CHAPTER 184

Geriatric Trauma

Jeremiah D. Schuur | Zara Cooper

PRINCIPLES

Older adults make up a growing proportion of trauma patients in emergency departments (EDs). US trauma systems and management principles were developed in the 1970s and were based primarily on advances from military medicine and designed to serve younger adult patients. Although the general principles of trauma care for younger adults apply to older adults, there are special considerations for the older trauma patient. This chapter focuses on evaluation and management decisions for trauma in older patients that may differ from those in younger adults.

Background and Importance

There is no standard definition of the term *geriatric trauma* in the literature; studies include patients older than 45 to 65 years. Risk-adjusted analyses have demonstrated patients older than 55 years to be at higher risk of mortality, and some studies further stratify older adults into the oldest old group, those older than 80 or 85 years. In this chapter, unless noted, we are referring to patients 65 years and older. The literature on trauma in older adults has several limitations. Older adults are frequently excluded from clinical trials, a limitation in considering high-risk interventions such as surgery or invasive hemodynamic monitoring. Furthermore, studies conducted using trauma databases include only trauma center patients evaluated by a trauma team; the results may not be generalizable to non–trauma center ED populations.

Demographics and Epidemiology

The US population is aging, and older adults are living more independently and have more active lifestyles, which explains the dramatic rise in geriatric trauma. More than one in eight Americans were aged 65 years or older in 2012, whereas by 2030 one in five will be 65 years or older.[1] In 2011, US adults aged 65 and older accounted for almost 13% of all injury-related ED visits, and this percentage is expected to increase with the aging of the population.[2]

Older trauma patients have increased morbidity and mortality owing to the severity of injury, presence of comorbid conditions, and independent effects of age. In similar accidents, older adults sustain more severe injuries than younger adults, a strong predictor of mortality. In 2010, unintentional injury was the ninth leading cause of death among those older than 65 years.[3] Older adults are more likely to have significant underlying medical conditions that limit their physiologic response to injury and increase the risk of death after trauma, especially in less severe injuries.[4] Age is independently predictive of morbidity and mortality, even when controlling for comorbidities and the Injury Severity Score (ISS).[4]

Age as a Trauma Triage Criterion

Age should be considered in determining criteria for transfer to a trauma center and for activation of a trauma team. Traditional triage criteria based on mechanism and vital signs miss many older adults with major injuries.[5-7] Fewer older patients are transported to trauma centers despite meeting trauma center criteria, and older adults are less likely to be admitted to trauma centers than younger adults.[8] Ohio has developed and implemented additional prehospital triage criteria for geriatric trauma that trigger automatic transport to a trauma center (Box 184.1). Applying these triage criteria to a statewide database increased sensitivity for severe injury by 32% while decreasing specificity by 12%.[9] An Eastern Association for the Surgery of Trauma guideline does not give level I support for age as an independent criterion for trauma center referral or activation, but found less robust evidence to support using advanced age (≥65 years) in patients with comorbidities or severe anatomic injuries as a criterion for transfer to a trauma center, respectively.[10] The Advanced Trauma Life Support (ATLS) program recommends that emergency medical services (EMS) use age older than 55 years as a criterion for transfer to a trauma center.[11] However, the effect of trauma center care on older adults is not clear; several studies have shown that older patients with severe injuries have better outcomes when treated at a trauma center[12,13]; however, a larger study of 69 hospitals in 14 states found no survival difference. At trauma centers, age is often a criterion for trauma team activation, and single-center studies have shown decreased mortality after trauma team activation criteria were changed to include age older than 65 or 70 years.[14] We recommend using age of 70 years and older and the Ohio state criteria listed in Box 184.1 as criteria for trauma center referral and trauma team activation.

Mechanisms of Injury

Falls are the leading mechanism of injury and the leading cause of injury-related death in patients older than 65 years.[15] In 2013, there were 2.5 million ED visits for falls among those 65 years and older, and one-third were hospitalized. Up to one-third of older adults sustain a significant fall each year, and serious injuries occur in up to 25%. Most falls are from standing and occur at the older adult's place of residence. Risk factors for falling include, in decreasing relative risk, weakness, balance or gait deficit, visual deficit, mobility limitation, cognitive impairment, impaired functional status, and postural hypotension. Up to 10% of those who fall sustain a major injury, with head injury being the most frequent.[16] Although the height of the fall is associated with severity, falls from standing carry significant risk for older adults; same-level falls result in serious injury (ISS > 15) 30% of the time in older patients, and peri-injury mortality from low falls is up to 10%.[17]

Motor vehicle accidents (MVAs) and pedestrians struck by a motor vehicle are the second and third most frequent causes of trauma in older adults.[18] Older adults are more likely than younger adults to be involved in daytime crashes occurring close to home. A detailed crash history is important, and single-vehicle crashes should raise the suspicion that a medical problem caused the crash (eg, syncope, myocardial infarction, stroke), and an evaluation for coincident events leading to trauma should be undertaken

BOX 184.1

Ohio Prehospital Geriatric Trauma Triage Indicators

- Trauma patients ≥70 years are defined as having suffered geriatric trauma.
- If an injured older adult has any of the geriatric indicators, he or she must be transported directly to a trauma center.

GERIATRIC ANATOMIC INDICATORS
- Injury sustained in two or more body regions

GERIATRIC PHYSIOLOGIC INDICATORS
- Glasgow Coma scale score <15 with a known or suspected traumatic brain injury
- Systolic blood pressure < 100 mm Hg

GERIATRIC MECHANISM INDICATORS
- Fracture of one or more proximal long bones (humerus or femur) sustained in a motor vehicle accident
- Pedestrian struck by a motor vehicle
- Falls from any height—including standing—with evidence of a traumatic brain injury

Adapted from State of Ohio, State Board of Emergency Medical Services, Trauma Committee: Geriatric trauma task force report and recommendations. www.publicsafety.ohio.gov/links/ems_geriatric_triage.pdf.

during the trauma management process. Older adults are more likely to be struck by a motor vehicle than younger pedestrians because of poor eyesight, limited mobility, and slower reaction time. Pedestrians who are struck sustain significant injury patterns and have the highest fatality rate of all geriatric injuries, 30% to 55%.

Thermal injuries, self-injury, and elder abuse are less common but important injury patterns in older adults. Thermal injuries such as burns and smoke inhalation occur more frequently and are more severe in older adults owing to decreased mobility and physiologic skin changes.[19] Older adults have a lower likelihood of attempting self-injury but a higher likelihood of completing suicide attempts than any other age group, with men at higher risk. Elder abuse is a complex problem that can involve psychological, social (eg, financial), and physical abuse. Studies have found that around 5% of older adults self-report abuse in the previous month, although lower rates of physical abuse are reported to protective services. All older adults with injuries should be asked if they feel safe at home and if there is anyone in their life who is threatening or injuring them.

Anatomy and Physiology

Older adults are more vulnerable to trauma owing to age-related changes in anatomy, physiology, and pathophysiology. Aging's main effects on human physiology are decreased functional reserve, seen across organ systems, due to reductions in the volume of viable tissue and intrinsic function of the tissues. Older adults are more likely to have comorbidities and to be taking multiple medications that affect their likelihood to get injured and their response to injury. The assessment of the geriatric trauma patient should be informed by these important differences.

Pathophysiology

Due to decreased functional reserve, older adults are less able to compensate for physiologic demands of hypovolemia and stress resulting from hemorrhage associated with trauma. Although older adults in a good state of health have sufficient reserves to accomplish activities of daily living, when they are stressed by acute trauma and the subsequent response to injury, the decrease in physiologic reserve can lead to a more rapid progression to tissue hypoperfusion and organ failure, a common cause of death in older trauma patients.

Comorbidities

Older adults are likely to have significant comorbidities at the time of injury. The percentage of older adults experiencing at least one of five chronic diseases—arthritis, stroke, chronic lower respiratory tract disease, coronary heart disease, and diabetes mellitus—varies from 15% to 47%, with only 33% of men and 25% of women having none of these comorbidities.

Effect of Medications

Medication use is common in older adults. A representative survey of community-dwelling US adults (aged 57–85 years) has found that 81% use at least one prescription medication, and 29% use five or more prescription medications. Approximately 5% of older adults are on warfarin, a growing number are on novel oral anticoagulants, and more than 30% are on an antiplatelet agent, increasing the likelihood and severity of hemorrhage. Medications increase the likelihood of older adults experiencing a traumatic accident (eg, sedative-hypnotics causing falls). Some, such as beta blockers, affect the physiologic response to trauma. Medications' effect on vital signs should be considered during the primary survey, and a full medication history should be taken early in the secondary survey.

CLINICAL FEATURES

Modifications to the Trauma Assessment of Older Adults

A systematic trauma assessment, including a primary and secondary survey and resuscitation, should be conducted in older adults (see Chapter 33). However, many signs and symptoms of injury in the younger adult, such as hypotension, tachycardia, and pain, will be mild or absent in many older adults. Normal vital signs should not be reassuring because significantly injured older adults often display delayed hemodynamic signs of injury, such as tachycardia or hypotension.[20]

Primary Assessment and Resuscitation

Airway

Establishing and maintaining a patent airway is the primary objective. Because older patients are likely to have multiple risk factors for a difficult airway, emergency clinicians should perform a systematic airway assessment, focusing on the ability to mask-ventilate, endotracheal intubation, and a cricothyrotomy. Early intubation is indicated for unstable patients, as defined by signs of shock, altered mental status, and significant chest trauma. Because direct laryngoscopy is more difficult in older adults because of limited cervical mobility and less mobility at the temporal mandibular joint, the use of videolaryngoscopy is recommended.[21] Cricothyrotomy is more likely to be complex in older adults because they are more likely to have had scarring from neck surgery, radiation, or neck tumors, which distort normal anatomy. Older patients are also more likely to be anticoagulated. Finally, rapid sequence intubation (RSI) medications should be tailored to the older adult (see Chapter 1).

Breathing

High-flow supplemental oxygen should be initially applied to all patients, including those with chronic pulmonary disease. The short-term benefits of avoiding hypoxia and increasing oxygen reserves are important because older adults have a reduced pulmonary reserve, which can cause systemic pulmonary injuries to overwhelm the ability to oxygenate and ventilate. The respiratory rate should be closely followed because older adults are more likely to tire and can rapidly decompensate as a result of pulmonary injuries or aggressive fluid resuscitation.

Circulation

Older patients are particularly vulnerable to shock because their blunted response to stress and limited physiologic reserve increase the risk of organ dysfunction. The assessment of circulatory status is complicated because responses to hypovolemia, such as tachycardia and hypotension, are reduced by physiologic changes and medications (eg, beta blockers). Vital signs are insensitive because normal blood pressure does not reliably exclude significant hemorrhage or shock. Systolic hypertension is common among older adults, so normotension may indicate significant hypovolemia. It is important to remember that the therapeutic window for cardiac preload is narrow, and inadequate monitoring of fluid status may lead to errors in volume resuscitation. Vitals signs should be frequently reassessed; in older trauma patients, trends are more important than specific cutoffs.

First, life-threatening bleeding should be identified and controlled. This includes external bleeding, such as hemorrhage from scalp injuries, which can be significant in older adults. The focused assessment with sonography in trauma (FAST) modality has emerged as an important adjunct to the primary survey but has not been specifically studied in older patients. A urinary catheter can be placed to monitor urine output, although this is a less sensitive predictor of renal blood flow than in younger patients. Invasive hemodynamic monitoring is appropriate for some severely injured older adults such as those with shock and poor ejection fraction, but routine use is not justified.

Fluid resuscitation should balance the risk of hypoperfusion with the unclear benefit of fluids and blood. We recommend beginning initial resuscitation with blood in the patient with significant bleeding, signs of hemodynamic instability, or significant injuries (eg, unstable pelvic fracture) because older adults do not tolerate large-volume resuscitation well and can easily become fluid-overloaded. In patients in whom there is no obvious source of blood loss, incremental boluses (eg, 500 mL) of warmed isotonic crystalloid should be used for resuscitation. The hemodynamic status should be reassessed frequently after small fluid boluses to avoid causing pulmonary edema and respiratory failure from fluid overload.

Prompt reversal of anticoagulation is important because a significant number of older patients are on warfarin, and others may have pathologic coagulopathy. Specific considerations for reversing coagulation abnormalities in older trauma patients are the volume of reversal agents required and the corresponding risk of fluid overload. Prothrombin complex concentrates (PCCs) require minimal volume compared with fresh-frozen plasma (FFP) but are more costly. We recommend early use of vitamin K and a PCC in older adults with major injuries who are on warfarin. In EDs that do not have rapid availability of PCCs, FFP should be given.

Disability

Evaluation of older adults for disability includes examination for traumatic brain injury (TBI), spinal cord injury (SCI), and vertebral fractures and injuries. The primary neurologic examination of older adults should focus on mental status, verbal responsiveness, pupil responsiveness, and gross motor examination. The Glasgow Coma Scale (GCS) is often used to detect mental status changes after TBI but was not designed for this purpose and lacks sensitivity for mild injuries. Any GCS score less than 15 is concerning for TBI, and a GCS score below 8 is highly predictive of a poor outcome. Subtle changes in mental status such as confusion or decreased alertness or symptoms such as headache may be the only signs of TBI. The mental status examination in older adults is complicated by comorbidities such as previous stroke and the increasing prevalence of cognitive impairment in older adults, including dementia and delirium. Delirium can be the cause of traumatic injury, such as falls, or can be the result of traumatic injuries. Abnormal pupillary responsiveness or motor function should raise concerns for significant intracranial hemorrhage (ICH), with associated increased intracranial pressure (ICP). Ultimately, no combination of historical features and physical findings has been shown to reliably predict the absence of intracranial injuries in the older trauma population. Brain computed tomography (CT) is indicated for older adults with head trauma, significant multisystem trauma, or symptoms or signs of TBI, because no clinical decision rule has been validated in older trauma patients.

Older adults are at higher risk of vertebral fractures, and cervical fractures in particular, and they are more likely to sustain SCI as a result of trauma. Clinical decision tools that are available for cervical spine imaging in trauma are not recommended for older adults. The Canadian C-Spine Rule (CCR) classifies all patients 65 years and older as inherently high risk, requiring radiography; the derivation study found that age older than 65 years had an odds ratio of 3.7 (95% confidence interval [CI], 2.4–5.6) for clinically significant cervical spine injury. The National Emergency X-Ray Utilization Study (NEXUS) included all ages but found that patients aged 65 years and older had a relative risk of 2.1 (CI, 1.8–2.6) for clinically significant cervical spine injury. Other studies have shown that only 45% of older patients with cervical spine fractures had cervical spine tenderness on examination; therefore, the absence of tenderness cannot be used to rule out cervical spine injury in older patients. Older adults are also at increased risk of thoracic, lumbar, and sacral vertebral fractures, for which CT is more sensitive than the physical examination or plain radiography.

Exposure

Older trauma patients are more likely to develop hypothermia because of physiologic changes and mechanisms of injury. Because the skin thins with aging, and muscle and fat mass decrease, normal thermoregulatory mechanisms are no longer intact. Prolonged immobilization with exposure to the elements is common when older adults fall and are unable to get back up, leading to hypothermia, dehydration, and renal insufficiency. A rectal temperature should be routinely taken, and hypothermia should be rapidly treated. Because skin breakdown and relatively minor wounds can cause serious complications in older patients, older adults should be removed from backboards as soon as possible and examined for pressure ulcers. Older patients are more likely to require a tetanus booster, and older trauma patients should receive tetanus immunization if it is not up to date.

Secondary Assessment

The stable geriatric trauma patient requires a thorough secondary assessment. A complete history should be obtained from the patient or a care provider, with particular emphasis on corroborating the accident history, past medical history, medications and

allergies, and social history, including baseline functional status and living arrangements. Patients should be screened for alcohol and substance abuse and elder abuse.[22]

Laboratory Testing

We recommend the following routine laboratory tests: complete blood count, comprehensive metabolic profile, coagulation studies (international normalized ratio [INR]), lactic acid level, base deficit, urinalysis, cardiac enzyme levels, and toxicology. An elevated lactic acid level and base deficit, which can signal tissue hypoxia and organ dysfunction, are predictive of mortality and can help determine the prognosis in older adults with normal vital signs. Electrocardiography and cardiac monitoring are advised because many older patients have cardiac causes or complications of their traumatic event.

Imaging

Older trauma patients deemed unstable should undergo portable plain radiography of the chest and pelvis. CT is the imaging modality of choice for stable older trauma patients; plain radiography is less sensitive. Older adults have less additional lifetime risk from the radiation associated with CT scans than younger adults owing to their lower life expectancy, but they are at greater risk from contrast-introduced nephropathy. When possible, intravenous (IV) contrast should be avoided, and renal protective strategies should be used, including IV fluids, bicarbonate, and *N*-acetylcysteine.

SPECIFIC DISORDERS

Traumatic Brain Injury

TBI is common in older adults, can occur with minimal head trauma, and can be asymptomatic. Overall mortality rates among older patients with TBI range from 30% to 80%, and increasing age is an independent predictor of disability and mortality in patients with TBI. Physiologic changes of aging and the frequent use of anticoagulant and antiplatelet medications increase the likelihood and severity of TBI in older adults. With aging, the size of the brain decreases by 10% on average, resulting in less tortuous bridging veins and increased intracranial free space. The atrophied brain is more mobile within the skull, and trauma is more likely to shear bridging veins, leading to ICH.

Differential Diagnosis

If there is concern for intracranial injury, cranial CT is indicated, regardless of reported loss of consciousness. Diagnosis of TBI is more difficult in older adults because cognitive impairment is more common and increased intracranial free space can allow the accumulation of blood without changes in mental status. Clinical variables alone are insufficient to identify all cases of significant intracranial injury reliably following trauma in older patients; both the New Orleans Criteria (exclude age >60 years) and Canadian Head CT Rule (excludes age ≥65 years) exclude older adults.

Management

Treatment of TBI includes supportive care, rapid reversal of anticoagulation, and evaluation for decompressive surgical intervention. Supportive care aims to avoid cerebral hypoxia and hypoperfusion, which are significant predictors of adverse outcomes. All patients should initially receive high-flow oxygen to maintain high oxygen saturation. Patients with hypercarbic respiratory conditions (eg, chronic obstructive pulmonary disease) require an individualized determination of the appropriate oxygen saturation. Preventing cerebral hypoperfusion requires close monitoring of hemodynamic parameters, including blood pressure and urine output; individual patients may benefit from invasive hemodynamic monitoring. Early neurosurgical consultation is indicated to assess the need for and usefulness of surgical ICP monitoring and decompression. Current guidelines for ICP management have not been studied in older adults with TBI.

Prompt reversal of anticoagulation with a PCC, or FFP if PCC is unavailable, is indicated for older adults taking warfarin. The evidence supporting PCCs has shown that immediate administration of PCC is associated with more rapid reversal and less hematoma growth than vitamin K and FFP, including one study of years trauma patients.[23] To date, however, there have been no prospective randomized studies demonstrating better outcomes.[24] Treatment or reversal of antiplatelet agents and other anticoagulants, including low-molecular-weight heparins and novel oral anticoagulants, is based on expert opinion rather than clinical trial data. Thus, EDs should determine local practice in coordination with their trauma and neurosurgery consultants.

Disposition

TBI in older adults is associated with significant morbidity and mortality, but ED prognosis is not precise. Negative prognostic factors include increasing age, anticoagulation,[17] use of antiplatelet medications, greater severity of TBI, and lower GCS score.[25] Although many patients with severe injuries, significant comorbidities, or anticoagulation have no chance of a meaningful outcome, others can return to living in the community.[26] Patients with moderate or severe TBI, or any TBI and anticoagulation, require neurosurgical consultation and intensive care in which frequent neurologic checks and rapid reversal of anticoagulation can be accomplished. This is problematic for emergency clinicians at hospitals without neurosurgical coverage because it requires transferring patients with a grave prognosis, potentially for long distances. When an older adult with TBI is being transferred, reversal of anticoagulation and prevention of hypoxia and hypotension are important early management steps. Older patients with isolated head trauma, normal cranial CT, and normal INR are generally safe for discharge if they have a safe environment, responsible care provider, and reliable follow-up.[27]

Vertebral Fractures and Spinal Cord Injuries

Age-related changes to the vertebral bones, intervertebral disks, and spinal canal place older adults at greater risk of vertebral fractures, result in a greater likelihood of SCI, and make physical examination and diagnostic imaging results less accurate. Based on radiologic studies, approximately 25% of patients older than 65 years have cervical stenosis, and 90% of men older than 50 years and 90% of women older than 60 years have evidence of degenerative changes in the cervical spine. These changes have the effect of creating leverage on the spinal column when an external force is applied, such as in a fall with an impact to the head, concentrating force on weakened bone and increasing the risk of fracture and SCI.

Differential Diagnosis

Spinal canal stenosis and the resulting spinal cord compression are clinically manifested as a myelopathy, with impairment of coordination, gait, bowel or bladder function, and motor or sensory function, or both. Geriatric patients with vertebral injuries and SCIs are more likely to sustain incomplete neurologic

injuries of lesser severity than younger patients, largely because they have lower force injuries.

In cases of suspected vertebral fracture or SCI, continued immobilization, spine surgery consultation, and admission are indicated. Older adults are at higher risk for SCI without obvious radiographic abnormality owing to spinal cord stenosis and cervical kyphosis. Evaluation for ligamentous injury and SCI with magnetic resonance imaging (MRI) is appropriate in patients with focal neurologic deficits. Most geriatric vertebral fractures and SCIs are represented by three types of injuries: (1) central cord syndrome; (2) cervical extension-distraction injuries; and (3) odontoid fractures.

Central Cord Syndrome. Central cord syndrome (CCS) is characterized by weakness disproportionately greater in the arms than in the legs after a hyperextension injury. Most cases of CCS in older adults are the result of hyperextension injuries in patients with canal stenosis and no bony fracture. In CCS, injury may result from anterior compression of the cord by osteophytes or pinching of the cord posteriorly by the ligamentum flavum, resulting in bleeding into the central part of the cord or with axonal disruption in the lateral columns of the spinal cord. Injuries associated with CCS syndrome are typically stable and require immobilization with a hard collar. Surgical decompression may be indicated. Patients with symptoms concerning for CCS and without fracture should undergo MRI.

Cervical Extension-Distraction Injury. Cervical extension-distraction injury occurs in the patient with reduced cervical range of motion. A hyperextension injury of the cervical spine and external signs of trauma to the forehead or face in an older adult should raise suspicion for an extension-distraction injury. The patient may report that she or he is able to touch the pillow on the bed with the back of the head, which she or he was unable to do before the injury. This is a result of the fracture, which opens and lengthens the anterior column of the spine, resulting in the term *open book fracture*. Clinical symptoms can range from nerve root compression to severe SCI. These fractures are typically unstable and require surgical fixation.

Odontoid Fractures. Fracture of the C2 vertebral body, specifically the odontoid process, is usually the result of a fall with impact to the head, resulting in anterior or posterior displacement of the odontoid process. Although most odontoid process fractures are displaced, less than 10% cause neurologic deficits. Type II odontoid fractures, at the base of the dens at its attachment to the body of C2, are the most common C-spine fracture in older trauma patients. There is no agreement on the best approach to manage type II odontoid fractures[28]; types I and III fractures are typically managed nonoperatively with neck immobilization.

Thoracic Trauma

Older adults are at increased risk of rib and sternal fractures, pulmonary contusions, and their complications with low-force injuries. More than 50% of older patients admitted to hospital with rib fractures sustained them during a fall, and a significant number occurred during low- or moderate-speed MVAs.

Differential Diagnosis

The risk of pneumonia and complications increases with the number of ribs fractured.[29] Pulmonary contusions are more frequent with minimal trauma, even without accompanying rib fractures, and can cause significant morbidity and mortality in older adults.

Diagnostic Testing

Chest CT is recommended for older patients with significant chest trauma, multiple rib fractures by plain film, or respiratory complications from trauma.

Management

Patients with significant chest trauma require airway monitoring, with consideration of early intubation to anticipate their clinical course, pulmonary therapy, and pain control. Pain control is of particular importance because rib fractures will lead to splinting and atelectasis and increase the risk of pneumonia.[30] Analgesia can be administered with epidural analgesia, paravertebral analgesia, or opioids orally or with patient-controlled analgesia.

Disposition

Geriatric trauma patients with severe pain from rib fractures should be hospitalized to manage pain adequately and safely. Those with flail segments, multiple rib fractures, or pulmonary contusions may require intensive care unit admission.

Abdominal Trauma

Older adults are more likely to sustain intra-abdominal injuries and have higher mortality from such injuries. The general management principles are similar to those in younger adults, although there is less clinical evidence supporting nonoperative management (NOM) and angiographic embolization of solid organ injuries.

Differential Diagnosis

The focus of the emergency clinician is on the early diagnosis of intra-abdominal injuries, vigilant hemodynamic monitoring, and early resuscitation. Clinical manifestations of serious abdominal injury in older patients are often minimal. Reliance on the abdominal examination may lead to missed abdominal injuries, and the emergency clinician should use a low threshold of suspicion to carry out imaging.

Diagnostic Testing

The FAST examination should be part of the initial evaluation and can be repeated as part of ongoing hemodynamic monitoring, although it is insensitive for solid organ injuries. Older patients with abdominal tenderness, significant multisystem trauma, or hemodynamic instability should undergo CT scanning. Angiography is a reasonable option for the older trauma patient with solid organ injury and a blush or extravasation on CT.

Management

Although advanced age was initially an exclusion from NOM of solid organ injuries, there is more than a decade of evidence showing that carefully selected older adults are candidates for NOM. In several case series, approximately 80% of older adults with splenic injuries were successfully managed nonoperatively, with the caveat that grade III injuries were more likely to fail NOM, and all geriatric patients with grade IV or V injuries required an operation. There are limited data on NOM of liver injuries in older adults.

Extremity Injuries

Fractures are the most common injuries in older adults with trauma due to osteopenia. Fractures that affect mobility and the

ability to live independently, such as hip fractures, are associated with significant perioperative and 1-year mortality in older adults.

Differential Diagnosis

The most common fractures sustained by older adults, in order of frequency, are distal radius fractures (Colles' fractures), proximal humerus fractures, and elbow fractures, which usually occur during a fall onto an outstretched arm. Older adults with proximal humoral fractures can have remarkably few symptoms.

The most common lower extremity fractures in older adults are ankle fractures, hip and pelvic fractures, and tibial plateau fractures. Pelvic fractures can occur with relatively little force in older adults and fracture patterns are similar between older adults and younger adults, with lateral compression fractures more common than anteroposterior fractures. In older adults, both fracture types are associated with significant hemorrhage. Overall pelvic fracture mortality is 9% to 30% and up to 81% in older patients with open pelvic fractures. Emergent treatment of pelvic fractures consists of hemodynamic monitoring, resuscitation with blood, stabilization of the fracture with wrapping or external fixation, and control of bleeding, with consideration of embolization to treat retroperitoneal hemorrhage.[31] Hip fractures are common in older adults, occurring annually in approximately 1% of men and 2% of women. Whereas isolated hip fractures are not associated with significant immediate hemorrhage or mortality, such as seen in pelvic fractures, they are associated with an 8% to 30% 1-year mortality.

Diagnostic Testing

Hip fractures are usually seen on plain x-ray films (sensitivity ≅ 90%) and CT scans, but occult fractures are a well-described phenomenon in older adults. Patients with the inability to ambulate or who have persistent pain after trauma require further evaluation; MRI and bone scanning are useful imaging studies to delineate the pathology. Ultrasound-guided femoral nerve block or fascia iliaca compartment block can improve analgesia and reduce the use of opioids in the ED.[32]

Management

Older adults with fractures have better outcomes with early surgery (<72 hours) and care in a distinct orthogeriatric service.[33,34] Emergency clinicians should consider transferring older adults with hip fractures to hospitals with such services.

DISPOSITION: END-OF-LIFE CONSIDERATIONS

Emergency clinicians are faced with difficult decisions regarding prognosis, the effectiveness of aggressive care, and end-of-life decisions in geriatric trauma. Older trauma patients have a uniformly worse prognosis than younger adults. Several factors that portend a grave prognosis from the ED include a GCS score of 3, a GCS score below 8 with anticoagulation, and hemodynamic instability from internal hemorrhage with anticoagulation. However, initial injury in the ED does not predict an individual patient's long-term prognosis perfectly, and emergency clinicians have not traditionally withheld trauma care, including transfer to a trauma center and involvement of trauma surgeons. Emergency clinicians should discuss end-of-life decisions, such as intubation, cardiopulmonary resuscitation, transfer, and surgery, with patients, family members, caregivers, and surgical consultants. Although age alone is not an indication to withhold aggressive treatment, comfort measures may be more appropriate than transferring patients to a trauma center in select cases with a grave prognosis and when the patient's goals of care are known.

KEY CONCEPTS

- We recommend that advanced age (≥70 years) be used as triage criteria for transfer to a trauma center and activation of a trauma team.
- Emergency clinicians should consider shock in all older trauma patients. Because vital signs, including tachycardia and hypotension, are unreliable to detect hemodynamic instability in older adults, emergency clinicians should closely follow alterations in mental status, urine output, and skin perfusion.
- Older adults are at significant risk from shock, yet they are also at risk from aggressive resuscitation. Resuscitation should be rapid but should also include frequent reassessments of vital signs, respiratory status, and other potential indicators of shock. Start resuscitation with blood in the patient with significant bleeding, signs of hemodynamic instability, or significant injuries (eg, unstable pelvic fracture).
- Older patients are at high risk of hypothermia and develop pressure ulcers more rapidly. They should be removed from backboards as soon as possible, and rectal temperature should be routinely checked in the secondary survey.
- Clinical decision tools for radiographic imaging have generally excluded older patients. A low threshold for imaging should be used for older adults with trauma, and CT should be used as the primary modality, except for extremity imaging.
- Falls are the leading cause of injury-related death in older adults , and ground-level falls can result in major injuries. Although there is debate about the effectiveness of interventions for secondary prevention of falls, we advise that emergency clinicians assess gait and notify the primary care physician, and we recommend close follow-up at a minimum. Engaging social services, including arranging a home safety visit, may be beneficial.
- Among patients with TBI or hemorrhagic injuries, anticoagulation predicts poor outcome. Rapidly reverse warfarin with a PCC or FFP if a PCC is unavailable.
- Rib fractures and pulmonary contusions are associated with poor outcomes in older patients. Patients with flail chest, two or more rib fractures, or pulmonary contusions should be hospitalized for monitoring, pulmonary care, and analgesia.
- Older adults with hip fractures have improved survival on a dedicated orthogeriatric service. Consider transfer of patients to hospitals with this service available.
- Routinely screen for elder abuse. A valid screening question is: "Has anyone close to you tried to hurt you or harm you recently?"

The references for this chapter can be found online by accessing the accompanying Expert Consult website.

REFERENCES

1. An Aging Nation: The older population in the United States: population estimates and projections; current population reports. <www.census.gov/prod/2014pubs/p25-1140.pdf>.
2. National Center for Health Statistics, National Hospital Ambulatory Medical Care Survey: 2011 emergency department summary tables. <www.cdc.gov/nchs/data/ahcd/nhamcs_emergency/2011_ed_web_tables.pdf>.
3. Heron M: Deaths: leading causes for 2010. Natl Vital Stat Rep 62:1–96, 2013.
4. Hashmi A, Ibrahim-Zada I, Rhee P, et al: Predictors of mortality in geriatric trauma patients: a systematic review and meta-analysis. J Trauma Acute Care Surg 76:894–901, 2014.
5. Zarzaur BL, Croce MA, Magnotti LJ, et al: Identifying life-threatening shock in the older injured patient: an analysis of the national trauma data bank. J Trauma 68:1134–1138, 2010.
6. Nakamura Y, Daya M, Bulger EM, et al: Evaluating age in the field triage of injured persons. Ann Emerg Med 60:335–345, 2012.
7. Goodmanson NW, Rosengart MR, Barnato AE, et al: Defining geriatric trauma: when does age make a difference? Surgery 152:668–674, 2012.
8. Hsia RY, et al: Factors associated with trauma center use for older patients with trauma: A statewide analysis, 1999-2008. Arch Surg 146:585–592, 2011.
9. 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 65:92–100, 2015.
10. Calland JF, Ingraham AM, Martin N, et al: Eastern Association for the Surgery of Trauma: Evaluation and management of geriatric trauma: an Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg 73:S345–S350, 2012.
11. American College of Surgeons, Committee on Trauma: Advanced trauma life support (ATLS) student course manual, ed 9, Chicago, 2012, American College of Surgeons.
12. Pandya SR, Yelon JA, Sullivan TS, et al: Geriatric motor vehicle collision survival: the role of institutional trauma volume. J Trauma 70:1326–1330, 2011.
13. Goodmanson NW, Rosengart MR, Barnato AE, et al: Defining geriatric trauma: when does age make a difference? Surgery 152:668–674, 2012.
14. Bradburn E, Rogers FB, Krasne M, et al: High-risk geriatric protocol: improving mortality in the elderly. J Trauma Acute Care Surg 73:435–440, 2012.
15. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control: Web-based injury statistics query and reporting system (WISQARS). <www.cdc.gov/injury/wisqars/index.html>.
16. Chisholm KM, Harruff RC: Elderly deaths due to ground-level falls. Am J Forensic Med Pathol 31:350–354, 2010.
17. Collins CE, Witkowski ER, Flahive JM, et al: Effect of preinjury warfarin use on outcomes after head trauma in Medicare beneficiaries. Am J Surg 208:544–549, 2014.
18. National Center for Health Statistics. Health, United States, 2013, Table 88. <www.cdc.gov/nchs/hus/contents2013.htm#088>.
19. Zanni GR: Thermal burns and scalds: clinical complications in the elderly. Consult Pharm 27:16–22, 2012.
20. Heffernan DS, Thakkar RK, Monaghan SF, et al: Normal presenting vital signs are unreliable in geriatric blunt trauma victims. J Trauma 69:813–820, 2010.
21. Brown CA, 3rd, et al: Improved glottic exposure with the video Macintosh laryngoscope in adult emergency department tracheal intubations. Ann Emerg Med 56:83–88, 2010.
22. Bond MC, Butler KH: Elder abuse and neglect: definitions, epidemiology, and approaches to emergency department screening. Clin Geriatr Med 29:257–273, 2013.
23. Edavettal M, Rogers A, Rogers F, et al: Prothrombin complex concentrate accelerates international normalized ratio reversal and diminishes the extension of intracranial hemorrhage in geriatric trauma patients. Am Surg 80:372–376, 2014.
24. Matsushima K, Benjamin E, Demetriades D: Prothrombin complex concentrate in trauma patients. Am J Surg 209:413–417, 2015.
25. McIntyre A, Mehta S, Aubut J, et al: Mortality among older adults after a traumatic brain injury: a meta-analysis. Brain Inj 27:31–40, 2013.
26. McIntyre A, Mehta S, Janzen S, et al: A meta-analysis of functional outcome among older adults with traumatic brain injury. Neurorehabilitation 32:409–414, 2013.
27. Cohn B, Keim SM, Sanders AB: Can anticoagulated patients be discharged home safely from the emergency department after minor head injury? J Emerg Med 46:410–417, 2014.
28. Pal D, Sell P, Grevitt M: Type II odontoid fractures in the elderly: an evidence-based narrative review of management. Eur Spine J 20:195–204, 2011.
29. Battle CE, Hutchings H, Evans PA: Risk factors that predict mortality in patients with blunt chest wall trauma: a systematic review and meta-analysis. Injury 43:8–17, 2012.
30. Wardhan R: Assessment and management of rib fracture pain in geriatric population: an ode to old age. Curr Opin Anaesthesiol 26:626–631, 2013.
31. Tinubu J, Scalea TM: Management of fractures in a geriatric surgical patient. Surg Clin North Am 95:115–128, 2015.
32. Haines L, Dickman E, Ayvazyan S, et al: Ultrasound-guided fascia iliaca compartment block for hip fractures in the emergency department. J Emerg Med 43:692–697, 2012.
33. Simunovic N, Devereaux PJ, Sprague S, et al: Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. CMAJ 182:1609–1616, 2010.
34. Martinez-Reig M, Ahmad L, Duque G: The orthogeriatrics model of care: systematic review of predictors of institutionalization and mortality in post-hip fracture patients and evidence for interventions. J Am Med Dir Assoc 13:770–777, 2012.

CHAPTER 184: QUESTIONS & ANSWERS

184.1. A 76-year-old man is brought to the emergency department (ED) after a fall at home. The paramedics tell you that he slipped in the shower and struck his head on a tile floor. The patient is awake and alert. He is unsure if he lost consciousness and complains of headache. When you obtain a computed tomography (CT) scan of his head, it reveals evidence of a cerebral contusion. The paramedic tells you that he has a history of severe congestive heart failure (CHF) and takes warfarin and furosemide daily. When he returns from CT, he seems slightly confused. Laboratory tests are pending. What is the best initial treatment?

A. Administer a prothrombin complex concentrate (PCC).
B. Administer desmopressin (DDAVP) intravenously (IV).
C. Administer protamine sulfate IV.
D. Transfuse 2 units fresh frozen plasma.
E. Transfuse one bag of platelets.

Answer: A. Prompt reversal of anticoagulation is important because approximately 5% of older adults is on warfarin, and others have pathologic coagulopathy. Specific considerations for reversing coagulation abnormalities in older trauma patients are the volume of reversal agents required and corresponding risk of fluid overload. PCCs require minimal volume compared with fresh-frozen plasma (FFP) but are costly. To reverse anticoagulation fully, 1 to 2 L of FFP may be required, presenting a limitation to rapid reversal in older patients at risk of fluid overload. Platelets, protamine, and DDAVP will not reverse the elevated international normalized ratio caused by warfarin.

184.2. Which of the following is the most common cervical spine fracture in geriatric trauma patients?

A. Anterior wedge fracture
B. Compression fracture
C. Jefferson fracture
D. Spinous process fracture
E. Type 2 odontoid fracture

Answer: E. Because of the relative immobility of the cervical spine related to degenerative joint disease, the most common level of cervical spine injury in older adults is C1 to C3, a higher level than in younger patients. Among these upper cervical spine fractures, the most common is a type 2 odontoid fracture.

184.3. An 80-year-old woman presents after a motor vehicle accident (MVA). Her vital signs on arrival are as follows: heart rate of 112 beats/min, blood pressure of 88/65 mm Hg, respiratory rate of 18 breaths/min, and oxygen saturation measured by pulse oximetry (Spo_2) of 98%. The paramedic tells you that she has a history of CHF and takes furosemide daily. The primary survey does not reveal an obvious source of bleeding. Which of the following treatments is most appropriate to address the patient's tachycardia and hypotension while searching for its cause?

A. Give a bolus of 500 mL warmed normal saline.
B. Give 2 units of non–crossmatched type O blood.
C. Run an infusion of warm normal saline wide open.
D. Start dopamine at a low dose.
E. Type and match and wait for type-specific blood.

Answer: A. The most prudent approach in the hypotensive older trauma patient is controlled boluses of warmed isotonic fluids, with frequent assessment of physical examination, vital signs, pulse oximetry, and urine output. Resuscitation with crystalloid may correct the patient's hypotension, obviating the need for transfusion. The patient's hypotension must be addressed immediately, and treatment should not be delayed for type-specific blood. Given her history of CHF, a wide open infusion of normal saline without an endpoint should not be administered. Vasopressors such as dopamine should not be given to any trauma patient, except in extreme circumstances. If the patient had an obvious source of hemorrhage, use of non–crossmatched type O blood would be appropriate as a first step, and starting with 1 unit would be appropriate.

184.4. A 76-year-old man presents after slipping and falling down several stairs at home. The patient is awake and alert and unsure if he lost consciousness after the fall. He complains of chest pain and has left chest wall tenderness and crepitance on examination. When you obtain a CT scan of his chest, it reveals four contiguous lateral rib fractures. The patient's pain is only moderately relieved by 0.15 mg/kg of morphine sulfate IV. What is the most appropriate disposition for this patient?

A. Admission for pain control with IV opioids
B. Admission with anesthesia consultation for pain management
C. Continued observation in the ED for 6 additional hours of IV opioid management, followed by reassessment
D. Discharge home with oral opioids

Answer: B. Geriatric trauma patients with severe pain from rib fractures often require hospitalization to allow adequate and safe pain management, and those with flail segments or larger numbers of rib fractures may require intensive care unit admission. Pain control is of particular importance because rib fractures will lead to splinting and atelectasis and increase the risk of pneumonia. Analgesia can be administered with IV opioids via patient-controlled analgesia or an epidural analgesic. An anesthesia consultation is appropriate for the older rib fracture patient without pain relief from parenteral opioids.