Advanced age is a well-known risk factor for poor outcomes in trauma patients. Older patients can benefit from the intensive monitoring and aggressive management associated with trauma team involvement. Several common topics were chosen for discussion in which the treatment options may differ slightly because of the advanced age of the patient. We discuss the following selected topics: resuscitation of the elderly trauma patient, solid organ injuries, hip fractures, rib fractures, and head injuries.

The United States is witnessing a rapid growth of its elderly population. During the last century, the number of persons younger than 65 years tripled while the number of persons older than 65 years increased by a factor of 11. Because the elderly population in this country continues to grow and because elderly persons maintain independent and active lifestyles, there will be an increasing number of elderly patients requiring treatment for trauma-related injuries.

Increasing age puts a trauma patient into a higher-risk category. Elderly patients sustaining major trauma are known to have higher complication and mortality rates than their younger counterparts. A study of almost 200,000 trauma patients found that there was an increase in mortality starting at the age of 40 years. Many believe that the increase in morbidity and mortality that is seen in elderly trauma patients is partially due to preexisting medical conditions and the diminished physiologic reserves of elderly patients and the inability to compensate for severe injuries.

Although advanced age is a risk factor for poor outcomes in trauma patients, several articles have demonstrated that older patients can benefit from the intensive monitoring and aggressive management associated with trauma team involvement. Because of this, we wanted to outline a few common topics in which the treatment options may differ slightly because of the advanced age of the patient. This is by no means meant to be a comprehensive review of trauma care for elderly patients. We selected the following topics for discussion: resuscitation of the elderly trauma patient, solid organ injuries, hip fractures, rib fractures, and head injuries.

**RESUSCITATION OF THE ELDERLY TRAUMA PATIENT**

It is well known that elderly trauma patients are much more likely to die than their younger counterparts. The elderly patient does not have the physiologic reserves to respond to the added stress of injury or critical illness. While adrenal function remains largely intact with aging, most organ systems demonstrate decreased functional capacity. Most significantly, the cardiopulmonary system demonstrates age-related changes that affect the elderly patient’s response to severe trauma. An insufficient cardiac output and lower maximum heart rate with a higher peripheral vascular resistance limit the ability of the cardiovascular system to compensate to meet increased metabolic demands. It is these age-related changes that make the diagnosis of shock more important and more difficult.

The presence of shock is a reliable indicator of poor outcome and is associ-
ated with mortality rates as high as 100%. In addition to physiologic injury scores, hemodynamic factors and mental status were also suggested to be useful in predicting outcome in elderly trauma patients. A prospective randomized study of elderly patients who sustained hip fractures demonstrated that invasive monitoring with pulmonary artery catheters was associated with a significantly reduced mortality rate when compared with elderly patients monitored with only a central venous pressure catheter. Unfortunately, no resuscitation factors or end points were prospectively identified in this study. A notable article by Scalea et al demonstrated that a significant difference in cardiac output and peripheral vascular resistance existed between survivors and nonsurvivors in severely injured elderly patients. In the study by Scalea et al, pulmonary artery catheters were used to guide resuscitation to a cardiac index of 4 L/min per square meter or an oxygen consumption of 170 mL/min per square meter. The authors noted that the limited compensatory mechanisms of elderly patients might lead to the missed diagnosis of a perfusion deficit due to a decreased cardiac output.

Identifying those patients who may benefit from invasive monitoring is an important early step in the evaluation of an elderly trauma patient. Laboratory data used to estimate the acidemia due to perfusion deficits may help identify high-risk patients. The presence of an increased base deficit (less than or equal to −6 mEq/L) on arterial blood gas sampling is associated with an increased mortality. In addition, an elevated serum lactate level has also been implicated in occult hypoperfusion and the rate of clearance directly correlates with mortality. Elderly patients are less able to compensate for occult hypoperfusion. The presence of a lactic acidemia level of more than 22 mg/dL (≥2.4 mmol/L) for longer than 12 hours is associated with an increased mortality. Prompt normalization of the base deficit and serum lactate level are thought to be appropriate end points in trauma resuscitation.

We recommend the usage of pulmonary artery catheters in elderly trauma patients who have hypotension, have significant injuries (as defined by an Abbreviated Injury Score >3 or a Trauma Score <15), or have uncertain cardiovascular and/or fluid status. Furthermore, the use of base deficit and lactate measurements can identify those patients who have occult hypoperfusion and may benefit from invasive monitoring with pulmonary artery catheters. These patients should be resuscitated with fluid and supported with pressor medications, as needed, to maintain a cardiac index of at least 4 L/min per square meter or an oxygen consumption of 170 mL/min per square meter.

ELDERLY PATIENTS AND THE NONOPERATIVE MANAGEMENT OF SOLID ORGAN INJURIES

Traditionally, elderly patients who sustained blunt splenic or hepatic injuries were considered a prohibitive risk for nonoperative management. In 1996 Godley et al reported that 91% of patients older than 55 years failed nonoperative management of splenic injuries. This finding prompted these authors to conclude that advanced age alone should be a contraindication for nonoperative management of splenic injuries (NOMSI). In 2002 Albrecht et al reported a NOMSI failure rate of 33% in elderly patients. Those who failed NOMSI were noted to have higher grades of splenic injury and free intraperitoneal fluid levels. A potential explanation why older patients are twice as likely to be managed operatively may be because of increased splenic fragility and decreased physiologic reserves associated with advanced age. However, these studies do not tell the complete story.

Improvements in diagnostic imaging and intensive care unit monitoring have permitted safe observation of patients previously thought to require operative intervention. Recently, multiple investigators have reported higher rates of successful nonoperative management of blunt abdominal trauma in elderly patients. Myers et al documented that older patients had similar success rates for NOMSI as their younger counterparts. The Eastern Association for the Surgery of Trauma study group reported that successful nonoperative management of blunt splenic injuries could be predicted by hemodynamic stability, grade of splenic injury, and Glasgow Coma Score, without regard to patient age. In these articles, it was noted that elderly patients had higher mortality rates for both operative and nonoperative management of splenic injuries. Another article looking at criteria that may predict failure of NOMSI were similar to the criteria from the Eastern Association for the Surgery of Trauma study that predict success: hemodynamic instability, radiographic evidence of high-grade injuries, and pooling of radiopaque contrast material. Again, age was not an independent predictor of failure of nonoperative management of solid organ injuries.

While there are no studies specifically addressing potential radiologic findings in elderly patients that could be predictive of failure of NOMSI, most authors recommend nonoperative management in all hemodynamically stable patients without regard to grade of injury. Additional studies have also confirmed that the condition of patients older than 55 years may be successfully managed nonoperatively provided their conditions were hemodynamically stable and significant blood transfusions were not required.

Age is no longer considered an exclusionary criterion for the nonoperative management of solid organ injuries. As experience with nonoperative management of blunt trauma increases, the indications for observation have diversified. Several patient groups previously thought to require operative intervention are considered to be good candidates for nonoperative management of solid organ injuries. Elderly patients are a prime example of this change in practice. In addition, the increasing reliability of radiographic evaluation of solid organ injuries has allowed better selection of patients requiring operative intervention. This has permitted more blunt trauma patients to be observed without the need for performing surgical exploration. All patients, regardless of age, who sustain blunt splenic and hepatic injuries and whose conditions are hemodynamically stable, are candidates for nonoperative management of their injuries.
TIMING OF OPERATIVE FIXATION OF HIP FRACTURES IN ELDERLY PATIENTS

Early operative fixations of long bone fractures in young patients within 24 hours may decrease morbidity, mortality, and the length of hospital stay. However, the elderly patient with a hip fracture presents a more challenging situation. Preexisting medical conditions and the lack of physiologic reserve make elderly patients less optimal candidates for urgent operations.

There have been many mechanisms postulated for the improved results with early stabilization of orthopedic injuries. Early fixation and mobilization may prevent decubitus ulcers, deep vein thrombosis, and pulmonary embolism. Early mobilization can improve respiratory status by decreasing atelectasis, increasing functional residual capacity, and increasing diaphragmatic excursion. As a result of early exploratory surgery and evacuation of necrotic tissue and hematoma around the fracture, the inflammatory response can be blunted. Early fixation can also decrease pain levels and the need for intravenous narcotics.

There are several studies that document decreased morbidity and mortality rates in elderly patients who had hip fractures treated with early fixation of their fractures within 24 to 48 hours of presentation. These data support a role for early fixation of hip fractures in healthy elderly patients. But these studies did not control for comorbid factors and some did not include patients with active medical diseases. However, preexisting comorbidities in patients with hip fractures have also been shown to be a significant factor associated with increased morbidity and mortality. Kenzora et al reported that early fixation within 24 hours was associated with increased mortality in elderly patients, and further analysis revealed that the increased mortality was attributed to preexisting comorbidities.

Taking a brief period to optimize a patient's medical conditions prior to operative fixation may be sensible. The delay incurred to treat the preexisting medical conditions can improve morbidity and mortality. Additional support for optimizing medical conditions prior to early fixation is provided by Grimes et al who studied 3805 elderly trauma patients with hip fractures who underwent fixation after 24 hours. The study compared 3 groups of patients: those who underwent fixation between 48 and 72 hours; those between 72 and 96 hours; and those longer than 96 hours from the time of the fracture. The patients who had their operation within 24 hours were considered to be in good health and were excluded from the analysis. After adjusting for underlying medical illnesses and additional confounding factors, there was no association between the length of time-to-repair and increased mortality. Delaying the procedures was not associated with an increase in 30-day mortality or long-term mortality. In addition, there was no association with a delay-to-repair to the development of serious bacterial infections, myocardial infarction, or thromboembolism. The only factor associated with length of time-to-repair was decubitus ulcers.

We support the early fixation of hip fractures and believe that this strategy can be safely applied to elderly patients as long as they are in good health. However, other issues must be considered when contemplating early fixation in elderly patients who have a hip fracture with other active medical problems. Morbidity and mortality may be increased if active medical issues are not promptly addressed. It is, therefore, prudent to take the time to medically optimize elderly patients’ preexisting comorbidities prior to operative fixation of their hip fractures.

CHOICE OF ANALGESIA FOR RIB FRACTURES IN ELDERLY PATIENTS

Rib fractures can be found in about 10% of trauma patients with an associated 12% overall mortality and 35% incidence of pulmonary complications. However, the incidence of rib fractures in elderly trauma patients is much higher and is reported to be near 60%. Elderly patients who sustain rib fractures have twice the mortality and morbidity of younger patients with similar injuries. Each additional rib fracture increases the mortality rate by 19% and the risk of pneumonia by 27%. Clearly, with even a few rib fractures, the elderly trauma patient needs more aggressive treatment in an inpatient setting. Pain control is of critical importance when treating these patients and may help improve mechanical ventilation and pulmonary toilet. There has been some debate over the ideal choice of analgesia in treating the elderly patient who has rib fractures.

Many consider epidural analgesia to be the ideal choice for pain control in the elderly trauma patients with rib fractures. Epidural analgesia produces optimal pain control and can improve mechanical ventilation and pulmonary toilet. There is an associated increase in maximal inspiratory pressure and vital capacity with epidural analgesia. These improvements in mechanical ventilation and pulmonary hygiene are major factors that lead to improved outcomes in elderly patients with rib fractures.

Significant decreases in mortality and pulmonary complications were found with the use of epidural analgesia compared with parenteral analgesia. Wisner studied epidural analgesia in trauma patients older than 60 years who had rib fractures. When comparing the parenteral analgesia group with the epidural analgesia group, mortality decreased from 16% to 4%, instances of pneumonia decreased from 19% to 8%, and occurrences of adult respiratory distress syndrome decreased from 14% to 6%. A study by Bulger et al confirmed the potential life-saving attributes of epidural analgesia. Bulger et al found that when comparing elderly patients with rib fractures who did not receive epidural analgesia with those who did, the mortality rate decreased from 25% to 11%.

The risks with epidural catheters and analgesia are low. There were no major complications with epidural analgesia reported in 173 trauma patients with multiple rib fractures. Another study by Mackersie et al reported no catheter-related infections or epidural hematomas. These authors noted the importance of removing the catheters within 5 days. Minor complications can include pruritus (15%), urinary retention (5%), and transient hypotension (2.5%). Potential hemodynamic consequences are of special concern when administering

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Epidural analgesia in elderly trauma patients. However, the 2 studies on elderly trauma patients by Bulger et al and Wisner reported no episodes of hypotension with epidural analgesia use. Epidural analgesia is also cost-effective. There are cost savings in nursing and pharmacy time because of the decreased need for repeated intravenous injections. To help reduce costs, certain institutions do not require an intensive care unit admission for epidural analgesia. Moreover, patients having fewer pulmonary complications translate into shorter hospital stays and reduced hospital costs. A randomized study by Ullman et al on patients with rib fractures showed a statistically significant decrease in the length of intensive care unit stay, duration of mechanical ventilatory assistance, and length of hospital stay with epidural analgesia use.

Epidural analgesia in elderly trauma patients with rib fractures produces better pain control, improved ventilatory function and pulmonary hygiene, decreased inflammatory cytokine levels, and decreased morbidity and mortality rates. These benefits are achieved with low risks and lower overall costs. Epidural analgesia is the ideal choice of analgesia in elderly trauma patients with rib fractures.

EFFECTS OF AGE AND COUMADIN THERAPY ON HEAD INJURIES

It is well accepted that older patients fare worse when sustaining traumatic brain injuries than younger patients. Age is an independent predictor of mortality and long-term disability in patients with severe head injuries. To complicate matters, some elderly patients with an intracranial hemorrhage often present while receiving oral anticoagulant therapy. While there is a well-accepted increased incidence of chronic subdural hematoma in the patient who receives anticoagulant therapy, the risk of traumatic intracranial hematomas in this patient population is less understood. Elderly patients who fall or sustain blunt trauma while receiving anticoagulant therapy present a particularly difficult clinical challenge because the risk of adverse events while receiving anticoagulant therapy may approach the rate of complications after the effects of anticoagulant therapy are reversed.

Kennedy et al reported that elderly patients receiving coumadin therapy sustain no greater morbidity or mortality from head injuries than those patients who are not receiving anticoagulant therapy. There are claims that there is no increase in the mortality or length of hospital stay secondary to head injuries in elderly patients taking coumadin. Garra et al stated that the likelihood of significant head injuries was so low that routine screening computed tomographic scans of the head are not indicated. In addition, falls by inpatients undergoing stroke rehabilitation while receiving coumadin therapy were no more likely to result in serious injuries when compared with patients who were not receiving anticoagulant therapy.

In contrast to these data suggesting that oral anticoagulant therapy with coumadin has minimal influence on closed head injuries in elderly patients, other studies have demonstrated increased incidence and mortality rates of clinically significant head injuries in this patient population. Blunt head trauma is reported to have a clinically significant intracranial hemorrhage rate of 7% in the elderly patient receiving anticoagulant therapy. More significantly a 50% mortality rate has been documented for blunt head injuries in elderly patients who have an international normalized ratio of 3.

Elderly patients receiving oral anticoagulant therapy present a particularly difficult clinical challenge to the trauma surgeon. Management of the patient who is receiving anticoagulant therapy who sustains blunt head trauma should include a thorough initial evaluation, including coagulation studies and a computed tomographic scan of the head, if indicated. Since the mortality in patients who receive anticoagulant therapy has been suggested to be 4- to 5-fold higher than control subjects, all trauma patients who receive anticoagulant therapy may benefit from inpatient observation for progression of intracranial injuries. Furthermore, as intracranial hematomas and cerebral contusions may increase in size and severity in the first 12 to 24 hours, close observation is warranted. Secondary brain injuries related to hypoxia or systemic hypotension and intracranial pressure fluctuations are associated with a significantly poorer prognosis.

Patients who require neurosurgical intervention should have their anticoagulant therapy reversed for the perioperative period. This can be accomplished safely without serious sequelae. Patients with intracranial hemorrhages not requiring emergency decompression should also have their coagulopathies reversed, as temporary discontinuation of anticoagulant therapy does not significantly increase the risk of cardiovascular complications and may prevent deterioration of the neurostatus. Reversal of anticoagulant therapy can be accomplished with vitamin K administration; however, the use of fresh frozen plasma and cryoprecipitate may be necessary in patients with concerning injuries and increased coagulation profiles. Recently recombinant coagulation factors and prothrombin complex concentrates have also demonstrated efficacy in the reversal of oral anticoagulant therapy.

CONCLUSIONS

As surgeons involved in the care of trauma patients, we will see an increasing number of elderly patients requiring treatment for trauma-related injuries. Increasing age puts a trauma patient into a higher-risk category and elderly patients sustaining major trauma are known to have higher complication and mortality rates than their younger counterparts. Although advanced age is a risk factor for poor outcomes in trauma patients, improved outcomes in elderly trauma patients can be accomplished with the intensive monitoring, aggressive management, and comprehensive care provided by the experienced trauma team.

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REFERENCES


**Correction**

Error in Table. In the Original Article by Camprodon et al titled “Transgastric Surgery for Posterior Juxtacardial Ulcers: A Minimal and Safe Approach,” published in the July issue of the ARCHIVES (2003;138:757-761), an error occurred in Table 2 on page 760. In that table, the follow-up for patient 3 should have read as follows: “Died of myocardial infarction 30 mo after surgery.” The journal regrets the error.