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REVIEW ARTICLE

Polytrauma in the elderly: specific considerations and current concepts of management

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Abstract With an aging and more active older population, an increased incidence of elderly trauma patients, including severely injured geriatric patients, is anticipated. Poorer functional outcomes and increased mortality and morbidity rates in these patients compared to their younger counterparts may be inevitable due to the associated pre-existing medical conditions and the reduced physiological reserves and compensatory mechanisms secondary to aging. However, mortality and complication rates can be reduced, and outcomes can be improved, when prompt and aggressive treatment is provided. Knowledge of the specific issues, challenges and the distinctive injury patterns of this unique trauma population is important when treating elderly polytrauma patients. In the herein study, the special needs of these patients and the current concepts on their management are summarised. Research in this field is ongoing in order to develop advanced management strategies to optimise outcomes. Overall, these patients should not be treated as "older adults", but as a special population with special considerations and the trauma care should be tailored to meet their specific needs.

Keywords Polytrauma · Elderly · Geriatric trauma · Management

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Introduction

Trauma remains a major cause of death and disability worldwide [1]. Even though trauma mainly affects young adults, it can also affect the elderly, especially in the western countries, where the population is rapidly aging [2]. With the increasing life expectancy, the elderly population is not only growing, but also it can live a more healthy and active life, resulting in an increased exposure to various mechanisms of injury and, thus, in an increased number of older trauma patients requiring health care.

Defining who or what constitutes an elderly patient is difficult, and, often, there is no consensus in the literature, with the definition of geriatric trauma varying from age greater than or equal to 55, 60, 65, 70, 75 and even 80 years [3]. Most studies define geriatric trauma patients as patients over the age of 65 years. Furthermore, the rapidly increasing demographic of the population over 70 and over 80 years of age has led to a differentiation between old and the very old [4].

In elderly trauma patients, the mortality risk rises dramatically. A six times greater mortality rate has been reported in the elderly compared to the younger trauma patients when controlling for degree of injury [5]. Overall, in the older adult, trauma results in an increase in complications and mortality, since the presence of co-morbidities and physical changes occurring as a natural process of aging decrease the physiological reserves and affect trauma outcomes [6, 7]. In conjunction with a worse outcome and long-term morbidity, the elderly trauma patients also consume disproportionate amounts of health care resources [8, 9]. The literature regarding the management of these patients remains sparse. This study, therefore, is focused on the special needs and the current concepts prevailing with regard to the management of this special group of patients.

Polytrauma and the elderly

Especially for polytrauma elderly patients, the current evidence is limited, as this topic has previously been given only cursory attention, even though such patients will be seen with increasing frequency [10]. Polytrauma is defined as an injury to at least two organ systems, leading potentially to a life-threatening condition [11]. It is of note, however, that a consensus definition is lacking within the international trauma community [12]. The overall severity of the trauma load on the patient's anatomy and physiology is usually expressed as an Injury Severity Score (ISS) $\geq$ 16 or 18 [13, 14]. As expected, polytrauma patients have significant mortality and morbidity, requiring multidisciplinary medical management and prolonged hospitalisation and recovery periods, with immense social and economic implications [14, 15].

The management of polytrauma patients has evolved considerably in the last century with the recent developments made in all medical disciplines, including pre-hospital care, diagnostics, ventilation strategies, interventional radiology, surgical and fracture fixation techniques, as well as rehabilitation and late reconstruction procedures [15, 16]. However, providing trauma care for the elderly represents an additional challenge [17], as traditional resuscitation protocols, pharmacological agents, interventions and even orthopaedic implants that are established modalities for the management of younger polytrauma patients may not be suitable for the elderly polytrauma. In addition to the trauma insult itself, special considerations should also be taken into account during the management of these patients based on physiological body changes, mechanisms of injury, pre-existing medical conditions, responses to injury and special health care needs from the pre-hospital care to discharge [3, 10, 17].

Specific considerations for the elderly polytrauma

Aging, physiological changes and pre-existing conditions

While considering the physiological changes that occur with aging, it is important to bear in mind that the age as a numerical value alone is not enough information. Each patient should be considered individually [6], as chronologic age may not reflect a patient's physiologic age or the nature and extent of pre-existing medical conditions [3]. Since each individual ages differently, the physiological reserves are not known until they are tested under the stress of trauma. Nevertheless, a narrow physiologic tolerance and restricted reserves should be expected when managing elderly trauma patients [4].

Pre-existing conditions, which may be known or not during the initial management of the older polytrauma patient, may compromise the outcome either by not enabling adequate response to treatment or by not tolerating any further physiological derangement. Alterations in the cardiovascular and respiratory systems limit the potentials to respond to hypoxia and shock [17]. For example, cardiovascular conditions such as coronary artery disease and congestive heart failure cannot compensate for the increased myocardial oxygen demands and cardiac output in the case of hypovolaemia. The possibility of pre-existing hypertension should also be taken into consideration and a blood pressure that would seem normal for a younger adult should be looked at with suspicion in the elderly patient [6]. Pre-existing conditions of the respiratory system increase the risk for atelectasias and pneumonia, as well as the risk for acute respiratory distress syndrome (ARDS). Also, decreased cough reflex predisposes to aspiration. Furthermore, chronic renal insufficiency or little reserve increase the risk of fluid/electrolyte imbalance and fluid overload, and reduce drug metabolism. In addition, alterations from the central nervous system can reflect a pre-existing condition (stroke, dementia), the cause of the accident (stroke) or a symptom of traumatic brain injury (subdural haematoma, brain contusion, middle cerebral artery tear). Immunological deficiencies in the elderly predispose to sepsis and hepatic dysfunction to coagulopathy and bleeding. Regarding the musculoskeletal system, previous conditions such as muscle atrophy, osteoporosis or the existence of an implant or a joint prosthesis can increase the severity of injuries with less kinetic energy, and can alter the fracture patterns or treatment [17]. Finally, the loss of skin tone and loss of subcutaneous tissue may result in degloving injuries often seen in elderly trauma patients [6].

Nevertheless, because of the emergent nature of the trauma admission, the medical history of the older patient may not be available, making it more difficult to determine whether the clinical findings are acute or chronic. Moreover, the patient's routine medications may not be known, complicating the overall management. These may interact with drugs administered during resuscitation, raising issues of adverse drug reactions. In general, decreasing drug doses should be considered in the elderly patients in order to prevent drug accumulation and toxicity. Two frequently used medications among the elderly population are the beta blockers, which may not allow the heart rate to increase when the patient is hypovolaemic, and the anticoagulants, which could complicate even minor injuries due to excessive bleeding [6]. Finally, in the elderly trauma patients, a co-morbid condition or a medical emergency such as myocardial infarction or stroke may be the initiating event of the accident and its management should also be considered during the overall patient's treatment.

Interestingly, it has been observed that, even in the absence of physiological abnormality in older trauma patients, there is still a relatively higher mortality rate, suggesting that it might be more difficult to predict outcome and which patients should be treated more aggressively [10].

Mechanisms and patterns of injury in the elderly

The mechanisms and the distribution of injuries are different in the elderly trauma population, in which the incidence of osteoporosis is high [18]. Although older adults are more active and can be involved in high-energy trauma, often, they can become multiply injured following low-energy trauma with poor outcomes [19].

Falls are the most common mechanism of injury in the elderly [20]. Low-energy falls have been reported to account for only 9–11% of injury-related deaths in the general population; but in the elderly, they comprise more than 50% of traumatic deaths in persons over 65 years of age [21, 22]. Because of the physiological changes in sensations (with decreased visual, auditory, proprioceptive and vestibular inputs), delay in reaction time, unsteady gait, loss of strength and coordination, cardiac dysrhythmias and even orthostatic hypotension, the older adult is more likely to fall. It has been reported that the greater the age, the greater the likelihood of falls as a mechanism of injury [4] and that up to 10% of falls can create significant injuries [23].

Motor vehicle accidents are the second most common mechanism of injury in the elderly polytrauma, either as drivers/passengers or mostly as pedestrians hit by a vehicle. Fourteen percent of all traffic fatalities involve older adult drivers [17]. In pedestrian–vehicle collision patients, the mortality rate is higher than the other trauma mechanisms in the elderly [24]. Once again, changes such as visual and hearing impairment, slow reaction time, loss of memory and inability to recognise and avoid hazards increase the risk for the older individuals [17, 25]. The risk of accidents was found to increase with advancing age, despite travelling a decreased number of miles [23], and older adults are more likely to be at fault for a motor vehicle accident [6].

Even though falling and being hit by a motor vehicle were found to be the leading mechanisms of injury in the elderly [26], physical abuse or even neglect can also be the cause of geriatric trauma. Its incidence is not well documented, but it should always be suspected, especially when the circumstances of the accidents are ambiguous and inconsistent or do not correlate with the injuries [17].

Regarding the injury patterns seen in the elderly trauma population, long bone, pelvic, rib and sternal fractures are most commonly seen due to osteoporosis (Fig. 1a–d). Pulmonary contusions secondary to rib fractures are also common, as well as subdural haematomas due to fragile veins and a firmly adherent dura to the skull, eliminating the epidural space [17, 20]. Overall, subdural haematomas occur three times more frequently in the elderly trauma population compared to their younger counterparts [20], but the symptoms may be more subtle and gradual, due to associated cerebral atrophy. Injuries of the upper cervical spine, and especially the odontoid and the C1–C2 level, represent the most frequent spinal injuries in the elderly [20, 27]. Cervical spine fracture patterns in geriatric patients can also involve more than one level, they are frequently clinically unstable and they can result from simple falls from standing or seated height [27]. Central cord syndrome can also occur more often in the geriatric traumatised patient, due to the narrow cervical spinal canal. Furthermore, there is a continuously increasing incidence of fall-induced, fracture-associated, spinal cord injuries in the elderly [28].

In addition, abdominal injuries can also be present in the elderly polytrauma, even as occult injuries, with a four times higher mortality rate compared to younger trauma patients [20, 29]. Injuries to the great vessels are also common in the elderly polytrauma due to the decreased elasticity and, therefore, less adaptability to acceleration and deceleration forces [29]. Long bone fracture patterns may be complex due to the presence of implants or prosthesis. Regarding pelvic fractures, fracture patterns differ in older patients with lateral compression fractures occurring more frequently and commonly causing significant blood loss [30]. Soft tissue injuries are more common and more severe due to the thinning of the epidermis and the loss of skin elasticity and associated muscle atrophy (Fig. 1e, f). Finally, there is an increased susceptibility to bleeding in the elderly trauma group.

Triage of elderly trauma patients and trauma team activation

In major trauma patients, the mortality in the elderly was found to be nearly double compared to the mortality in the younger group [10] and the complication death rate to be markedly higher (especially for pulmonary and infectious complications). A summary with the most recently published studies on the different mortality rates of this specific trauma population is presented in Table 1 [10, 24, 31–35]. It has been, therefore, recommended to triage and transfer elderly trauma victims to trauma centres at a much lower threshold than similarly injured younger patients [36, 37]. The rationale is that, since major determinants of outcome after trauma include numerous parameters such as the severity of injuries, patient's age and pre-existing medical conditions, time from injury to treatment and the quality of care [38], the provided management can be

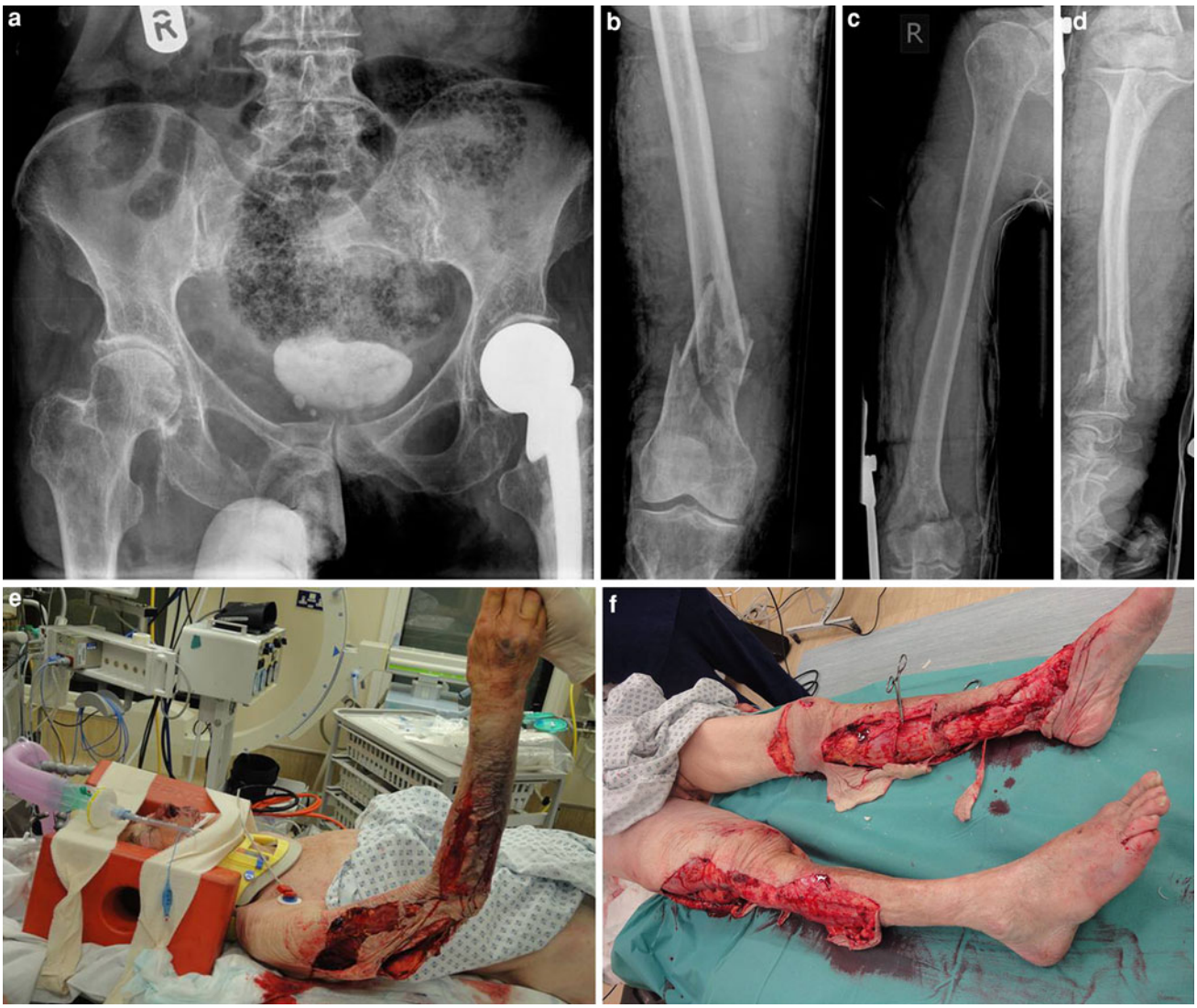

Fig. 1 An 83-year-old female polytrauma patient (pedestrian hit by car). She sustained pelvic fracture (**a**), open distal femoral fracture (**b**), ipsilateral fractures of the clavicle, the humerus (supracondylar open fracture) (**c**) and the wrist (**d**), facial injuries with fractures of the zygomatic arch, lateralorbital wall and lateral wall of the maxillary sinus, and extensive degloving injuries in the upper (**e**) and lower (**f**) extremities. There were no other associated injuries. The cervical spine was immobilised with a cervical collar until trauma computed tomography (CT) was obtained and the patient was intubated prior to CT, as she was vomiting in order to avoid aspiration (**e**)

optimised in a designated trauma centre or as part of a state-wide trauma system [8]. However, there is still undertriage of such patients [3, 8], and, especially in elderly major trauma cases from falls, the triage criteria fail to identify nearly all cases [39], meaning that patients with severe or potentially severe injuries were not evaluated correctly on initial assessment [6]. In 2004, the American College of Surgeons Committee on Trauma (ACS-COT) recommended that age as well as the existence of pre-existing diseases should be considered when evaluating trauma patients [40]. Since then, a positive trend in triage accuracy for older injured persons has been observed [41].

Furthermore, it has been proposed that age should be added as an indication for in-hospital trauma team activation, even though it is not currently included in the standard haemodynamic criteria used. It has been shown that prompt activation of the trauma team for elderly injured patients (aged 70 years or more) in combination with a protocol of early aggressive monitoring and resuscitation improves survival [42]. However, further research in this field is required in order to establish the real impact of including the age for trauma team activation.

Resuscitation of the elderly trauma patients and admission to the trauma intensive care unit

Since the elderly have limited physiologic reserve and tolerance for hypoxia, hypovolaemia and shock [20],

Table 1 A summary of the most recently published studies on mortality rates in the elderly trauma population

Author/year	No. of elderly patients (≥65 years of age)	ISS	Mortality rate	Mortality in young counterparts	Other findings
Meisler et al. 2011 [31]	341[a] 102[b]	25[a] 26[b]	24.9%[a] 46.1%[b]	2%[d] 5.6%[e] 10.4%[f]	Increasing age was also associated with an increased proportion of falls and fatal head and spine injuries
Moore et al. 2011 [32]	15,309	>15	23.2%	vs. 12.8%	Geriatric trauma patients are less often transferred to a neurosurgical centre ($p < 0.0001$)
Clement et al. 2010 [33]	TARN data	1–15 16–24 >24	5.2%	vs. 2.2% ($p = 0.01$)	Increased risk of death (OR 6.4, 95% CI 5.2–7.8, $p < 0.001$) in the elderly trauma patients The risk of dying late after sustaining minor trauma (ISS <16) is increased if a PMC exists (OR 5.5, $p = 0.004$)
Giannoudis et al. 2009 [10]	438	>25 (median)	42% >65 years (almost 50% when >75 years)	vs. 20% ($p < 0.001$)	ARDS 34% (vs. 23% in the young group) MOF 35% (vs. 14% in the young group)
Akköse Aydin et al. 2006 [24]	371	9.3 (mean)	10.2%	n/a	There was a statistically significant difference between the ages of the survivors and non-survivors ($p < 0.001$) Head trauma and abdominal trauma were significantly more frequent in the non-survivors
Henary et al. 2006 [34]	PCDS data[c]	23 (mean)	30%	vs. 11% ($p < 0.001$)	The elderly were more likely to have an ISS ≥ 9 (odds ratio = 2.72), to have higher AIS scores to almost every body region, and to die (odds ratio = 6.68)
Yee et al. 2006 [35]	178	Not reported	26.4%	vs. 9.49% ($p < 0.001$)	(Road traffic injuries only)

TARN Trauma Audit and Research Network, *PCDS* Pedestrian Crash Data Study, *PMC* pre-existing medical condition, *ARDS* acute respiratory distress syndrome, *MOF* multiple organ failure, *n/a* not applicable

[a] 60–79 years, [b] ≥80 years, [c] ≥60 years, [d] 0–17 years, [e] 18–39 years, [f] 40–59 years

reduced transport time, prevention of hypothermia and immediate support of vital organ functions are of fundamental importance. The overall management follows the principles of the Advance Trauma Life Support (ATLS) protocol of the ACS [43] and initial evaluation begins with the Airway with immobilisation of the cervical spine, Breathing, Circulation and Disability (ABCD). However, specific issues should be considered while managing elderly trauma patients. For instance, the presence of dentures or brittle teeth and the loss of protective airway reflexes may complicate the airway management in the acute setting. A higher suspicion for cervical spine injury needs to be present, even in lower energy mechanisms of injury. Supplementary oxygen must be administered promptly during the initial resuscitation, since elders have less tolerance of hypoxia [17, 44]. Assessment of oxygen saturation by using pulse oximetry monitoring is essential in this group of patients to keep saturation between 85 and 90% [6, 45]. Moreover, regarding the circulatory status, the elderly may present a confusing picture due to pre-existing diseases or medications, altering the response to shock. In these patients, shock may be present with heart rate and blood pressure within normal limits [17]. Also, bilateral arm blood pressure measurements should be obtained because of atherosclerotic changes and higher blood pressure values [40]. Lastly, the evaluation of disability and neurologic status may be challenging and any finding may exist prior to injury, may be the cause of the injury or may be a post-traumatic symptom.

Prolonged exposure to allow full inspection and hypothermia should be avoided in the elderly trauma patient because their thermoregulatory mechanisms are less efficient, leading to myocardial irritability and dysrhythmias [17]. Fluid resuscitation for these patients is also challenging. Geriatric patients do not tolerate hypovolaemia nor do they tolerate hypervolaemia, and, therefore, volume replacement is given cautiously. Fluid resuscitation protocols that are followed in young adults cannot be used in older patients. Ringers lactate is considered to be the fluid of choice in the elderly due to the potential of normal saline causing hyperchloraemic acidosis in patients with impaired renal functioning due to aging [17]. Cardiogenic pulmonary oedema from limited cardiac reserve can be prevented with multiple small fluid boluses (250 mL) and regular clinical assessment. However, conventional monitoring with heart rate, blood pressure and urine output may not be reliable parameters for assessing the haemodynamic and hydration status in the elderly patient [17]. Kidneys

may have lost the ability to concentrate urine, due to aging [6]. In contrast, early invasive haemodynamic monitoring to guide resuscitation and fluid replacement using a pulmonary artery catheter can be of great benefit [46].

In general, there is evidence indicating that the injured elderly patients benefit by an aggressive approach to resuscitation. However, there are insufficient data to support a level I recommendation for the method and endpoints of resuscitation in the elderly patient as a standard of care [3].

Elderly trauma patients are often admitted to the intensive care unit (ICU) despite their potentially stable appearance because of their high propensity to deteriorate rapidly. Early transfer from the emergency department to the ICU allows the performance of thorough and continuous monitoring. In this setting, aggressive but thoughtful management is enabled to avoid hypoperfusion, reduce the incidence of multiple organ failure and improve survival, and to allow further diagnostic workup [17]. Early invasive haemodynamic monitoring with a pulmonary artery catheter can measure oxygen delivery and oxygen debt moving beyond blood pressure and can early identify patients with occult shock and improve survival [47, 48]. In addition to the haemodynamic monitoring, the adequacy of resuscitation and the oxygen debt and tissue perfusion can be monitored by base deficit measurements from arterial blood gases [17]. A base deficit of ≤ -6 mmol/L indicates a severe injury with significant mortality, especially in patients older than 55 years [49]. Level II recommendations advocate that any geriatric patient with physiologic compromise, significant injury, high risk mechanism of injury, uncertain cardiovascular status, or chronic cardiovascular or renal disease should undergo invasive haemodynamic monitoring using a pulmonary artery catheter. Attempts should be made to optimise to a cardiac index ≥ 4 L/min/m^2 and/or an oxygen consumption index of 170 mL/min/m^2 (level III recommendations) [3].

Finally, the management of the elderly trauma patient in the ICU presents many challenges, as the provided care is costly and time- and resource-consuming, with uncertain outcome and even ethical issues to be considered [4]. A number of guidelines have been proposed for the injured elderly in the ICU, including an accurate history with premorbid disease and medication profile, determination of non-survivable injuries in the elderly trauma patients and prompt interventions, such as intubation, tracheostomy or feeding. Early frank discussion with the family is essential, to whom the realistic expectations should be presented. Lastly, early proactive discharge planning should begin in the ICU, involving a coordinated team-oriented approach [4].

Special considerations for the management of specific injuries in the elderly polytrauma

Specific issues should be considered during the management of specific organ injuries and injury patterns in the elderly trauma population [8]. Specifically, blunt chest injury and rib fractures, which are common in these patients, were found to significantly increase morbidity and mortality in the elderly compared to younger trauma patients [50, 51]. Therefore, specific treatment strategies should address these injuries in order to optimise pulmonary function.

Moreover, for the management of splenic injuries, non-operative management, although well-established in haemodynamically stable trauma patients [52], higher levels of failed non-operative management of up to 33% have been recently reported in the geriatric trauma patient population [53]. These findings suggest that, although the appropriately selected geriatric trauma patients can be managed non-operatively, for patients with high-grade splenic injuries and free fluid in the pelvis, age should not be used as a criterion to deny these patients non-operative management.

Specific considerations should also be taken into account regarding the brain and cervical spinal injuries in the elderly polytrauma. Cervical spine fracture patterns can often be clinically unstable in geriatric patients [27]. Nevertheless, the criteria for clinical clearance of the cervical spine from the National Emergency X-Radiography Utilization Study (NEXUS) can be applied safely to these patients, with an expected reduction in cervical imaging comparable with that achieved in non-geriatric trauma patients [54]. Regarding the management of head injuries, especially because the combination of head injury and anticoagulation is associated with adverse outcomes after traumatic brain injury in elderly patients [55], head computed tomography (CT) on all elderly patients, even with minimal head trauma, and serial neurologic evaluation after the CT are recommended [8, 56].

Regarding the orthopaedic injuries, long bone fracture treatment may be complicated and altered by the presence of implants or prosthesis, arthritis, decreased bone density, poor soft-tissue quality, specific anaesthetic and rehabilitation considerations, and delayed surgical intervention [57]. Particularly for pelvic fractures, trauma patients ≥ 65 years of age have worse outcomes and a higher mortality rate compared to their younger counterparts [58]. In older patients, pelvic fractures are more likely to produce haemorrhage and require angiography [30]. These patients are more likely to die from multisystem organ failure compared to younger patients [55].

The staged approach of damage control orthopaedics (DCO) [59] for the management of the orthopaedic injuries in the multiply injured patients is also applicable in the

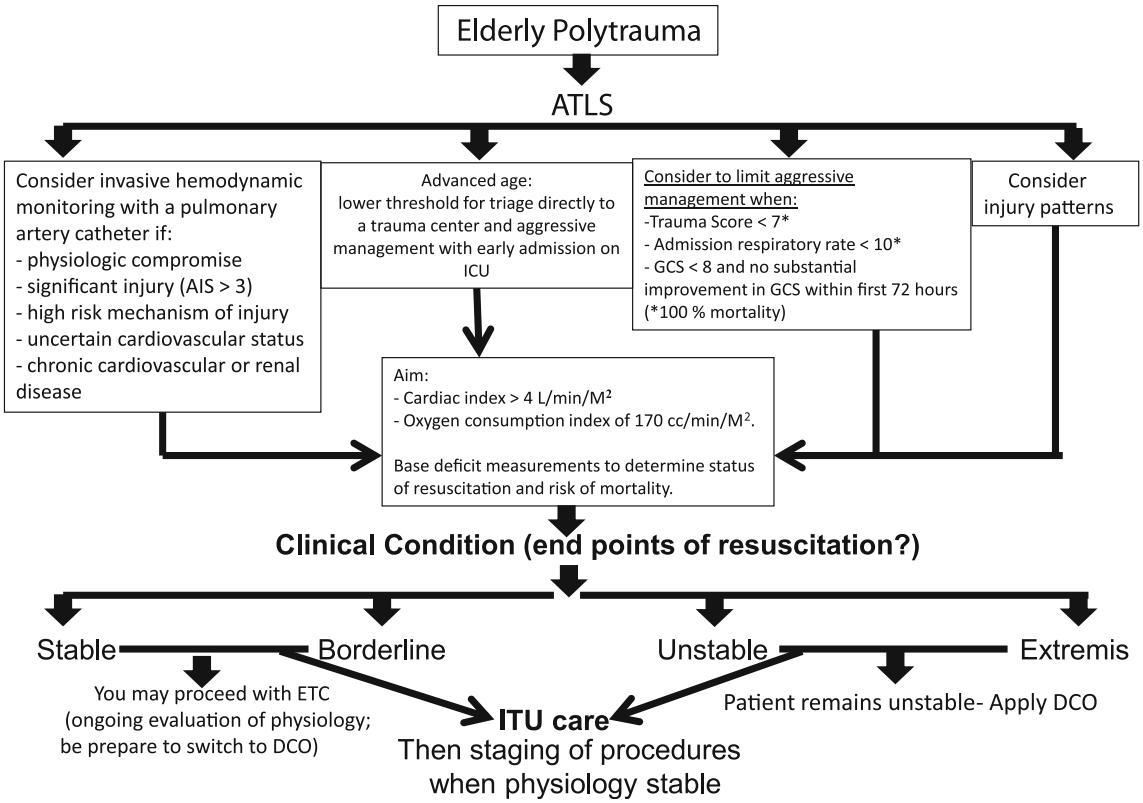

Fig. 2 A basic algorithm for the initial management of the elderly polytrauma patient. *AIS* Abbreviated Injury Scale, *DCO* damage control orthopaedics, *ETC* early total care, *GCS* Glasgow Coma Scale, *ITU* intensive trauma unit

elderly trauma population. Especially in the presence of chest injuries, which is relatively common in this group of patients, or in case of significant pre-existing conditions, the concept of providing temporary stabilisation of fractures with external fixation and reducing the additional physiological burden ('second hit') of a prolonged and more invasive surgical procedure [60] is rational. Although DCO is indicated in the case of unstable or extremis physiological state in adult trauma patients [61], the indications may be even broader in the elderly, due to their reduced physiologic reserves. Furthermore, as there is evidence that the DCO approach controls the lethal triad of hypothermia, acidosis and coagulopathy, and regulates the evolving systemic inflammatory response by reducing the complications of adult respiratory distress syndrome and multiple organ dysfunction [61], such an approach could reduce mortality and improve outcome, since these complications are less tolerated by the elderly patients. A basic algorithm for the management of the elderly polytrauma patients is presented in Fig. 2.

Special considerations in the anaesthetic management of elderly trauma patients

The anaesthetic management of the elderly trauma population is also challenging and more complicated than in younger adults. Preoperative optimisation of the patient is desirable. Additionally to the injuries, a thorough preoperative assessment and planning should embrace the variability and frailty of the physiologic status of the geriatric patient with the associated changes due to aging [62]. Altered pharmacokinetics of the anaesthetic drugs in the elderly, such as sedatives and opioids, should be taken into consideration with appropriate dose alterations. Decreased protective airway reflexes may also be present, increasing the risk of aspiration. Fluid and electrolyte balance is also challenging during the anaesthetic management of these patients and haemoglobin levels should be maintained at adequate levels, requiring constant and meticulous monitoring. Peri-operatively, it is important to minimise additional stresses such as hypothermia, hypoxaemia and pain [62].

Other special care needs and long-term issues in elderly trauma patients

During the overall care of these patients, other specific considerations are also essential in order to reduce the incidence of 'preventable' complications, since aggressive strategies throughout management may improve their survival [63] and reduce the incidence of late mortality seen in elderly trauma victims [33, 64]. Older trauma patients,

even without physiological derangement on admission, were still found to be at a relatively high risk of inpatient mortality [10], suggesting that it might be more difficult to predict which older patients might benefit from more aggressive monitoring or treatment.

In general, these patients require more intensive rehabilitation, particularly after traumatic brain injury [65]. Issues for meticulous skin care, optimum nutritional and immune status, early mobilisation and pulmonary physiotherapy, adequate pain control and even emotional support are important components of post-resuscitation management and quality of care, as they can alter a patient's recovery [17]. Postoperative management of the elderly trauma patients should focus on early mobilisation and thromboembolic prophylaxis in order to avoid the complications of recumbency. Adequate nutritional status should be maintained, particularly during the initial post-traumatic and post-operative catabolic period [57].

Among geriatric trauma patients, there is an increased susceptibility to develop nosocomial infection compared with younger patients, compromising outcome and increasing mortality and hospital or ICU length of stay [66]. Although the exact underlying mechanisms are unknown, a decrease in the immune response to bacteria in the elderly with reduced neutrophil function lasting for 5 weeks after trauma was noted [67]. This highlights the importance of the prevention and the prompt and effective treatment of infectious complications and the need for additional research in this area to reduce infectious morbidity in this trauma population.

Moreover, the adverse effects of trauma can be permanent or can persist for an extended time after injury, especially in the elderly [20]. Since these patients may not regain their pre-injury level of health, mobility and independence [68], long-term rehabilitation and care are challenging obstacles and should be meticulously planned through a multidisciplinary approach in order to avoid recurrent injury and maximise quality of life [17].

Finally, as contemporary trauma scoring systems are insufficient in directing management and predicting survival for the elderly injured patients [69], further research is needed to include age and other parameters in more predictive trauma scores and advanced treatment algorithms in this trauma population.

Conclusion

As the elderly population expands rapidly, an increased incidence of geriatric trauma patients, including severely injured elderly patients, is anticipated. Poorer functional outcomes and increased mortality and morbidity rates in these patients compared to their younger counterparts may be inevitable due to the associated pre-existing medical conditions and the reduced physiological reserves and compensatory mechanisms secondary to aging. However, there is evidence that outcomes can be improved when prompt and aggressive treatment is provided in designated trauma centres, with early admission to the intensive care unit (ICU) and protocols developed especially for this unique patient population [8]. It is, therefore, important to elucidate further the physiologic changes seen during the aging process and the response to injury, and to include these additional parameters during the assessment and the management of the elderly trauma patients, as well as during the evaluation of outcomes.

Although the field of geriatric trauma is still in its infancy, research on this topic is ongoing to develop advanced management strategies and improve outcome. Meanwhile, efforts on injury prevention strategies in this trauma population should continue, and trauma and critical care clinicians should not treat these patients as 'older adults', but as a special population with special considerations. Overall, an aggressive approach should be pursued throughout the management of the elderly trauma patients in order to reduce mortality and the incidence of permanent disability, as the majority of trauma patients with ISS > 16, who survived initial hospitalisation, can still return to independent living after trauma [33, 70].

Conflict of interest All of the authors declare that there is no conflict of interest.

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