderly patients^[7]. Anticoagulants are commonly used in elderly patients to reduce the risk of potential stroke, but this potential benefit must be weighed against the risk of falls with potentially fatal bleeds^[13,49]. Anticoagulant use was associated with progression of known intracranial hemorrhage as well as the development of new foci of hemorrhage on repeated head computed tomography^[50]. In this scenario, the use of the CHADS scores could be helpful to distinguish which patients at risk of falls clearly benefit from antiplatelets or anticoagulants^[51]. In recent years, new anticoagulants have been developed, which are replacing vitamin K antagonists^[13]. More elderly patients face severe trauma under these new anticoagulants^[14]. Until recently, specific antidotes were not developed, and urgent treatment was limited to general measures and different doses of prothrombin complex concentrate, activated prothrombin complex concentrate or even recombinant factor VIIa^[14,52]. All these measures had variable and limited support of clinical evidence^[52]. Currently, a specific antidote for direct thrombin inhibitors (dabigatran) is available, idarucizumab, which is a Fab fragment of a monoclonal antibody. In the case of FXa inhibitors (apixaban, edoxaban, rivaroxaban) it has been recently developed the andexanet alfa, a recombinant, modified human factor Xa decoy protein that binds factor Xa inhibitors but does not have intrinsic catalytic activity^[52,53]. However, these agents have not been extensively evaluated in trauma patients. Fortunately, and contrary to initially expected, large recently published series showed that trauma patients under new anticoagulants had a better outcome than those anticoagulated with vitamin K antagonists^[54,55]. This controversy highlights the need of specific screening protocols for coagulopathy in this setting.

CAN WE PREDICT OUTCOME?

The Eastern Association for the Surgery of Trauma published in 2012 their guidelines for the management of elderly trauma patients, concluding that evidence-based care of this population requires aggressive triage, correction of coagulopathy and limitation of care when clinical evidence suggests a clear likelihood of poor prognosis^[56]. This implies treating aggressively patients with limited physiological reserve and uncertain outcome. In this context, several tools to predict morbidity and outcome have been developed and can help to make the

right decision.

Min *et al*^[57] recently developed a simple clinical risk normogram to predict mortality-associated geriatric complications in elderly patients using a secondary analysis of the National Trauma Data Bank. They found that elderly patients had complicated and unfavorable clinical courses compared with younger patients if they developed pneumonia, abscess, wound infection, empyema, urinary tract infection, bacteremia, aspiration pneumonia, failure of reduction/fixation, pressure ulcer, deep venous thrombosis, pneumothorax, pulmonary embolism or compartment syndrome^[57]. A recent systematic review identified increasing age (those aged > 74 years), increasing severity of injury and low systolic blood pressure as independent predictors of mortality^[58]. As detailed above, the Geriatric trauma Outcome Score can be helpful to predict in-hospital mortality with good results^[43]. Its performance is even better when patients with care restrictions are excluded. However, it has a poor ability to predict 1-year mortality^[59].

Given these limitations, the frailty index^[15,44-46] can be of interest to predict which patients are at highest risk of having poor outcomes and then require focused interventions. Joseph *et al*^[60] recently showed that frail patients were more likely to develop in-hospital complications (non-frail: 12%, pre-frail: 17.4%, and frail: 33.4%, $P = 0.02$) and an adverse discharge disposition. The Edmonton frail scale, which has a great interest in the general population, has not been extensively evaluated in elderly trauma patients except in postoperative state after hip fracture^[61]. More interest raised other markers of frailty, such as sarcopenia and osteopenia, that were found to be associated with 1-year mortality in elderly trauma patients^[62]. A dichotomy approach of responding vs non-responding at 72 h after intensive treatment could identify patients with higher in-hospital mortality and was associated with differences in end-of-life decision making^[63].

POSTACUTE CARE AND PALLIATIVE CARE

Despite aggressive treatment, more than 60% of elderly trauma patients who survive are ultimately discharged to different types of facilities, including skilled nursing facilities, assisted living or long-term rehabilitation care^[64-66]. To determine which type of facility may be of benefit for these patients is challenging and remains to be elucidated^[65]. An appropriate management of these facilities is essential for optimal transfers and prevention of readmissions^[66].

In cases with a clear likelihood of poor prognosis despite aggressive initial treatment, especially in those patients aged > 74 years old and with non-responding traumatic brain injury, palliative care must be considered^[67]. Limitation of care plays an important role in the high in-hospital mortality of elderly trauma ICU patients in our environment^[7], so a comprehensive

approach fulfilling patient needs and comfort is warranted^[65-67]. Future investigations may deepen in this approach and in the quality of life rather than in-hospital mortality for evaluating outcome in elderly trauma patients^[67,68]. Returning to their baseline quality of life is difficult in these patients, even in relatively minor trauma^[69]. This expectative must be discussed with the patient (if possible) and relatives when we consider the treatment alternatives of elderly trauma patients. Interventions to reduce frailty in the community are required and are potentially effective to improve the ability to prevent and recover from injuries^[70]. Effective interventions included exercise, nutrition, cognitive training, geriatric assessment and management and prehabilitation^[70].

CONCLUSION

In summary, elderly trauma patients present specific characteristics that imply increased morbidity and mortality. Appropriate triage, evaluation of frailty and aggressive early management including correction of coagulopathy can improve outcome. In non-responding cases with a clear likelihood of poor prognosis, limitation of care and palliative measures must be considered.

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