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Evaluation of Trauma in Older Adults

The healthcare system has increasing numbers of older adults, with unique physiologic and anatomic considerations that need to be taken into account in trauma resuscitation to maximize each patient's outcome.

— Ann M. Dietrich, MD, Editor

Introduction

With the growing older adult population in the United States, emergency and trauma physicians are caring for increasing numbers of older adults with traumatic injuries. In 2020 alone, there were more than 2.8 million emergency department (ED) visits for older adults with traumatic non-fatal falls, and another more than 62,000 who died from their traumatic injuries.[1] The 2019 Advanced Trauma Life Support (ATLS) guidelines list geriatric trauma as a special population, suggesting additional attention is needed to the physiologic changes and comorbidities that affect the trauma exam and management.[2] The presence of common comorbid conditions in older adults, such as cardiovascular disease, liver disease, coagulopathy, chronic obstructive pulmonary disease (COPD), and diabetes, significantly increases the risk of mortality from traumatic injury.[3-6] Common older adult trauma presentations, comorbidities, and patterns of injury have been reviewed recently.[7,8] This article reviews advances in the care of older adults with traumatic injuries and the quality improvement and accreditation programs that involve the initial ED care.

Epidemiology

The next decade will be marked by a significant proportion of the population reaching old age, projecting more than 77 million adults older than 65 years of age by 2034.[9] The older adult population in the United States will increase from 15% in 2016 to 21% in 2030.[9] Older adults are the fastest growing demographic of trauma patients, and traumatic injury is the seventh leading cause of death for older adults.[10,11] Analysis of the National Trauma Database demonstrated that the proportion of geriatric trauma increased from 18% to 30% between 2005 and 2015, and the continuing rise in the older adult population is expected to cause a proportional surge in this trauma population.[12]

The most common cause of trauma in older adults is falls, which account for approximately 75% of all cases.[8,13] Additional important mechanisms of older adult trauma, in order of incidence, include motor vehicle collisions (MVCs), burns, and penetrating injuries. In 2018, 10% of older adults in the United States had a fall-related injury.[14] Moreover, the direct medical cost incurred from fatal and non-fatal falls in older adults amounts to $51 billion annually.[15]

EXECUTIVE SUMMARY

- The most common cause of trauma in older adults is falls, which account for approximately 75% of all cases. Additional important mechanisms of older adult trauma, in order of incidence, include motor vehicle collisions, burns, and penetrating injuries.
- The American College of Surgeons, American College of Emergency Physicians, and Institute for Healthcare Improvement all emphasize multidisciplinary care and screening/managing geriatric syndromes, such as delirium, fall risk, frailty, and difficult transitions of care.
- Older adults can experience severe injuries with minimal change in vitals and from low-energy mechanisms, such as a ground-level fall.
- Older patients exhibit decreased forced expiratory volume (FEV_1) and forced vital capacity (FVC) because of reduced chest wall compliance, weakened diaphragm/accessory muscles, and loss of lung elastic recoil with increased residual volume. These physiologic changes place the older adult trauma patient at increased risk of respiratory decompensation secondary to pulmonary injury or chest wall injury.
- Frailty is a condition that affects 13% of community dwelling older adults. It is a clinical syndrome of low physical activity, weight loss, and slowed mobility. Frailty doubles the risks of death and complications for trauma patients and increases the risk of perioperative death for any type of surgery needed.
- Placing frail trauma patients on a multidisciplinary frailty pathway of early ambulation, geriatric consultation, nutrition, and physical therapy evaluation reduces complications and delirium for these patients.
- All older adult trauma patients should be screened for evidence of abuse/neglect, substance use, and depression/suicidal ideation as precipitants for their trauma.
- Rehabilitation teams and case management are essential in arranging home healthcare, equipment, and acute rehabilitation in discharge planning of an older adult recovering from traumatic injury.

For those who survive the initial injury, recovery can be difficult, and their risk of subsequent death in the ensuing six to 12 months also is increased.[16]

Accreditation Programs

In response to the higher morbidity and mortality seen in older adults, the American College of Surgeons (ACS) published the 2012 Geriatric Trauma Management Guidelines.[17] The following year, the American College of Emergency Physicians (ACEP) and American Geriatrics Society published the Geriatric ED Guidelines, which also address trauma care for older adults.[18,19] In the past decade, these organizations, as well as the Institute for Healthcare Improvement (IHI), have developed accreditation programs for high-quality care of older adults in the ED. The IHI guidelines focus on incorporating the 4 Ms, summarized as What Matters, Medications, Mobility, and Mentation.[20]

All three accreditation programs emphasize multidisciplinary care and screening/managing geriatric syndromes, such as delirium, fall risk, frailty, and difficult transitions of care. These additional assessments are added to the traditional ABCDE (airway, breathing, circulation, disability, exposure) algorithm of ATLS care,[21] adding an "F" for frailty assessment and a "G" for geriatric screening.[20] Table 1 summarizes some of the elements of the geriatric accreditation/verification programs. For a complete list of the elements required for certification/accreditation, the individual program documentation should be reviewed. The Geriatric ED program is focused on the emergency care and initial transitions, while the ACS Geriatric Surgery Verification involves outpatient clinics and elective surgery centers as well as inpatient and ED care. The IHI program can be implemented in multiple settings, from a small unit or clinic to an entire health system. This can involve the ED care in different ways, from geriatric trauma-triage criteria through the ED management of trauma patients to disposition considerations.

Considerations in Triage

Multiple studies have demonstrated the tendency to under-triage older adult trauma patients to facilities with insufficient trauma capabilities, requiring subsequent transfer to Level I/II trauma centers.[22-25] This is in large part because current triage criteria emphasize physiologic parameters and high-energy mechanisms. In contrast, older adults can experience severe injuries with minimal change in vitals and from low-energy mechanisms, such as a ground-level fall. Age-related anatomic and physiologic differences decrease the sensitivity of these metrics, leading to under-triage and under-transport.[25]

Several prehospital tools have been studied to aid in decision making for transport to a higher level trauma center. The Glasgow Coma Scale (GCS) has historically predicted the need for full trauma team activation and hospital admission after traumatic injury.[26] GCS is an integrated tool with ATLS protocols for trauma activation and still plays an integral role within geriatric trauma evaluation. Recent studies have suggested a modified GCS-motor scale can be used to efficiently triage trauma patients in the prehospital setting without significant adverse outcomes or change in rate of transfer to higher level of care.[27] However, these studies did not specifically evaluate the geriatric population. In a recent cohort study, Deeb et al demonstrated that older trauma patients frequently present with non-motor symptoms and that use of GCS motor scales would further exacerbate the level of geriatric under-triage.[28] As a result of the limited data and efficacy, the inclusion of modified GCS scales was considered in National Field Triage Guidelines but is not advised currently.[3] Furthermore, older adults have been shown to exhibit different injury patterns and may present with severe

Table 1. Quality Accreditation Programs and Their Requirements for the Care of Trauma Patients in the Emergency Department

	ACEP Geriatric Emergency Department Accreditation	ACS Geriatric Surgery Verification	IHI Age-Friendly Health Systems
Program summary	• Three tiers of accreditation based on the number of quality improvement protocols in place (1, 10, or 20) • Emphasizes screening for geriatric syndromes and multidisciplinary approach to care	• Involves improvement of all surgery in the health system, under oversight of a Geriatric Surgery Quality Committee. Annual QI efforts targeting delirium prevention and management, mobility, palliative care and end of life wishes, and functional status • Multidisciplinary approach recommended for trauma patients	• QI program incorporating annual improvement and emphasizing the 4-M model of goals of what matters, mentation, mobility, and medications • A unit, division, or entire health system can be accredited.
Personnel	• Level 1 requires access to geriatric consultation, case managers/social workers, and therapists during the ED stay.	• Access to palliative medicine and geriatric consultants, therapists, and case managers if indicated	• Varies
Patient population	• Emergency department patients	• All surgical patients	• Varies
Equipment required	• Walkers and mobility devices, hearing aids and sensory impairment devices, and delirium management tools	• Focus on use of home sensory impairment devices, reorientation with large clocks and daily schedules, and fall prevention equipment	• Varies
Annual quality improvement activities	• Not required, but outcomes are submitted annually	• Required	• Required

ACEP: American College of Emergency Physicians; ACS: American College of Surgeons; IHI: Institute for Healthcare Improvement; QI: quality improvement; ED: emergency department

traumatic brain injury even in the setting of a high GCS when compared to younger counterparts.[29-31] A small decline in GCS from 15 to 14 in older adult trauma patients is associated with significantly increased mortality, and this association is not seen in younger adults.[32] As such, the use of GCS in isolation for triage and trauma activation is unreliable in the geriatric trauma population.[31]

In the National Field Triage Guidelines, the GCS is incorporated into a larger assessment combined with systolic blood pressure and respiratory rate.[3] These physiologic parameters comprise a Revised Trauma Score (RTS), which has a strong correlation with survival and morbidity, but still under-triages older adults. Hypoperfusion not apparent on traditional vital signs measurements occurs in as much as 20% of geriatric trauma patients.[33] Because of this, guidelines have been amended to have a lower threshold for activation at higher GCS and higher systolic blood pressure (SBP), as demonstrated in Table 2.

Increasing age is an independent risk factor for mortality and morbidity secondary to traumatic injury, with a 2.4-5.6 greater risk of death.[34-39] The Major Trauma Outcome Study concluded that at all levels of injury severity and mechanisms, patients older than 55 years of age had increased in-hospital mortality.[34] Many studies have evaluated older age as a stand-alone cutoff for trauma activation.[35,36,40] In one retrospective cohort, an age cutoff of 55 years for trauma activation would have resulted in a modest ~13% increase in sensitivity but a large ~31% decrease in specificity. The subsequent increase in over-triage using age > 55 years alone could be untenable in many trauma centers. Therefore, caution should be used in using age alone as a metric for automatic trauma activation. Other analyses have demonstrated that age older than 70 years may be an appropriate cutoff when combined with other factors. Patients older than 70 years of age have significantly greater mortality when risk stratified by Injury Severity Score (ISS), and in one study 63% of those older than 70 years with severe injuries (ISS > 15) did not have hemodynamic signs that would meet trauma activation.[35,36] Adjusting trauma triage alert criteria for

Table 2. Guideline-Based Geriatric Trauma Center Triage Considerations

- Systolic blood pressure < 110 mmHg[a,b,c,d]
- Lower overall "threshold" for activation in any geriatric patient[b,c]
- Penetrating injury [a,b,c,d]
- Geriatric fall from any height with anticoagulation and head strike[b,c,d]
- Geriatric trauma in a patient with Glasgow Coma Scale score ≤ 14 with suspected head trauma[a,d]
- Injury sustained in two or more body regions[b,d]
- Age > 70 years old[d]
- Geriatric pedestrian struck at any speed[d]
- Fracture of 1+ proximal long bone in geriatric patient[d]

Listed with annotation from different evidence-based trauma guidelines, including: [a] Advanced Trauma Life Support (American College of Surgeons); [b] Eastern Association for the Surgery of Trauma; [c] National Field Triage Guideline (American College of Surgeons and Centers for Disease Control and Prevention); [d] Trauma committee of Ohio EMS

those older than 70 years of age seems to be the best age marker given current data.

Specific aspects of trauma triage criteria from different organizations can be found in Table 2. The American College of Surgeons (ACS), ATLS guideline, and Eastern Association for the Surgery of Trauma (EAST) all agree that adults with advanced age with comorbid conditions should have a lower threshold for triage to major trauma centers following injury.[2,17,21,41] In 2011, the Trauma Committee of Ohio EMS derived a set of geriatric-specific prehospital triage criteria that has increased the sensitivity for severe injury in older adult patients by 32%.[42] National Field Triage Guidelines developed by the Centers for Disease Control and Prevention (CDC) in consortium with the ACS have revised special considerations for geriatric trauma triage as well.[3]

Considerations in the Primary Survey

The standard primary survey described by the ATLS guideline is appropriate for the initial trauma assessment of older adults.[2,21] However, there are special considerations within each step of this approach because of the physiological changes with aging and increased medical comorbidity.

Airway

The evaluating physician should identify barriers to ventilation, intubation, and possible surgical airway. Cervical collars often do not fit older adults well and contribute to iatrogenic respiratory difficulty that can be mistaken for respiratory distress. Prior to intubation, consider maintaining c-spine immobilization manually and repositioning the position in reverse Trendelenburg to see if that improves respiration. If intubation is needed, thoroughly examine the mouth. Older adults are more likely to be edentulous. Dentures may facilitate bag-mask ventilation but can significantly compromise laryngoscopy during attempted intubation.[21]

Cervical mobility is reduced in older adults from underlying arthritic changes, degenerative disk disease, and sometimes prior surgical fixation.[43] Intubation using video laryngoscopy should be first line, except when contraindicated by excessive blood or secretions in the mouth. Video laryngoscopy increases the rate of first-pass intubation success from 79% to 90% in the general trauma population.[44] Increased cervical column curvature, preexisting neck malignancies, or prior surgery may alter the normal cervical anatomy, which may increase the difficulty of surgical airway procedures.

Rapid sequence induction with etomidate or ketamine is used commonly in older adult trauma patients. Because older adults are more likely to have hypopnea and hypotension from induction agents, reducing the initial dose by 50% (etomidate 0.15 mg/kg or ketamine 1 mg/kg to 2 mg/kg) and pretreating post-intubation hypotension by starting intravenous (IV) fluid resuscitation prior to or during intubation may reduce side effects. Benzodiazepines have a longer half-life in older adults and are not a good induction agent for emergency intubation. Similar to sedatives, neuromuscular blockade medications, such as succinylcholine or rocuronium, will have longer half-lives in older adults. If there is any concern that the patient was on the ground for a long time and could have muscle breakdown and hyperkalemia, use rocuronium instead of succinylcholine.

Breathing

Overall pulmonary function declines with age. Older patients exhibit decreased forced expiratory volume (FEV_1) and forced vital capacity (FVC) because of reduced chest wall compliance, weakened diaphragm/accessory muscles, and loss of lung elastic recoil with increased residual volume. These physiologic changes place the older adult trauma patient at increased risk of respiratory decompensation secondary to pulmonary injury or chest wall injury. Flat immobilization can exacerbate and impair respiration. Elevate the head of bed to limit dependent atelectasis and reduce shunting, using reverse Trendelenburg position to maintain spinal precautions if needed.[45] Noninvasive mechanical ventilation is a potentially beneficial therapeutic option in blunt chest trauma. It has been shown to decrease the rate of intubation and subsequent complication.[45,46] A trial of positive pressure ventilation should be considered in the alert, oriented patient in respiratory distress with evidence of pulmonary contusion or flail chest.[47] However, data are limited regarding benefits in terms of mortality.[48] End-tidal capnography is highly recommended for older adults if there is concern for underlying lung disease (COPD, pulmonary fibrosis, or pulmonary hypertension), thoracic injury (rib fractures or pulmonary contusions), or if analgesia and sedatives are provided.

Circulation

Coronary artery disease, cardiomyopathy, heart failure, valvular disease, and diastolic dysfunction limit the normal physiologic responses to blood loss.[49,50] Decreased adrenergic receptor responsiveness to catecholamines with

Table 3. Considerations in the Primary Survey for the Older Trauma Patient

Airway
- Bag mask valve ventilation impaired by changes in dentition
- Neck mobility impaired by cervical arthritis, kyphosis, masses, and post-surgical changes
- Surgical airway anatomy impaired by kyphosis
- Increased risk of post-intubation hypotension because of lack of physiologic reserve

Breathing
- Decreased pulmonary reserve because of thoracic kyphosis, decreased chest wall compliance, and chronic lung disease such as COPD
- Decreased compensatory mechanism for rib/sternal fractures leading to respiratory distress
- Consider noninvasive mechanical ventilation early in blunt chest trauma/pulmonary contusion

Circulation
- Diastolic dysfunction, arrhythmia, and cardiomyopathy limit augmentation of stroke volume
- Medications impair tachycardic response to hypoperfusion, leading to pseudo-normal vital signs
- Anticoagulant use is prevalent and increases risk of life-threatening hemorrhage

Disability
- Assessment of neurologic function can be confounded by dementia and delirium, and sedative medications
- Brain atrophy and anticoagulation increase risk of intracranial hemorrhage
- GCS does not correlate with injury severity in older adults

Exposure
- Pressure ulcers can form quickly from backboards or cervical collars
- Progressive age impairment of thermoregulation and decreased muscle mass
- Oral temperature may be inaccurate; consider rectal temperature
- Be aware of skin findings associated with non-accidental trauma

COPD: chronic obstructive pulmonary disease; GCS: Glasgow Coma Scale

advanced age limits the augmentation of stroke volume in response to increased demand.[50] As a result, increasing heart rate may be the primary mechanism of increasing cardiac output to compensate for blood loss. Unfortunately, the heart rate response also may be impaired because of existing conduction system abnormalities, loss of pacemaker cells with aging, and commonly used negative chronotropic agents (beta-blockers, calcium channel blockers). These physiologic changes can result in "normal" appearing vital signs that do not reliably reflect the severity of injury in older adult trauma patients. Because "normal" vital signs are not definitively reassuring in the older adult population, adjusted parameters for heart rate and blood pressure (heart rate > 90 bpm, systolic blood pressure < 110 mmHg) are necessary to avoid relative hypotension and occult hypoperfusion, a finding associated with two times rate of mortality in older adult trauma.[51] For example, a patient with hypertension and a baseline SBP of 160 mmHg is relatively hypotensive when presenting with SBP of 110 mmHg. In addition to trending vital signs and reviewing past medical records for baseline levels, trending lactate to assess adequacy of perfusion and resuscitative efforts can serve as a useful adjunct in the resuscitation of these patients.[33]

Disability

A Glasgow Coma Scale is not as good a predictor for severity of injury in older adults as in younger adults, since a good GCS (14-15) does not correlate with severity of injury on computed tomography (CT) for older adults.[52] Baseline neurological function can be complicated by comorbid conditions, such as underlying dementia or acute delirium from the injury. All depressed neurological function, including amnesia to the event or confusion, should be evaluated as a potentially traumatic brain injury. Delirium can be present with a GCS of 15. Common tools validated in the ED include the b-CAM, the CAM, and the 4-AT.[53,54] Empowering other team members to confirm baseline mental status with family or caregivers while the physician and nursing team are performing their primary assessment can be very helpful. Delirium can be the result of injury or can lead to the injury (such as causing a fall or MVC).

Delirium management in the ED requires attention to pain control, ambulation, sensory impairment, and tethers (catheters, monitors, and intentional restraints). Allowing family into the room early can be helpful for the patient. While in the past Foley catheters were placed in most Level I trauma patients, they should be avoided in older adults unless indicated for potential bladder injuries or urgent surgery. Unnecessary Foley catheter placement can exacerbate delirium as well as lead to urinary retention and infections.[55]

Exposure

A full skin exam is critical. The skin exam can give insight into the cause of a fall or inform concern about elder abuse/neglect as a cause of injury. Bruising and lacerations can be easily missed, as can pressure ulcers from prolonged backboard/cervical collar use.[56] Keeping the patient warm in the trauma bay also should be prioritized. Many older adults experience an age-related decline in thermoregulatory capacity and muscle mass.[57] Oral and axillary temperatures can be less reliable (artificially low) in older adults.[58] A rectal temperature is most reliable if there is concern for altered mental status secondary to hypothermia. A summary of the considerations in the primary survey for the older trauma patient may be found in Table 3.

Frailty

Frailty is a condition that affects 13% of community dwelling older adults.[59] It is a clinical syndrome of low physical activity, weight loss, and slowed mobility.[60] Frailty doubles the risks of death and complications for trauma patients and increases the risk of perioperative death for any type of surgery needed.[61,62] Frailty predicts in-hospital and six-month mortality better than ISS.[63] Frail patients have altered inflammatory and endocrine responses, suggesting that they cannot heal adequately or respond to catecholamines as well following traumatic injury.[64] Frailty also is associated with a higher risk of bleeding from procedures and, presumably, injuries as well.[65-67]

Multiple frailty assessment tools have been validated in the trauma population, including the Clinical Frailty Score and the FRAIL score.[68-71] Automatic electronic health record frailty scores also can be used if incorporating bedside screening tools is difficult.[72] While understanding a patient's level of frailty may not change the initial imaging and surgical evaluation, it does affect their risk of complications and death. Early initiation of a trauma frailty pathway improves outcomes. Interventions should start within 24 hours of admission, which is why many programs are moving toward including a frailty assessment as part of the initial trauma evaluation in the ED. Placing frail trauma patients on a multidisciplinary frailty pathway of early ambulation, geriatric consultation, nutrition, and physical therapy evaluation reduces complications and delirium for these patients.[73,74]

Assessments

Medical Evaluation

Geriatric trauma and falls requiring ED care are sentinel events. The ED team must consider 1) identification and management of acute injuries; 2) identification of medical causes of the injury; and 3) prevention of future trauma. Injuries may be preceded by a medical emergency, such as myocardial infarction (MI), stroke, dehydration, pulmonary embolism, sepsis, and pharmacologic overdose (intentional or accidental). It is important to consider these medical precipitants when evaluating older trauma patients to appropriately stabilize and treat them in the hospital, as well as to prevent future falls and injuries. Consider an electrocardiogram (ECG), troponin, creatine kinase (if immobilized or found down for an unknown length of time), and infectious evaluation.

Prevention of future trauma may include geriatric assessment and fall prevention interventions. Several studies have shown that comprehensive geriatric assessment of older adults with traumatic injury results in improved outcomes.[75-77] Combination care provided by trauma teams and inpatient geriatric consultation has been shown to improve care, reduce hospital length of stay, reduce delirium, and reduce admission to skilled nursing facilities after a hospital stay for geriatric trauma.[75,76,78] An observation unit or short stay for physical therapy, geriatrician evaluation, and home safety assessment also can identify and address medical and environmental issues that contributed to their presentation.[79,80] The geriatric trauma guidelines recommend a collaborative or co-management approach between the geriatric consult team and the surgical team. Even if the original injury was not caused by a fall, it is beneficial to discuss how it could increase the risk of falls during recovery. For example, a transverse lumbar process fracture after an MVC can cause decreased ambulation because of pain, which leads to deconditioning and a subsequent fall. Medications to treat pain, or immobilization of injured limbs also can increase the risk of subsequent falls and injuries.

Home Medications

Patients with traumatic hemorrhage or hypotension require immediate assessment of anticoagulant status to guide prompt reversal.[81] In addition to checking the traditional measures of anticoagulation, such as international normalized ratio (INR), a thromboelastogram (TEG) should be considered if available. Older adult patients taking an anticoagulant have a 50% increased mortality rate from intracranial hemorrhage.[82] Patients may be prescribed oral anticoagulation for conditions such as atrial fibrillation, venous thromboembolism, and cardiac valvular disease. This increased prevalence has a significant impact on outcomes of traumatic injury. Trauma patients on direct oral anticoagulants appear to have similar-to-better mortality rates than those on vitamin K inhibitors.[83]

In addition to oral anticoagulants, other classes of medications can contribute to occult illness in primary/secondary evaluation in older adult trauma patients. The American Geriatrics Society has published a detailed list of medications that increase the risk of injury and morbidity to geriatric patients, known as the Beers criteria.[84] Table 4 lists a number of these commonly used agents and their effects on the trauma exam.

Non-Accidental Trauma Assessment

All older adult trauma patients should be screened for evidence of abuse/neglect, substance use, and depression/suicidal ideation as precipitants for their trauma. Up to 10% of older adults are victims of negligence or abuse by a caregiver.[85] Despite this prevalence, the vast majority of cases go unreported, with one study demonstrating that only one in 24 cases of elder abuse are identified and appropriately reported to authorities.[86,87] It is important that physicians perform a detailed history and tertiary physical exam on vulnerable patients after trauma assessment, particularly those with dementia, in conjunction with screening tools.[87] There are different types of screening tools depending on whether the patient is cognitively intact or not, including screening questionnaires, direct observational rating scales, or checklists with abuse indicators.[88] A quick tool is the Elder Abuse Suspicion Index (EASI).[89] The Senior Abuse Identification (Senior AID) is a longer tool to identify suspected elder abuse and was developed and validated for use in the ED setting.[90,91] Its use for throughput in efficient trauma care has yet to be validated. State policies differ, but in most states, physicians are mandatory reporters for elder abuse.

Table 4. Summary of Medication Classes Contributing to Geriatric Trauma Evaluation and Care

Medication Class	Examples	Side Effects that May Cause Trauma	Medication Effects that May Influence Trauma Evaluation
Anticholinergics	Diphenhydramine, hydroxyzine	Increase risk of falls, confusion, and delirium	• Tachycardia, hypertension, and urinary retention
Antihypertensives and diuretics	Metoprolol, carvedilol, diltiazem, amlodipine, lisinopril, furosemide	Risk of hypotension and falls	• Impaired tachycardic response to hypotension/blood loss • Impaired ability to maintain blood pressure and end-organ perfusion
Anticoagulants	Warfarin, apixaban, rivaroxaban	Risk of hemorrhage, altered mental status	• Increased bleeding • Need for urgent anticoagulant reversal • Increased mortality from ICH
Glycemic agents	Insulins, sulfonylureas	Hypoglycemia	• Iatrogenic hypoglycemia requiring dextrose administration
Immunosuppressants	Prednisone, chemotherapies, methotrexate	Can contribute to osteoporosis and fragility fractures	• Increases risk of wound infection and poor healing • May result in marrow suppression and cytopenias
Opioids	Oxycodone, hydrocodone, hydromorphone	Sedative effects	• Blunted pain response, increased risk of respiratory depression
Sedatives	Benzodiazepines, alcohol, antipsychotic sedatives	Sedative effects	• May impair underlying mental status • Increased risk of respiratory depression

ICH: intracranial hemorrhage

Fall Risk Assessment

Fall prevention risk assessment and outpatient management are part of the trauma evaluation and care. Preventing future injuries is important, since the risk of a subsequent fall is increased after a fall-related injury. Fall prevention involves identifying intervenable risk factors for falls with a standardized functional assessment. A multidisciplinary approach started from the ED or hospital is best. Multifactorial interventions decrease the risk of a subsequent injurious fall by 28%.[92] A case manager can review and document the living situation, caregiver support, and medical equipment at home. A physical or occupational therapist can assess function and gait. Community programs or community home safety assessments for fall prevention may exist in some areas. Many paramedic agencies will do home safety evaluations or wellness checks. The fall risk assessment and interventions may be done in the ED, in the hospital after injuries are stabilized, or as an outpatient referral. Developing policies to standardize these assessments and referrals takes much of the burden off the ED team.

Considerations in the Secondary Survey

Head Injury

Outcomes of traumatic brain injury have been shown to be poorer for older adults when compared to younger counterparts across all levels of severity.[30,93] Up to 80% of older patients with severe traumatic brain injuries die or experience major disability requiring placement in long-term care facilities.[94] The standard diagnostic approach to closed head injury often is not applicable in older adult trauma because mental status is not sensitive enough to rule out injury and clinical decision rules (such as New Orleans, Canadian Head CT, and NEXUS II criteria) have excluded the older adult population.[95-97] Traumatic brain injury should be considered in older patients even in the setting of low-energy mechanisms because of anatomic changes of the brain with age, anticoagulation/antiplatelet therapy, and other comorbidities. Cerebral atrophy and increased adherence of the dura to the skull with aging increases the shear stress on stretched bridging veins, thereby increasing the risk of subdural hemorrhage with head trauma in older adults. The risk of intracranial hemorrhage is further exacerbated by the large proportion of elderly patients on anticoagulation and antiplatelet therapy. There are several treatment options to reverse anticoagulation, including fresh frozen plasma (FFP), vitamin K, idarucizumab, cryoprecipitate, prothrombin precipitate complex (PCC), and factor VIIa, depending on the type of

anticoagulant the patient is prescribed.[81] Consideration should be taken when giving FFP in the volume-overloaded patient, and PCC or factor VIIa can be used alternatively to achieve reversal with smaller volume administration. Additional management of intracranial hemorrhage in older adults involves evaluation for the need for surgical decompression, early neurosurgical consultation, glucose control, oxygenation, head of bed elevation, and blood pressure control.

Patients with moderate to severe traumatic brain injury often will require disposition to a progressive or intensive care unit with frequent neurological checks. However, there remains a lack of consensus on disposition of older adults on anticoagulation who experience closed head injury without evidence of intracranial hemorrhage on initial imaging. In large part this is because atrophy and white matter changes with aging predispose the older adult to a delayed presentation of intracranial hemorrhage. Several studies have demonstrated a 1% to 1.5% rate of delayed intracranial hemorrhage in older adult patients.[98] If a patient has any difficulties returning to the hospital, such as lack of a caregiver for the first 24 hours after the injury, cognitive impairment, or a long distance from a hospital, consider 24-hour observation to monitor neurologic status.

Spine Injury

Geriatric patients are at a greater risk of spinal fractures even with a low mechanism of injury, such as ground-level falls.[99] It is recommended to avoid the use of backboard devices, since they are associated with morbidity and do not immobilize the spine adequately. Less than 1% of thoracolumbar fractures are unstable, limiting the utility of backboards.[100] During the secondary survey, the provider should palpate each section of the spine, assess for pain and injury, and conduct a thorough neurological exam. While a positive physical exam can increase the suspicion of a spinal injury, the lack of pain on exam is not necessarily sufficient to exclude spinal injury. Thoracolumbar clinical exam only has a 78.6% sensitivity and 83.4% specificity. Furthermore, up to 26% of older adult patients with a cervical fracture have been found to have a concomitant thoracolumbar fracture. Therefore, identification of any vertebral fracture in older adults should prompt whole spine imaging.[101]

Computed tomography is the recommended imaging modality to evaluate for both cervical and thoracolumbar fractures. Plain film X-rays have significantly decreased sensitivity and limited utility due to osteopenia, chronic changes in bone density, and decreased spinal mobility with age.[102,103] The Canadian C-spine rule and the NEXUS criteria are common decision-making tools for determining the need for spinal imaging in traumatic injury. The Canadian C-spine rule is not validated in patients older than 65 years of age. Although the NEXUS criteria were developed including geriatric patients with internal validation, subsequent studies have shown variable or decreased sensitivity for cervical spine fracture when compared to younger adults.[103-105] There are no clinical decision tools fully validated for thoracic or lumbar spinal fractures in older adults.

Thoracic Injury

Because of increased rates of osteoporosis and osteopenia, rib and sternal fractures are more common in geriatric patients who experience chest trauma and can be occult on chest X-ray. Pulmonary contusions also are very common with minimal trauma, even in the absence of rib fractures. The pain associated with this leads to splinting and atelectasis, which decreases pulmonary clearance and increases the risk of post-traumatic pneumonia, a more common complication in the older adult population.[106]

Chest X-ray and extended FAST examination, even when combined, have proven inadequate to diagnose thoracic injury in blunt thoracic trauma.[107] Thus, CT of the chest is recommended for all older patients with chest trauma or respiratory complications. Continuous evaluation and airway monitoring, and early intubation in anticipation of declining clinical course can be considered. Early pain control with an opioid or a paravertebral analgesic (rib block) can be instrumental in preventing post-traumatic pneumonia. Chest wall compliance decreases with age and respiratory muscle atrophy causes reductions in vital capacity (VC), functional residual capacity (FRC), and FEV, limiting the elderly patient's response to hypoxia and compensation during chest injury. As a result, the threshold for intensive care unit (ICU) monitoring in elderly patients is lower with thoracic injuries, especially in the case of multiple rib fractures, pulmonary contusions, and flail chest. Many trauma centers use the inspiratory capacity as part of a pulmonary injury score to guide the level of care needed by a patient, since rib fractures can cause delayed worsening in respiratory status.[108,109] Sternal fractures and pulmonary contusion patients also can be followed with this score.

Pelvic and Extremity Injury

Hip and pelvic fractures are common injuries in older adults and should be considered in any patient with upper leg, groin, pelvic, or sacral pain after trauma. Fractures of the pubic rami are the most common osteoporotic pelvic fractures because this area is weakened by osteoporosis more so than the acetabulum or the ischium.[110] A pelvis X-ray has poor sensitivity for clinically significant fractures requiring surgery, since osteoporosis and osteoarthritis decrease radiograph image quality for fracture detection. Around 40% of intertrochanteric fractures may be occult.[111] For posterior pelvic fractures, such as U-shaped sacral fractures, X-ray is only 2% sensitive, which means a plain film should never be used to fully "rule out" a fracture.[112] CT pelvis also is only 79% sensitive for occult hip fractures in older adults with trauma.[111] Many trauma centers and EDs have magnetic resonance imaging (MRI) protocols for patients with high suspicion for hip or pelvic fractures and negative CT. MRI also is better at detecting incomplete fractures, which may be an indication for hip replacement surgery or limited mobilization.[113] A key sign is pain with weight bearing.

For patients with proximal femur and intertrochanteric fractures, delay to operative repair > 48 hours is associated with a 30% to 50% higher odds of death.[114,115] Quick access to surgical

Table 5. Common Traumatic Injuries in Older Adults and Additional Considerations for Their Imaging, Disposition, and Management

Injury	Is X-Ray Sufficient to Rule Out Injury?	Effects of Age on Level of Care Required	Other Considerations
Intracranial hemorrhage	No	Monitor for delirium as well as neurologic changes.	Very high likelihood of requiring placement in rehabilitation center, so involve case management early.
Spinal fracture	No	Increased mobility difficulties occur with spinal immobilizers, including C-collars. Most older patients will need increased help at home or a rehabilitation facility.	High rate of non-contiguous fractures in older adults. If one spinal fracture is found, proceed to entire spine imaging.
Rib fractures	No	Even if oxygenation is stable, consider ICU or progressive units for older adults with two or more rib fractures.	Follow inspiratory pressure every eight hours to detect worsening pulmonary contusions.
Pelvic fracture	No	May require admission for pain control, physical therapy, and activities of daily living assistance.	Consider patient's home health needs and have a plan for daily assistance with bathing, dressing, and other activities of daily living.
Proximal femur fracture (intertrochanteric)	No	Admit and offer surgery to all patients, despite age or hospice status.	Consider bedside ultrasound-guided nerve blocks for pain control.

ICU: intensive care unit

repair even improves outcomes for patients in hospice,[116] and hip fracture repair is the only surgery that is covered by hospice benefits because of the reduced pain and increased mobility that come from surgical repair. We recommend having a hip fracture protocol with the orthopedic team or tertiary care referral hospital, which can include obtaining pre-operative assessments such as laboratory tests and ECG in the ED and managing pain with pericapsular or femoral nerve blocks. Nerve blocks have improved pain control over opioids and may decrease the risk of delirium.[117,118]

While the care of proximal femur and intertrochanteric fractures is orthopedic consultation and admission, the identification and management of non-operative pelvic fractures varies considerably. Surgical repair is an option for many injuries but often is delayed if the patient is hemodynamically stable. Physical therapy and analgesia are the first-line measures. Let patients know that the bone will take 100-150 days to heal, and they may need considerable home healthcare and support for activities of daily living for the first few weeks.[119] Many patients are sent home without pain medication or physical therapy or mobility aids at home.[120] These fractures are painful, and appropriate analgesia is essential to prevent delirium and to aid in physical therapy/mobility. See Table 5 for common traumatic injuries in older adults and additional considerations for their imaging, disposition, and management.

Skin Tears and Lacerations

Aging of the skin results in changes to the dermo-epidermal junction, which leads to tearing with sheer force. These lacerations can be large and hard to repair with simple interrupted sutures since the skin is very friable. One technique that can assist in repairing skin tears is placing adhesive strips (Steri-Strips or Fixomull) on either side of the tear and suturing through the strips in addition to the skin. This can prevent tearing of the remaining skin. Using horizontal mattress sutures for deeper tears also can help prevent the suture from "wire-cutting" through the remaining skin.

Wound healing takes longer for older adults, and they are more likely to have difficulties with hemostasis and infection. Remember also to offer a tetanus booster for those who are more than five years out from their last booster and have a concerning wound, or more than 10 years out and due for a booster regardless of laceration status.

Disposition

The frailty status and multidisciplinary insight from a geriatric trauma team often changes disposition decisions. Frail older adults dispositioned to a higher level of inpatient care have better outcomes.[23,121,122] Several scoring tools have been developed to risk stratify patients with traumatic injuries and provide insight into prognosis and need for additional resources. The ISS has shown a linear correlation with mortality, morbidity, and hospital length of stay.[123] Both ISS and RTS were developed using data from young trauma patients and showed promise in prognostication for trauma patient mortality, morbidity, and hospital length of stay, but there is a significantly decreased

correlation in older trauma patients.[124] A base deficit can be assessed expediently as an additional marker, which has been shown to indicate severe injury and significant mortality in all trauma patients and has increased positive predictive value for severe injury (ISS > 15) in older adult trauma patients.[125-127] It also has been shown to enhance the predictive value of RTS and should be used in consideration for ICU admission.[128]

While these tools often are used in the ICU for prognostication, they may be valuable for the emergency physician to guide admission level of care. One single center study risk stratified geriatric trauma patients with higher ISS to the ICU. With this criterion, it demonstrated a 19% increase in survival and decreased incidence of disability in patients 70 years of age or older who underwent early intensive care monitoring.[121] While it is difficult to discern which ICU interventions were responsible for improved survival and disability, a lower threshold for admission of older adults with high injury severity scores to intensive care is warranted. However, it is important to limit these intensive and extensive treatment modalities, such as ICU care, to patients whose injuries are not only survivable but also compatible with an acceptable quality of life for the patient.

Early advanced care planning (ACP) discussions in the ED should be done to guide patient and family-centered care. ACP discussions in which 93% of patients had goals of care documented within 24 hours of admission resulted in a decrease in ICU admissions from 17% to 5%.[129] Social workers and nurse case managers are integral members of the team and can initiate these discussions by gathering advanced care planning documents from the family while the physician and nursing team is doing their initial assessment. Not every older adult has ACP documents, but many healthcare systems have patient portals for them to upload their wishes and documents.

Although most older adult trauma patients will recover from their injuries, their recovery process is influenced and limited by comorbid conditions. Rehabilitation teams and case management are essential in arranging home healthcare, equipment, and acute rehabilitation in discharge planning of an older adult recovering from traumatic injury.

Conclusion

Multiple trauma organizations suggest age-specific protocols for the triage of older adults, the trauma evaluation, and the inpatient trauma care. Consider the ABCDEFG approach of screening for frailty and geriatric syndromes. A multidisciplinary approach to the injured older adult can start in the ED and improves outcomes for these patients. Finally, high-quality geriatric trauma care can be recognized with Geriatric ED Accreditation, Geriatric Surgery Verification, or as part of IHI Age-Friendly Accreditation, which may improve the care of older adults in the health system.

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The full list of references is available online: https://bit.ly/3BRCApY

CME/CE Questions

1. The emergency medical services (EMS) team calls into your emergency department (ED). They have begun transport of an 80-year-old man after a fall. He is not taking blood thinners. He has a small facial laceration. There are no other visible injuries or deformity. His vital signs are temperature 98.6˚F, heart rate 65 bpm, blood pressure 103/76 mmHg, and oxygenation 99%. He cannot remember what happened today, but he is oriented to self and place, so EMS reported his Glasgow Coma Scale (GCS) score as 15. Using the National Field Triage, American College of Surgeons, and Eastern Association for the Surgery of Trauma Guidelines, what advice should you give the EMS team? The nearest ED is not a trauma center. The trauma center is 40 minutes away.
   a. The patient is stable to go to the nearest ED (non-trauma center).
   b. The patient should be taken to the local trauma center ED but does not meet trauma alert criteria.
   c. The patient should be taken to the local trauma center ED as a leveled trauma alert.
   d. If the patient wishes, he does not have to be transported.
2. A 67-year-old man in a skiing accident is brought in with a cervical collar in place. He has a history of chronic obstructive pulmonary disease. He is alert, with a GCS of 15 with no respiratory distress at the scene. However, during the 30 minutes of transport to your ED, he develops some tachypnea and his oxygenation drops from 99% on room air to 87%, recovering to 92% on 1 L O_2. Other vitals include blood pressure 150/80 mmHg and heart rate 72 bpm. He has normal bilateral breath sounds, and the initial portable chest X-ray is normal. What are potential causes of his new hypoxemia?
   a. Rib fractures undetected on chest X-ray
   b. Spinal immobilization with backboard and C-collar
   c. Obesity hypoventilation from lying flat
   d. All of the above
3. An 81-year-old woman with dementia, atrial fibrillation on rivaroxaban, hyperlipidemia on a statin, and Sjögren's syndrome presents for an unwitnessed fall at her nursing facility. The patient is pleasant, with GCS of 15, and has no memory of the fall. She denies any complaints. The primary survey shows a posterior scalp hematoma. Vitals are temperature 98.6˚F, blood pressure 138/88 mmHg, heart rate 112 bpm, and oxygenation 95%. Her head and neck computed tomography (CT) do not show any bleeding or injury other than the scalp hematoma. What additional workup is indicated for this patient?
   a. The patient has dementia, so no further care is needed. She can be discharged back to her nursing facility.
   b. The patient requires a medical evaluation for the cause of the fall, including electrocardiogram, chemistry panel, creatine kinase, and troponin.

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c. The patient should be discharged with cardiology follow-up to evaluate the cause of the fall.
d. The patient should receive an abdominal CT and be discharged.

4. A 73-year-old woman presents to the ED after a ground-level fall. The GCS is 14. The trauma evaluation identifies two left rib fractures and a lumbar spinous process fracture. Pain is rated as 8/10 on the pain scale. Which intervention(s) are reasonable for pain control?
   a. Perform a brief medication reconciliation to determine if she is already taking any sedatives, especially analgesics, anticholinergics, or alcohol.
   b. Use capnography to monitor for reduced ventilation as a sign of oversedation.
   c. Consider a trial of non-opioid pain management, such as rib regional nerve blocks or topical lidocaine.
   d. All of the above
5. Which of the following is the most common cause of trauma in older adults?
   a. Falls
   b. Penetrating injuries
   c. Burns
   d. Motor vehicle collisions
6. An 82-year-old man presents for a fall. A thorough trauma evaluation identifies a proximal humeral fracture that does not require operative management. He lives at home with his wife, and his Clinical Frailty Score is 6 (moderately frail). Which of the following is *not* a benefit of hospital admission or observation for multidisciplinary assessment by a geriatrician, physical therapy, occupational therapy, and a case manager or social worker?
   a. Reduced six-month mortality rates
   b. Assessment of caregiver burden, home health needs, and provision of home health equipment
   c. Increased pain from the therapy evaluations
   d. Reduced delirium
7. A 70-year-old female presents via EMS after a ground-level fall. She does not take anticoagulant medications. The patient endorses positive head strike with evidence of abrasion and hematoma to the occiput, but the GCS is 15 and she has an intact neurological examination. The secondary survey reveals midline tenderness to the cervical spine, but examination of the thoracolumbar spine is unremarkable without evidence of pain or deformity. Which of the following is true?
   a. A head CT is not indicated because the patient has a normal GCS and mental status and no concerning signs by Canadian CT head criteria.
   b. X-ray plain films of the cervical spine are sufficient to evaluate the patient's neck pain and rule out cervical spine fracture.
   c. If a cervical spine fracture is identified, CT of the entire spine is indicated because of the probability of concomitant thoracolumbar fracture.
   d. Maintaining a back board for spine precautions is likely to decrease morbidity and mortality.
8. Which of the following contributes to "normal" appearing vital signs that can represent occult hypoperfusion in older adults?
   a. Decreased cardiac receptor responsiveness can limit stroke volume augmentation to maintain baseline blood pressure.
   b. A systolic blood pressure of 110 mmHg may be relatively hypotensive in an older adult patient who has baseline hypertension.
   c. Use of negative chronotropic medications such as beta-blockers can limit normal tachycardic responses in hemorrhage.
   d. All of the above
9. What laboratory test can be used as a marker to indicate severe injury in older adult trauma patients?
   a. Sodium
   b. Urinalysis
   c. Base deficit
   d. Serum glucose

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