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An Update on Care in Geriatric Trauma

Introduction

As the country's population ages, the geriatric population is one of the fastest growing segments of the American public. There are approximately 46.2 million persons 65 years of age or older in the United States. This is currently 14.5% of the population, and the percentage is expected to grow to 21.7% by 2040.[1] Estimates indicate that there will be 98 million Americans 65 years of age and older by 2060.[2] With the advances in medical care, people are living longer and having much more active lifestyles, and injury patterns in the elderly have changed. Healthcare providers now see injuries in geriatric patients that previously were more prevalent in the younger population.

Injury is the fifth leading cause of death in the elderly. This article is an update on the care of the geriatric trauma patient by looking at recent research.[3] There is considerable variation in the age at which a person is considered geriatric. The United States government sets this age at 65 years, but trauma mortality with equivalent injuries has been found to increase at 45 years of age.[4]

Geriatric trauma is a significant financial burden, accounting for 30% of all trauma costs in the United States, at an estimated cost of $9 billion in 2009.[5] This expenditure encompassed 219,000 geriatric trauma injuries,[5] with falls accounting for three-quarters of these injuries, followed by motor vehicle accidents at approximately 25%.[6]

Geriatric patients frequently have multiple comorbidities, such as hypertension and heart disease, as well as frequent polypharmacy and use of medications such as β-blockers, which can mask the vital sign derangements normally seen in trauma patients, and anticoagulants or antiplatelet agents, which can exacerbate hemorrhage. These factors can complicate both the resuscitation and the recovery of the geriatric patient from traumatic injury. Table 1 compares many physiologic and functional differences in geriatric patients to those usually found in a younger trauma patient.[6] These characteristics can make managing an injury that much more difficult.

A significant amount of recent discussion has been focused toward the triage and prehospital identification of geriatric trauma patients. The Eastern Association fo the Surgery of Trauma (EAST) released specific guidelines concerning the triage of geriatric trauma patients in 2001.[6] The specific question, which read in part, "Should age be an independent determinant of triage decisions such as whether trauma patients receive care as a trauma team 'alert' at a designated trauma center" was addressed in 2012 Guidelines on the Evaluation and Management of Geriatric Trauma.[7] EAST guidelines follow the recommendation of the GRADE working group when evaluating the certainty of

EXECUTIVE SUMMARY

- A lower threshold for transport to trauma centers and trauma team activation is recommended for elderly trauma patients, with the chief benefit being seen in the less injured victim.
- Routine CT scans are recommended in elderly head-injured patients, as there are no validated tools that can be used to clinically exclude imaging.
- Modified NEXUS criteria can be used to forego cervical spine imaging in appropriate geriatric trauma patients.
- Pre-injury use of anticoagulant and antiplatelet agents is associated with a worse short-term outcome following blunt trauma.
- Routine screening for alcohol and drug abuse is recommended in elderly trauma patients.

supporting evidence and the strength of recommendations. The authors of the 2012 Guidelines felt there were insufficient data to make any level 1 recommendation, a strong recommendation supported by high-quality evidence. Regarding triage of the elderly trauma patient, there was one level 2 recommendation — "Injured patients with advanced age (aged ≥ 65 years) and preexisting medical conditions should lower the threshold for field triage directly to a designated/verified trauma center"; and two level 3 recommendations — "A lower threshold for trauma activation should be used for injured patients aged 65 years or older who are evaluated at trauma centers" and "Elderly patients with severe anatomic injuries (e.g., one or more body systems with an Abbreviated Injury Scale [AIS] score of ≥ 3) should be treated in designated trauma centers, preferably in intensive care units (ICUs) staffed by surgeon-intensivists." Current Advanced Trauma Life Support (ATLS) teaching recommends that all trauma patients age 55 years and older should be transported directly to a trauma center.[5]

Undertriage, defined as patients not being transported or transferred to a level I/II trauma center who are appropriate for such care, is regarded as a significant problem in geriatric trauma. Undertriage rates begin to climb at age 60 years and can be as high as 60% for patients 90 years of age and older.[8] Current adult trauma triage guidelines may not be sensitive enough for geriatric patients, given their altered physiology. Some states, such as Ohio, have enacted geriatric-specific trauma triage criteria.[8] (*See Table 2.*)

The increase in sensitivity does come at the cost of specificity and an increase in overtriage. Although the Ohio geriatric trauma triage criteria were created to reduce undertriage and deliver a higher proportion of injured elderly patients to specialized trauma centers, an analysis of three years before and three years after their implementation found no change in transports to trauma centers in the injured elderly.[9] This may be due to several factors, such a patient preference to go the local hospital, geography resulting in long transport times to trauma centers, or emergency medical services (EMS) bias. It is also possible that some nontrauma center hospitals may have known specialized orthopedic or neurosurgical programs that attract and keep elderly patients with orthopedic or head injuries.[10]

One persisting observation runs counter to the belief that undertriage of the elderly trauma patient is harmful; there is not a consistent overall difference in mortality between those taken to a trauma center and those who were not.[9,11] The aforementioned Ohio study found no decreased mortality in more severely injured older adults treated at trauma centers compared to nontrauma hospitals, but did find a slightly lower mortality in individuals with mild injuries.[9] Similarly, a study of elderly trauma patients with serious injuries from three counties in California and four counties in Utah found no difference in mortality comparing those treated in trauma centers and those who were not.[11] As might be anticipated, costs were significantly higher for those taken to trauma centers.[11]

A criticism of basing prehospital triage decisions of elderly trauma patients on these two studies is that the data might be out of date. The Ohio study was performed from 2006 to 2011 and the California/Utah study conducted was from 2006 to 2007. Advances in trauma care, as more likely practiced in trauma centers, may make a difference in the elderly. But until high quality evidence is produced, strong recommendations for a lower triage threshold in elderly trauma patients cannot be made, as noted in the 2012 EAST practice guidelines.[7]

Although there is evidence that supports raising the systolic blood pressure criterion for trauma triage from the current 90 mmHg to 100-110 mmHg,[12] the evidence is conflicting regarding setting an age cutoff for automatic trauma transport or trauma team activation. Nakamura et al found that a mandatory field-triage age criterion of 60 years did not reliably identify seriously injured elderly patients without significantly increasing overtriage.[13] This is in contrast to Hammer et al, who found that an age of 70 years for automatic trauma activation in-hospital decreased the odds of death, but did not show a statistically significant decrease in all-cause mortality in geriatric trauma patients.[14]

Vital Signs

The geriatric patient's altered physiology and medication may make traditional standards of normal vital signs inadequate to assess changes in hemodynamic stability. While systolic and diastolic blood pressures can strongly predict the need for massive transfusion in a geriatric patient,[15] heart rate often is not as clinically useful because of medications or the physiologic inability to mount a significant tachycardia. There is research looking at

Table 1. Physiologic and Functional Pre-existing Differences in the Older Adult

Organ System	Normal	Potential Differences in the Older Patient
Vital signs	Increased mortality if HR > 130 beats/min or SBP < 95 mmHg	Increased mortality if HR > 90 beats/min or SBP < 110 mmHg
Neurologic	No baseline deficits	Baseline deficits (dementia, stroke, hearing loss) Report less pain for equivalent injuries, potentially limiting injury discovery
Cardiovascular	No baseline deficits, no hypertension No cardiac medications	Baseline hypertension Medications that affect blood pressure and heart rate (β-blocker, calcium-channel blocker, amiodarone) History of heart failure
Pulmonary	Normal functional residual capacity Potential smoker	Decreased functional residual capacity Chronic obstructive pulmonary disease
Renal	Normal renal function	Decreased glomerular filtration rate
Coagulation	Normal coagulation status	On blood-thinning medications including ASA, warfarin, and platelet inhibitors
Skeletal	Normal bone density	Osteoporosis, leading to easier fracture rate
Medications	Minimal medications	Polypharmacy that can change mental, hemodynamic, renal, and coagulation status

Abbreviations: ASA, acetylsalicylic acid; HR, heart rate; SBP, systolic blood pressure
Reprinted with permission from: Bonne S, Schuerer DJ. Trauma in the older adult: Epidemiology and evolving geriatric principles. *Clin Geriatr Med* 2013;29:142.

venous lactate as a possible substitute for traditional vital signs and titrating resuscitation to lactate, similar to septic shock. Salottolo et al found that venous lactate was 2.6 times better at predicting mortality than traditional vital signs in geriatric patients and that many patients with occult hypoperfusion based on lactate had no evidence of circulatory hemodynamic instability according to vital signs.[16]

Blunt Trauma: Falls and Motor Vehicle Accidents

The majority of geriatric trauma patients present with blunt trauma, with falls being the leading cause, followed by motor vehicle accidents as a distant second. In 2013, it was estimated that about 2.5 million older adults were in emergency departments (EDs) for fall-related injuries, with about 750,000 hospitalizations and 25,000 deaths.[17] In 2016, the EAST published guidelines on prevention of fall-related injuries.[18] This article noted that up 10% of independent older adults who fall sustain a serious injury, such as a long bone fracture. The guidelines strongly recommend risk stratification and targeted risk reduction strategies in high-risk groups and conditionally recommended an exercise program, physical environment modification, and frailty screenings.[18]

Patients older than 75 years of age are more likely to fall at home and/or due to a medical condition, with 30.6% of all falls resulting in a fracture and 23.6% resulting in mild traumatic brain injury.[19,20] These patients were also 1.67 times more likely to be hospitalized after the fall, with 3.82 times the in-hospital mortality compared to patients younger than 75 years of age.[19]

Falls in patients on oral anticoagulants have have a worse prognosis for multiple reasons.[20] One factor is the comorbidity of the condition for which the patient in on therapeutic anticoagulation contributes to a worse outcome. The second is the increased risk of trauma-related complications, such as acute lung injury and acute kidney injury. The third is the increased incidence of injury to the GI tract, liver, spleen, and kidney. And the fourth is the risk of intracranial hemorrhage.[20] Overall, patients taking oral anticoagulants had a higher 30-day mortality.[21] Unadjusted mortality was 16.2% in patients on oral anticoagulants compared with 6.8% in those not on these agents. Multivariate logistic regression found that mortality increased by 180% after a fall in patients on oral anticoagulants (odds ratio, 2.78; 95% confidence interval, 2.14-3.61.).

Hamden et al also looked at predictors for serious injury in the elderly who present with their baseline mental status. Although many elderly patients have slightly depressed mental status at baseline, severely depressed mental status portends a poor prognosis and is indicative of serious intracranial injury after a fall in elderly patients. Overall, elderly patients who present after a fall at their baseline mental status, as reported by family or nursing facility, had a low incidence of intracranial injury. The most reliable predictors of severe intracranial injury were signs of head or facial trauma and a reported loss of consciousness. Together, the two factors had a sensitivity of 92.6%, but a specificity of only 40.2% in predicting intracranial injury. Unfortunately the study is likely underpowered, with only 799 patients included.[22]

With such a large number of deaths attributed to falls, the National Center for Injury Prevention and Control

Table 2. Differences Between Ohio's 2009 Geriatric Trauma Triage Criteria and Adult Trauma Triage Criteria for EMS Providers

Geriatric Triage Criteria (Age ≥ 70 Years)*	Corresponding Adult Triage Criteria
Physiologic	
Systolic blood pressure less than 100 mmHg, or absent radial pulse with carotid pulse present	Systolic blood pressure less than 90 mmHg, or absent radial pulse with carotid pulse present
GCS score ≤ 14 in trauma patient with a known or suspected traumatic brain injury	GCS score ≤ 13
Anatomic	
Fracture of 1 proximal long bone sustained from motor vehicle crash	Fractures of 2 or more proximal long bones
Injury sustained in 2 or more body regions	No corresponding adult criteria
Cause of Injury	
Pedestrian struck by motor vehicle	No corresponding adult criteria
Fall from any height, including standing falls, with evidence of a traumatic brain injury*	No corresponding adult criteria

* Traumatic brain injury is defined as decrease in level of consciousness from baseline, unequal pupils, blurred vision, severe or persistent headache, nausea or vomiting, or change in neurologic status.
Reprinted with permission from: Ichwan B, Darbha S, Shah MN, et al. Geriatric-specific triage criteria are more sensitive than standard adult criteria in identifying need for trauma center care in injured older adults. *Ann Emerg Med* 2015;65:93.

performed a retrospective study to determine whether the increasing fall rate in the geriatric population could be attributed to other underlying conditions or etiologies. While they found that the number of fall deaths and fall-associated deaths increased in the past 10 years, they found that the breakdown in regard to all causes had not changed.[23] The overall increase in deaths may be related to the overall increase in the number of falls as the country's population continues to age.

With the increases in falls, some facilities have looked to outreach programs in an attempt to prevent falls. Lancaster General Hospital implemented a Fall Prevention Protocol to area geriatric facilities aimed at fall education for the staff, education on risk factor identification, and several fall-prevention strategies with the residents.[24] They found an almost 50% reduction in fall-related trauma admissions from these facilities after implementing the outreach program.[24]

With motor vehicle accidents being the second leading cause of injury in the elderly, EAST has made recommendations for prevention. These recommendations place more emphasis on automobile companies for safety, civil engineers to improve the visibility of crosswalks, and the consideration of medical screening to obtain continued licensure.[25] Youngquist et al set out to evaluate the prevalence of acute medical illnesses in elderly patients who presented after a motor vehicle accident and found that one in 10 elderly patients evaluated after a motor vehicle accident were found to have a concomitant acute medical illness.[26] Although there was a one in 10 prevalence, it could not be determined whether the illness precipitated the accident or vice versa.

Overall, the elderly have poor outcomes after a motor vehicle accident because of comorbidities. During a three-year study period, Cevik et al found that overall, 6.1% of elderly patients died in the ED, operating room, or intensive care unit, with heart failure increasing the odds of mortality by 20.2 and abdominal trauma from the motor vehicle accident increasing the odds of mortality by 26.9.[27] Etehad et al found the overall in-hospital mortality was 10.1% and that the overall mortality risk was doubled in geriatric pedestrians struck by a motor vehicle and in geriatric motorcyclists.[28]

Recent studies have refuted the belief that most patients aged 80 years and older involved in a motor vehicle accident will die within one year after discharge following the accident. Although the overall mortality rate was 11.1% within 12 months, more than 70% could be attributed to the motor vehicle accident.[29] This may be due to persistent pain related to the accident, which has negative consequences to the patient's ability to function and quality of life. Approximately one-quarter of elderly patients involved in a motor vehicle accident will have moderate to severe pain related to the accident six months after evaluation,[30] making adequate pain management extremely important.

Cervical Spine Injuries

Cervical spine injuries are most commonly associated with falls in the geriatric population. Cervical spine injuries are difficult to evaluate in the ED, especially in the geriatric population.

The Canadian C-Spine Rule advocates for CT imaging for anyone older than 65 years of age, while the NEXUS C-Spine Rule recommends imaging for any patient with altered mental status. Several studies have attempted to validate the NEXUS criteria in the elderly population, as older studies have recommended that the NEXUS criteria not be used in this population because of an increased rate of missed injuries.[31] The original study focused on severe blunt cervical spine trauma, but not in the elderly population specifically. The authors of a follow-up prospective study in 2014 agreed with the earlier studies that NEXUS criteria were not adequate for detecting cervical spine injury in elderly severe blunt trauma patients, with a sensitivity of only 65.9%.[32]

In 2015, Evans et al looked at NEXUS criteria through a retrospective study in the setting of fall (ground level, from height, down stairs, or found down) and found that the NEXUS criteria can be used with modified

criteria. They defined altered alertness as a change from the patient's baseline mental status (not a GCS of 15) and distracting injuries as injuries limited to signs of trauma to the head and face.

With these modifications, they found that NEXUS had a sensitivity of 100% and specificity of 12.6% in their cohort of 399 patients.[33] The study by Tran et al appears to validate these findings in a prospective cohort of 795 fall patients who were not triaged to a trauma bay. This prospective study found that the modified NEXUS criteria produced a sensitivity of 100% and specificity of 47.7%.[34] These studies are encouraging in that it may be possible to clear the C-spine of a geriatric fall patient without imaging.

Geriatric patients are at increased risk of C-spine fractures, particularly from falls, and have a predominance of upper C-spine injuries. Wang et al reviewed all trauma patients in a retrospective study over a five-year period; of the geriatric patients who had sustained C-spine fractures, 54% were due to ground-level falls.[35] The researchers also found that geriatric patients were more likely to have upper C-spine fractures, and were 1.5 times as likely to have multiple cervical fractures when compared to non-geriatric C-spine injuries.[35] These fractures represent a significant morbidity and mortality in the elderly population, with Delcourt et al finding a global mortality rate of 0-31.4% and a global morbidity rate of 10.3%-90.9%.[36] This was not improved with nonoperative management, although surgical management still showed morbidity up to 62.5% and mortality up to 40%.[36] Studies by Jubert et al and Sander et al had similar findings, indicating that comprehensive discussion may be appropriate with the patients and/or their family members about the possible outcomes and desire for aggressive treatment.[37,38]

Two recent studies looked at features related to acute C-spine fractures that could affect mortality in elderly patients. Although neither could make a definitive correlation, they did show trends indicating that spinal cord injury, a level of injury above C4, advancing age, and pre-existing comorbidities are indicative of an increased risk of mortality. Specific pre-existing comorbidities could not be identified.[39,40] Prior to the identification of a C-spine injury, many patients are placed in cervical collars and backboards. More recently, fewer patients are being placed on backboards because of the dangers associated with spinal immobilization. There is concern that the "spinal neutral" position achieved with the cervical collar may not be the best position for elderly patients, given the typical kyphotic thoracic spine that can provide excessive neck flexion.[41] This, coupled with the lack of level I and level II evidence to support routine C-spine immobilization, should give pause for EMS and ED providers to use cervical collars routinely in the ED prior to injury identification.

Head Injuries

Head injuries frequently are the cause for ED visits in the geriatric population and most frequently are due to a fall. Timler et al found that head injury due to falls accounted for 62.7% of head injuries.[42] There is no clinical decision rule currently validated to exclude the need for a head CT scan in geriatric patients. The Canadian CT Rule and NEXUS II Rule recommend CT for patients age 65 years and older, and the New Orleans Rule recommends CT for patients older than 60 years of age. The American College of Emergency Physicians' current clinical policy was created in 2008 and recommends CT imaging in all patients older than 60 years of age, with extension to 65 years of age if there is no loss of consciousness or post-traumatic amnesia.[43]

Anticoagulation and antiplatelet agents increase the concern for intracranial injury because they have been shown to be an independent risk factor for intracranial hemorrhage after any head injury in the elderly. Narum et al found that warfarin use increased the risk of 30-day mortality by a factor of 8, but antiplatelet use did not not confer an increased risk.[44] These findings are echoed by Inamasu et al, who also found the risk of decreased function and decreased GCS at discharge was elevated with warfarin use, but not with low-dose aspirin use.[45] Nishijima et al found that warfarin use and clopidogrel use were associated with increased risk for immediate traumatic intracranial hemorrhage, but did not evaluate aspirin use.[46] If the patient sustains intracranial injury, the presence of antiplatelet agents can worsen the short-term course. In an analysis of 1,558 adult patients seen in 32 Italian EDs with head injury and intracranial traumatic lesions, preinjury use of antiplatelet agents was associated with double the risk of short-term CT worsening, and the risk was increased five-times with clopidogrel.[47] And antiplatelet agents were associated with a 50% increased incidence of an unfavorable outcome at six months.

Taken together, these studies support a low threshold for CT imaging of elderly head injury patients. Given the current literature, there is little to refute that evaluating head injuries in the geriatric trauma patient is difficult to perform based on clinical exam only, and thus these patients will continue to require CT imaging to exclude intracranial injury.

Penetrating Trauma and Therapeutic Procedures

Penetrating trauma is not as common as blunt injury in the geriatric population and accounts for 8% of all geriatric trauma.[48] As the majority of geriatric trauma is blunt in nature, there is a paucity of research on penetrating trauma in the geriatric population. Allen et al found that geriatric patients with penetrating torso trauma had increased mortality when matched with a younger cohort, with an underlying cause that is described as a "failure to rescue."[48] They state that the failure to rescue is likely due to the lack of adequate patient care procedures and policies for the geriatric patient, as well as a lack of appropriate management of a patient's more complicated comorbidities.[48] Joseph et al researched mortality after a trauma laparotomy and found that geriatric patients performed poorly after laparotomy, with an overall mortality of 23.3% and progressively increasing mortality with advanced age. Mortality in the 55- to 65-year-old group was 16.7%, increasing to 21.7% in the 65 to 75 group, 30.8% in the 75 to 85 group, and reaching almost 67% in those older than 85 years in age.[49]

Resuscitation

Resuscitation is problematic in the geriatric patient because of their altered physiology. As has already been discussed, vital signs may be inaccurate secondary to medication use, and underlying heart failure makes fluid resuscitation concerning. Murry et al evaluated whether age is an independent risk factor for worsened mortality after massive transfusion and found there was no worsened outcome compared to younger patients.[50] They advocated massive transfusion protocols be used equally in the geriatric population but recommended early activation of a massive transfusion protocol in geriatric patients, as it allows for identification of patients at increased risk for poor outcomes.[50] Mitra et al echoed these findings, advocating early activation of massive transfusion protocol (MTP) in geriatric patients. They did not endorse fluid restricted resuscitations based on age alone, as early activation of MTP was associated with increased survival to hospital discharge.[51]

Although fluid restricted resuscitation is not endorsed after hospital arrival, Leenen et al found that limiting fluid resuscitation prehospital helps to prevent dilution coagulopathy as the total amount of crystalloid is decreased.[52] One principle of "damage control resuscitation" in hemorrhagic shock due to trauma is permissive hypotension, delaying volume resuscitation until the patient is in the operating room where the source of bleeding can be addressed. With permissive hypotension, the governing principle is to allow systolic blood pressure to reach a level that avoids hemorrhage exacerbation but maintains perfusion to vital organs. In younger adults, this is often with a systolic blood pressure below 90 mmHg. In the elderly, there is evidence that not intervening when systolic blood pressure drops to this level, perfusion to vital organs is impaired. Thus, the concept of permissive hypotension should be modified in geriatric trauma with hemorrhage with a target systolic blood pressure of 110 mmHg. A retrospective study performed by Bridges et al found no increase in mortality with increasing age. They also found a lack of data on permissive hypotension and could not recommend routine permissive hypotension in the elderly population.[53] Bar-Or et al investigated an alternative to traditional trauma resuscitation practices of damage control resuscitation that involved early trauma surgeon involvement and venous lactate-guided therapy. They found that in-hospital mortality was halved in patients with occult hypoperfusion that was not immediately identifiable based on traditional resuscitation guidelines.[54]

Anticoagulation

With a significant portion of the geriatric population taking antithrombotic agents, it is imperative to be familiar with the various agents and reversals that are available. Warfarin is the most commonly encountered anticoagulant and it works by inhibiting synthesis of vitamin K-dependent cofactors. In acute hip fractures, Gleason et al and Buecking et al found that oral vitamin K supplementation alone was sufficient to reverse the INR with no delay in surgery due to inability to reverse the anticoagulation.[55,563]

Sarode et al compared 4-factor prothrombin complex concentrates (4F-PCC) to plasma for rapid reversal of vitamin K antagonists in patients with major bleeding. They demonstrated non-inferiority in achievement of hemostasis, but showed superiority in rapid INR correction, with 69% of 4F-PCC patients achieving an INR less than 1.3 one hour after the start of infusion compared to none receiving plasma.[57] After 24 hours, more patients in the 4F-PCC group demonstrated an INR less than 1.3 than in the plasma cohort, 88% vs. 58%, respectively.[57] They found similar safety profiles between the two cohorts, and 4F-PCC had no more adverse effects than plasma.[57] These findings are echoed by Goldstein et al in evaluating for non-inferiority of 4F-PCCs compared to plasma in rapid reversal of vitamin K antagonists in patients needing urgent surgical or invasive interventions.[58]

Mangram et al compared 3F-PCCs and 4F-PCCs and found that while 4F-PCCs had a higher initial cost, they were more successful in correcting INR and were associated with fewer adverse events, particularly thromboembolic events, than 3F-PCCs.[59]

Reddy et al investigated whether prophylactic fresh frozen plasma (FFP) infusions of 400-450 mL would reverse INR and prevent delayed intracranial hemorrhage. They found that the majority of patients (78% in the study cohort) would not have their INR reversed to below 1.5 and that the prophylactic FFP did not decrease the incidence of delayed intracranial hemorrhage.[60] As a result, they could not recommend routine prophylactic FFP for INR reversal in suspected head trauma and negative head CT.[60]

Berndtson et al evaluated novel oral anticoagulants and possible reversal with FFP and PCCs and found that both direct thrombin and direct factor Xa inhibitors were not reversed reliably with these agents.[61] There are several reversal agents for the novel oral anticoagulants being researched. Idarucizumab, a monoclonal antibody fragment that binds with dabigatran, was recently released. The RE-VERSE AD trial by Pollack et al found that a 5 gram dose of idarucizumab almost immediately and completely reversed dabigatran activity in 88-98% of patients.[62]

Alcohol and Drugs

Historically, drug and alcohol abuse has not been thought to be associated with geriatric trauma to the same degree that it related to trauma in younger adults. In the general trauma population, the prevalence of substance abuse ranges from 46.5-71% of all patients admitted with traumatic injuries.[63,64] The American College of Surgeons mandates that all level 1 trauma centers have alcohol-screening programs.[65] Ekeh et al found alcohol and drug screening in older patients is inconsistent, with only 31.5% and 12.1% of trauma patients older than 65 years of age tested for alcohol and drugs, respectively.[66] In the 1,302 patients who underwent toxicologic screening, a blood alcohol greater than 8 mg/dL was found in 3.4% and a positive urine drug screen was seen in 48.3%. They expressed concern that the lack of testing for such substances could place the geriatric patients at increased risk for complications due to withdrawal or

altered physiology.

Elder Abuse

The CDC estimates that 500,000 elderly adults are subjected to abuse and maltreatment every year, and that this number is underestimated because of a lack of reporting.[67] Victims of elder abuse may present as trauma patients in the ED, with the most common types of injuries being skeletal fractures and head injury inconsistent with the history of the injury.[68] Fractures of the head, cervical spine, and trunk are more likely to result from physical assault, but spiral fractures of the long bones and fractures with a rotational component are more diagnostic of physical abuse.[68] Bruising is more indicative of abuse when located on the neck, ears, genitalia, buttocks, and soles.[69] Burns in a pattern similar to that of child abuse are applicable to elder abuse. Splash burns, stocking and glove burns, and burns with uniform depth also should raise suspicion for abuse.[69] Physicians who suspect elder abuse have a duty to ensure the safety of their patients. Mandatory reporting laws exist in 42 states, with many states providing immunity to physicians for reporting.[68]

Conclusion

America is aging, and elderly adults are expected to comprise approximately 21.7% of the population by 2040. Injury is the fifth leading cause of death in this population. Geriatric trauma accounts for 30% of all trauma costs. A lower threshold for transport to a trauma center and trauma team activation is recommended for elderly trauma victims, with current data are indicating benefit in the less injured and inadequate to demonstrate improved outcome in the seriously injured. With the altered physiology of the elderly population, venous lactate appears to be a good predictor of mortality and adequate volume resuscitation. Most falls happen at home, with mortality increasing as age progresses. In an attempt to reduce fall admissions, outreach programs to extended care facilities have been shown to improve fall rates after implementation.

Motor vehicle accidents account for the second most common cause for geriatric blunt trauma, with poor outcomes being related to underlying comorbidities. C-spine injuries are common in the elderly, but research is showing that CT scans may not be routinely necessary and that modified NEXUS criteria can be used to clear the C-spine in specific situations. When the C-spine is injured in the elderly, it more commonly involves the upper cervical spine and is associated with significant morbidity and mortality. CT scans are still recommended for head injuries in the elderly patient.

Penetrating trauma portends a poor prognosis in the elderly patient and appears to be related to the increased number of comorbidities that elderly patients possess. With penetrating trauma or severe blunt trauma, there often may be major bleeding or a need for an urgent procedure. With many of these patients taking anticoagulant medications, the authors recommend that patients taking vitamin K antagonists be given 4F-PCCs for reversal rather than FFP because of the more rapid correction. FFP and 4F-PCCs do not reliably reverse the anticoagulation provided by direct thrombin and direct factor Xa inhibitors. Factor replacement products have limited ability to reverse these novel oral anticoagulants, with only idarucizumab being available specifically for dabigatran.

While the presence of drugs and alcohol is less prevalent in the geriatric population, routine laboratory testing with ethanol levels and urine drug screens is recommended in the trauma patient, as withdrawal can lead to worsened outcomes. With the significant amount of elder abuse every year, it is important to be aware that the elderly patient's injuries may not be accidental. It is imperative that physicians be aware of injury patterns that could be related to abuse.

Geriatric trauma is a difficult area of care because of the varying complexities inherent in the elderly population. Recent research has attempted to improve the care of these patients, but there still are areas that lack adequate study. It is hoped that this update to the current literature will lead to improved care in the geriatric population.

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CME/CE Objectives

Upon completion of this educational activity, participants should be able to:

- recognize specific conditions in patients presenting to the emergency department;
- apply state-of-the-art diagnostic and therapeutic techniques to patients with the particular medical problems discussed in the publication;
- discuss the differential diagnosis of the particular medical problems discussed in the publication;
- explain both the likely and rare complications that may be associated with the particular medical problems discussed in the publication.

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CME/CE Questions

1. Which of the following is considered to be undertriage of geriatric trauma patients according to EAST practice management guidelines?
   a. Patients not being appropriately labeled as the highest level of trauma alert when applicable
   b. Geriatric trauma patients not being transported or transferred to a level I/II trauma center
   c. Labelling a patient as an acuity level 3 when they are appropriately an acuity level 2
2. Which of the following statements is *false* in regard to the geriatric vital signs in trauma?
   a. Hypotension per systolic or diastolic blood pressures can strongly predict the need for massive transfusion.
   b. Vital signs often are altered because of the patient's medications or physiologic inability.
   c. Heart rate is just as clinically useful in geriatric patients as in younger patients.

d. Venous lactate is useful in trauma in identifying occult hypoperfusion.

3. Which of the following is the most reliable predictor of serious intracranial injury?
   a. Depressed mental status below baseline
   b. Any GCS less than 15 after a fall
   c. Absence of facial or head trauma
   d. Any sign of head or facial trauma and a reported loss of consciousness

4. Research is showing that clinical decision-making guidelines can prevent CT imaging of:
   a. the head only.
   b. both head and neck.
   c. the neck only.
   d. neither the head nor the neck.

5. Factors influencing the poor outcome of penetrating trauma in the elderly include:
   a. lack of adequate policies and procedures.
   b. multiple comorbidities.
   c. physiologic changes.
   d. All of the above

6. Appropriate fluid resuscitation includes which of the following?
   a. Damage control resuscitation with permissive hypotension
   b. Venous lactate-guided resuscitation
   c. Fluid restriction prehospital to prevent dilution coagulopathy
   d. Early activation of massive transfusion protocols
   e. b, c, and d

7. When compared to plasma for rapid reversal of vitamin K antagonists, 4-factor prothrombin complex concentrates demonstrated:
   a. slower correction of INR.
   b. a greater proportion of patients with INR corrected after 24 hours.
   c. more adverse effects than plasma.
   d. plasma is preferred for patients who need urgent surgery or invasive interventions.

8. For INR reversal, 3-factor and 4-factor prothrombin complex concentrates are equally efficacious.
   a. True
   b. False

9. Novel oral anticoagulants are reliably reversed by:
   a. fresh frozen plasma.
   b. dedicated agents, such as monoclonal antibody fragments (idarucizumab).
   c. prothrombin complex concentrations.

10. Signs associated with physical elder abuse include which of the following?
   a. Spiral fractures of long bones
   b. Fractures with a rotational component
   c. Bruising on the neck, ears, genitalia, and buttocks
   d. Splash burns, stocking and glove burns, and burns with uniform depth
   e. All of the above

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An Update on Care in Geriatric Trauma

Physiologic and Functional Pre-existing Differences in the Older Adult

Organ System	Normal	Potential Differences in the Older Patient
Vital signs	Increased mortality if HR > 130 beats/min or SBP < 95 mmHg	Increased mortality if HR > 90 beats/min or SBP < 110 mmHg
Neurologic	No baseline deficits	Baseline deficits (dementia, stroke, hearing loss) Report less pain for equivalent injuries, potentially limiting injury discovery
Cardiovascular	No baseline deficits, no hypertension No cardiac medications	Baseline hypertension Medications that affect blood pressure and heart rate (β-blocker, calcium-channel blocker, amiodarone) History of heart failure
Pulmonary	Normal functional residual capacity Potential smoker	Decreased functional residual capacity Chronic obstructive pulmonary disease
Renal	Normal renal function	Decreased glomerular filtration rate
Coagulation	Normal coagulation status	On blood-thinning medications including ASA, warfarin, and platelet inhibitors
Skeletal	Normal bone density	Osteoporosis, leading to easier fracture rate
Medications	Minimal medications	Polypharmacy that can change mental, hemodynamic, renal, and coagulation status

Abbreviations: ASA, acetylsalicylic acid; HR, heart rate; SBP, systolic blood pressure
Reprinted with permission from: Bonne S, Schuerer DJ. Trauma in the older adult: Epidemiology and evolving geriatric principles. *Clin Geriatr Med* 2013;29:142.

Differences Between Ohio's 2009 Geriatric Trauma Triage Criteria and Adult Trauma Triage Criteria for EMS Providers

Geriatric Triage Criteria (Age ≥ 70 Years)*	Corresponding Adult Triage Criteria
Physiologic	
Systolic blood pressure less than 100 mmHg, or absent radial pulse with carotid pulse present	Systolic blood pressure less than 90 mmHg, or absent radial pulse with carotid pulse present
GCS score ≤ 14 in trauma patient with a known or suspected traumatic brain injury	GCS score ≤ 13
Anatomic	
Fracture of 1 proximal long bone sustained from motor vehicle crash	Fractures of 2 or more proximal long bones
Injury sustained in 2 or more body regions	No corresponding adult criteria
Cause of Injury	
Pedestrian struck by motor vehicle	No corresponding adult criteria
Fall from any height, including standing falls, with evidence of a traumatic brain injury*	No corresponding adult criteria

* Traumatic brain injury is defined as decrease in level of consciousness from baseline, unequal pupils, blurred vision, severe or persistent headache, nausea or vomiting, or change in neurologic status.
Reprinted with permission from: Ichwan B, Darbha S, Shah MN, et al. Geriatric-specific triage criteria are more sensitive than standard adult criteria in identifying need for trauma center care in injured older adults. *Ann Emerg Med* 2015;65:93.

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