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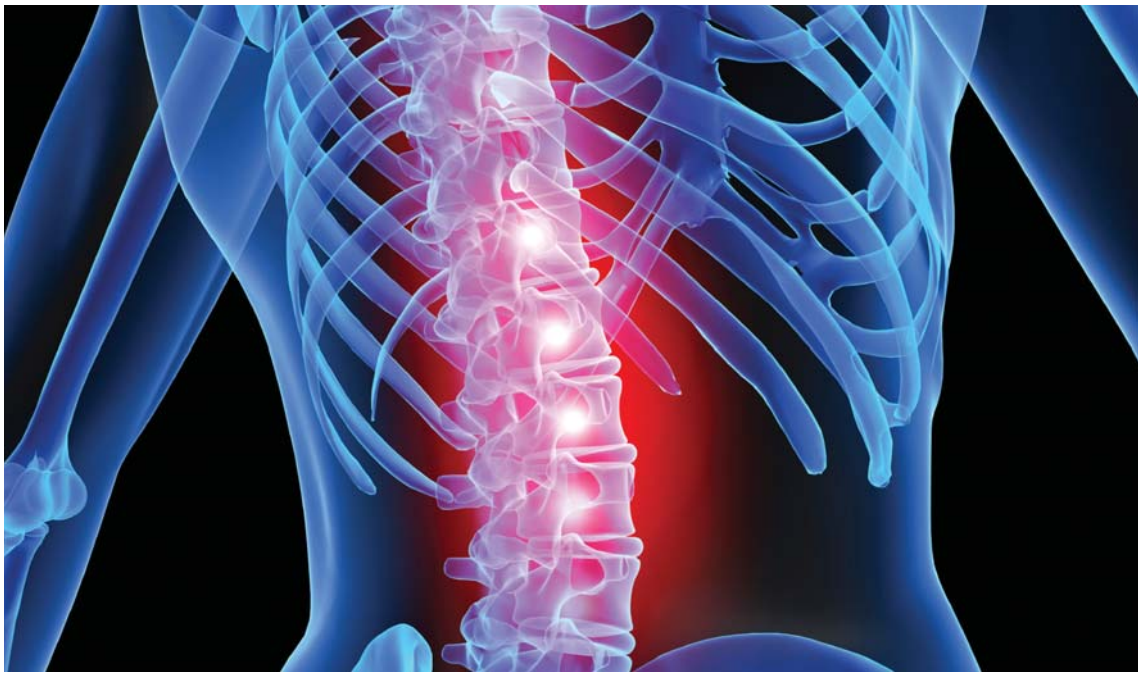

Early Management of Acute Spinal Cord Injuries

Brett A. Braly, MD, and Joon Y. Lee, MD

Nearly 11,000 acute spinal cord injuries (ASCIs) occur in the United States annually. Early diagnosis and management of these injuries is critical for decreasing further neurological risks, and for improving post-trauma function. Keys to assessing spinal cord injury include history, a complete exam, and timely imaging.

In any polytrauma patient, an acute spinal cord injury should be assumed until proven otherwise. Early immobilization is necessary to prevent neurologic injury during transport. Studies have estimated that 3 to 25 percent of spinal injuries occur during transport from the scene to the emergency department. Standardization of immobilization techniques has led to a decrease in mortality from complete spinal cord injuries from 55 percent in the 1970s to below 40 percent in the 1990s.

Once the patient arrives in the ED, the process of clearing the spine should begin as soon as possible. Both facial decubiti (from C-collar immobilization) and sacral decubiti (from back boards) have been reportedly caused by prolonged or improperly fitting immobilization. Details of the mechanisms of injury, symptoms of weakness, paresthesias, and neck or back pain should be questioned. Though it is often difficult to complete a full spine exam in the polytrauma algorithm, attention should be paid to

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Early Management of Acute Spinal Cord Injuries *(continued from cover)*

equality and symmetry of motor and sensory exams in both the upper and lower extremities as ascertained by a single examiner. An unresponsive or uncooperative patient may make it difficult to rely on physical exam findings. Findings that may indicate a spinal cord injury in obtunded patients include flaccidity, diaphragmatic breathing without the assistance of accessory muscles, priapism, and the presence of greater than three beats of clonus without decerebrate rigidity. In these scenarios, imaging is necessary to properly evaluate the spine.

Rates of up to 33 percent of missed spinal fractures have been reported in high energy trauma patients. Cervical spine clearance protocols have been evaluated through two large clinical studies, the National Emergency X-Radiography Utilization Study (NEXUS), and the Canadian C-Spine Rule (CCR). These studies have helped to decrease unnecessary radiographs, particularly in low-energy trauma patients. Helical CT scans have been shown more efficacious, cost effective, and sensitive than the standard three views in detecting cervical spinal trauma. If subtle ligamentous or soft tissue injury is suspected or the patient is obtuned, MRI evaluation may be warranted.

Injury patterns as guides to treatment

Unfortunately, not all spinal trauma is created equal. Knowing recommendations for specific injury patterns may aid in focusing care and preventing neurologic insult.

- ***Atlantooccipital articular injuries*** are devastating and usually fatal. Surviving patients should be rigidly immobilized until they can be placed into a halo vest. Excessive transfers should be avoided with urgency placed on surgical immobilization.
- ***Atlas fractures (Jefferson's fracture)*** comprise 10 percent of all cervical spine injuries and are only rarely associated with neurological injury. Rigid immobilization is warranted and is often the final method of treatment. Occasionally progressive displacement is noted and posterior arthrodesis is necessary.
- ***Odontoid fractures*** comprise 8 to 18 percent of cervical fractures, and associate with neurological deficits in 10 to 20 percent of cases. Cervical collar immobilization is recommended during the polytrauma evaluation. Further treatment is depicted by the fracture pattern. Type III fractures (fractures within the C2 body) can usually be treated in a collar. Type II fractures (fractures at the base of the odontoid) are more difficult to treat. Treatment with a

halo vest versus surgical fixation depends on host factors, concomitant injuries, and characteristics of the fracture (displacement and angulation).

- ***Traumatic spondylolisthesis of the axis (hangman's fractures)*** should be placed in a rigid cervical collar and are usually treated in such definitively.

- ***Subaxial cervical trauma*** should be rigidly immobilized and stability evaluated by CT and possibly MRI. Subluxations or dislocations require emergent reductions and possible surgical fixation.

- ***Thoracolumbar fractures*** usually fall into one of four patterns: compression, burst, flexion-distraction (Chance), or fracture-dislocations. Most compression-type fractures are stable, and can be treated with rigid thoracolumbar orthosis. Flexion-distraction injuries, or Chance fractures, result from forceful flexion of the spine, and thus the posterior elements fail in tension while the anterior vertebral column may fail in compression or tension. A common cause of this injury pattern results from a motor vehicle collision in which the patient has been wearing a lap belt without the shoulder strap. If this mechanism is suspected, careful attention should be paid to evaluation for intra-abdominal injury, as these are concomitant in about 45 percent of cases. Neurological injury may occur in 10 to 15 percent of Chance-type injuries.

Timing to surgery

The issue of timing to surgery for spinal cord injuries is controversial. Most surgeons agree that early operative intervention may benefit patients with incomplete spinal injuries. Timing may be less crucial in patients with complete or no neurological injury.

A final controversial issue is the use of steroids in treating acute spinal cord injuries. Early studies like National Acute Spinal Cord Injury Study (NASCIS) supported their use, demonstrating improved functional outcomes and more rapid recovery. More recent research has questioned these results, and a consensus has been made that the benefits of steroid use do not outweigh the risks.

Acute spinal cord injury is a devastating and potentially life-threatening scenario. Assumption of injury and care to safely immobilize may benefit those patients who have sustained these injuries. Knowledge of the mechanism of injury and special consideration to physical exam may raise concern for spinal injuries. Imaging modalities help aid in definitively diagnosing spinal trauma and planning treatment options. In any patient where spinal cord injury is suspected, rigid immobilization and limitations on rolling and transfers should be instigated.

Brett A. Braly, MD, is an orthopaedic spine fellow at UPMC Presbyterian; Joon Y. Lee, MD, is an assistant professor of orthopaedic surgery in the Division of Spinal Surgery, UPMC Presbyterian.

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Acute spinal cord injury is a devastating and potentially life-threatening scenario.

Acute Heat Illness

by Nathan T. Gilmore, MD

Heat-related illnesses are common, especially as temperatures rise and exposures increase. While outdoor activities and rigorous physical exertion can lead to heat illness, so can exposure to warm temperatures for too long with too little reserve. Less obvious exposures must be considered and recognized, including the fact that higher-risk populations can develop these conditions under conditions that one would not normally associate with heat illness. Problems as simple as loss of power and air conditioning, or being outside longer than planned, can create a significant exposure for those at higher risk.

Heat stroke, heat exhaustion, and cramps can occur independently or in combination with other conditions, including trauma. In the setting of trauma, the possibility of hyperthermia and heat-related illnesses must be assessed, recognized, and treated effectively. Often, heat-related illnesses will be present long before arrival at the trauma center; therefore, prehospital and nontrauma emergency department personnel should remain alert to the possibility of heat illness to identify and manage it.

Some specific factors have been identified that increase risk for heat-related illness. These include extremes in age, amount of exposure and exertion, medical conditions, and drugs and toxins (such as diuretics or stimulants, both prescribed and recreational).

Physiology of heat illness

Progressing hyperthermia follows three phases of injury:

1. In the **acute phase**, events include increased inflammatory mediators, vasodilation with shunting of blood to the periphery, metabolic acidosis, and hyperventilation with respiratory alkalosis.
2. The **enzymatic phase** involves disruption of the coagulation cascade, with endothelial injury and microvascular thrombosis, and eventually disseminated intravascular coagulopathy (DIC).
3. The **late phase** is characterized by end organ injury and failure. These include hepatic failure from vascular congestion; renal failure from underperfusion and extreme prerenal state; CNS injury from edema, petechial hemorrhage secondary to vascular congestion and DIC, and neuronal degradation; and cardiovascular dysfunction, including hypotension and shock from hypovolemia and vasodilation, often leading to death.

Types of heat illness

Specific heat-related illnesses are well described: heat cramps, heat syncope, heat exhaustion, and heat stroke.

Heat cramps are characterized by brief, intermittent, involuntary cramps of skeletal muscles. They are caused by prolonged activity in the heat, coupled with inadequate electrolyte intake or repletion. Calves and rectus muscles are most often affected. Treatment includes hydration and electrolyte repletion (PO and/or IV). Comorbidities often make this condition worse.

Heat syncope is caused by cerebral underperfusion. A prodrome of light-headedness, vertigo, nausea, restlessness, and yawning usually precedes the condition. Heat syncope can be precipitated by hypovolemia secondary to dehydration and vasodilatation. Treatment includes hydration, PO and usually IV. Place the patient supine in a cool area. Heat syncope needs to be thought of as a diagnosis of exclusion. With the presence of other risk factors, patients usually need evaluation of other causes of syncope as well.

Heat exhaustion results from significant heat stress that causes intravascular depletion and electrolyte disturbances. Gradual onset of weakness and extreme fatigue characterize the condition. Often, symptoms include headache, lightheadedness, thirst, and nausea and vomiting. Patients are usually tachycardic, tachypneic, and hyperthermic (but still below 40 C or 104 F). Often orthostatic hypotension

develops. Patients may or may not be diaphoretic. By definition, patients with heat exhaustion do not have altered mental status. Treatment includes rest and aggressive hydration and electrolyte replacement, usually IV. If the patient tolerates PO as well, sugar content should be less than 6 percent (for example, Pedialyte or WHO fluid, but not soft drinks). Cool the patient actively, with ice packs to the neck and groin. Cold saline is very effective, as is evaporation. Above all, remove the patient from heat exposure.

Heat stroke is a severe, overwhelming decompensation with a relatively abrupt onset, usually caused by significant exposure or activity. This condition is a true emergency, independent of other illnesses. Heat stroke is characterized by a classic triad of findings:

- hyperthermia (greater than 40 C or 104 F)
- anhydrosis (though this sign is sometimes absent)
- by definition, CNS disturbance

CNS symptoms often begin with ataxia, progressing to overt confusion, syncope, seizures (status), hemiplegia, coma and death.

Initial treatment for heat stroke must be rapid and aggressive:

- Again, heat stroke is a true emergency: Eliminate exposure ASAP.
- As always, address the ABCs.
- IV access, high-flow O2, and cardiac monitoring are called for.
- Monitor core temperature, if possible.
- Check glucose early; these patients often have symptomatic hypoglycemia.
- Rapid, active cooling is essential: The goal is to decrease core temperature below 40 C ASAP. Cold saline, or ice-water baths are most effective, as is evaporation or ice packs to the neck, axilla, groin, and scalp.
- Active cooling should be halted once body temperature reaches 39 C, to avoid overshooting.

Upon arrival at the emergency department, treatment hinges on continuing to bring body temperature to a safe level and addressing issues stemming from the heat illness and treatment:

- Valium or Ativan may be employed to control shivering.
- Pulmonary status should be monitored: IV fluids plus vasoconstriction equals pulmonary edema!
- Shock should be treated with fluids, then Dobutamine (alpha-agonists are contraindicated due to vasoconstriction and interference with heat transfer and cooling).
- Treatment should not include antipyretics, alcohol baths, Dantroline, norepinephrine or atropine, or anticholinergics.

Patients with heat syncope, heat exhaustion or heat stroke usually merit admission and observation. Patients with heat stroke often merit ICU admission and monitoring.

Summary

Patients with various other medical problems, including trauma, also are at risk for heat-related illness. Identifying risk factors and exposures can aid in identifying signs and symptoms, even when subtle.

Treating heat-related illnesses should begin in the field and continue through emergency department treatment and the destination of definitive treatment. Treatments begin with the ABCs, continuing with removal from exposure, cooling the patient to normothermia, and aggressive IV and PO hydration with electrolyte replacement.

Further evaluation and management is often merited, including admission and, at times, ICU-level care. Carefully identifying and treating patients' multiple ailments, including heat-related illness, will decrease morbidity and even mortality.

Nathan T. Gilmore, MD, is an emergency medicine resident, Department of Emergency Medicine, UPMC Presbyterian.

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The Hourglass and the Heavy Rescue

by Ben Reynolds, PA-C

It can be difficult for trauma providers who work only in the hospital setting to appreciate the adversities and stresses unique to the prehospital provider. When the message on the trauma pager says "prolonged extrication," the reader may not appreciate just what that entails.

The impression left by the popular media is that firefighters get out their "jaws of life," cut the car out from around the patient, and then quickly load him or her into the ambulance. And I suppose in a perfect world, that's how it would go: All extrications occur within five or 10 minutes, and little of the precious "golden hour" is consumed with the machinations of removing the patient from the vehicle.

For the rescuer, a "prolonged extrication" is an intense physical, mental, and emotional exercise which, if lengthy, can be exhausting and frustrating. Imprinted in the back of the rescuers' minds is the image of an hourglass emptying. Blood is being lost. The patient isn't breathing effectively. The brain may be swelling. There is always an unspoken understanding between all involved that the "golden hour" is quickly slipping away.

Medically directed rescue

And so the concept of "medically directed rescue" was conceived. The idea is that without the patient, there is no rescue — and that the goal of the rescue should not just be the technical act of removing the patient from the hazard, but for medical care to be provided while the rescue is performed.

Hazards that threaten the rescuer must of course be given equal priority to the technical act of the rescue: "Scene safety first." Nevertheless, it is the delivery of care to the patient by a trained provider simultaneous with the rescue that helps to increase he probability of a positive outcome. The airway is supported; external sources of hemorrhage are controlled; cervical-spine control is achieved; perhaps an IV can be placed, and fluids administered. All the while, the doors are removed, the dash lifted, the roof cut back, and the patient is extricated safely.

Providing this level of advanced rescue necessitates advanced training in rescue techniques and prehospital medicine. It requires extensive coordination between fire and EMS services to mitigate and control hazards that will not only affect the patient, but may threaten the safety of the rescuers as well. The final goal is not just a patient upon whom advanced life saving measures have been implemented, but a safe rescuer who will go home to his family afterward.

A case study

What follows is an example of a successful medically directed rescue of a patient this author helped to rescue and subsequently cared for as their trauma provider at UPMC Presbyterian.

"J.M." was a 25-year-old white male involved in a motor vehicle crash, sedan versus tractor-trailer. The patient had been driving the sedan, which was trapped beneath the trailer with severe intrusion of the driver's compartment by the dash and roof. He was bleeding profusely from the scalp and was not responsive. Rescuers heard gurgling as the patient attempted to breathe.

Rescuers established incident command, created a safety zone, and then began the work of cribbing and stabilizing the vehicle. Because of the extensive damage to the driver's side, they achieved entry through the rear window. A paramedic entered the vehicle to access the patient and perform the role of "inside rescuer."

The inside rescuer applied a cervical collar; on cursory examination the rescuer noted obvious arterial spurting from the scalp. This bleeding emanated from a large degloving scalp injury that extended from the left frontal region across the left temple to just behind the left ear. The paramedic performed a jaw thrust, maintaining cervical-spine alignment; the patient breathed more easily.

Outside the vehicle, again because of the angle of the impact and the damage to the driver's side, the heavy-rescue crew removed the front passenger door, the rear passenger door, and the passenger-side "B" post (the second post on the passenger side counting from the front of the vehicle; in this case, between the two doors). A modified dash lift (using

hydraulic equipment to push the dashboard and the floorboard apart to create more rescue space, only modified to be done so without the usual removal of the driver's door and the driver's side "A" post) was performed. Rescuers effected a safe extrication on a long spine board. Total extrication time was 28 minutes. The paramedic crew then intubated the patient in the ambulance.

At the hospital, trauma staff discovered that the patient had a hyperacute epidural hematoma, as well as extensive right-sided chest injuries. They inserted a right-sided chest tube and transferred the patient to the operating room, where neurosurgeons performed an emergent craniotomy and evacuation of the epidural hematoma. The surgeons left a portion of the skull off to allow for brain swelling, and inserted a ventriculostomy to help relieve and measure pressure within the brain.

On the third post-trauma day, the patient began purposefully to follow commands; the ventriculostomy was removed. The patient was extubated on the fifth post-trauma day. The patient was discharged to traumatic brain injury rehabilitation on the eighth day with a gastrostomy tube, and then discharged from rehabilitation to home four weeks later. Two months later, neurosurgeons replaced the missing section of the skull.

As illustrated, an effective medically directed rescue is key to producing an optimal outcome in the critically injured patient who is trapped. A patient-centered rescue achieves multiple simultaneously competing goals in a complex entrapment/extrication scenario.

Ben Reynolds, PA-C, is a certified physician assistant, Division of Trauma Surgery, UPMC Presbyterian; and captain, Edgewood Volunteer Fire Department.

An effective medically directed rescue is key to producing an optimal outcome in the critically injured patient who is trapped.

Calendar of Events

Continuing Education Classes

Name	Date(s)	Time	Location
Third Thursday EMS Lecture Series	Aug. 19, Sept. 16, Oct. 21, Nov. 18	6 to 9 p.m.	UPMC Mercy St. Ferdinand Clark Auditorium 1400 Locust St. Pittsburgh, PA 15219
ALS Skills Review	Sept. 9	6 to 9 p.m.	Elizabeth Township Area EMS 911 Swiss Way Elizabeth, PA 15037
ALS Skills Review	Sept. 13	6 to 8:30 p.m.	The Washington Hospital 155 Wilson Ave. Washington, PA 15301
ALS Skills Review	Sept. 29	9 a.m. to 3 p.m.	City of Uniontown Fire Department 84 N. Beeson Ave. Uniontown, PA 15401
ALS Skills Review	Sept. 30	8 a.m. to 3 p.m.	Baldwin EMS One Readshaw Way Pittsburgh, PA 15236

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Advanced Trauma Life Support 2010

Oct. 14 to Oct. 15
Oct. 15 (Re-verification)
Nov. 18 to Nov. 19
Nov. 19 (Re-verification)

For more information about ATLS courses, e-mail **upmcatls@upmc.edu**, call **412-647-3520**, or fax **412-647-1045**.

For a list of nationally available ATLS courses, see **http://web2.facs.org/atls/ATLSSearch.cfm?Search=USA**.

Consider the opportunity to earn continuing education credits by reading *Trauma Rounds* and completing the corresponding continuing education test. After reading, log on to http://prehospitalcare.upmc.com/traumarounds.htm. On the *Trauma Rounds* website, you can print the test and mail the completed version back to UPMC, or you can take the test online through the Pennsylvania Department of Health's online testing program.

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Calendar of Events *continued*

Name	Date(s)	Time	Location
ACLS/PALS Renewal	Oct. 6, Oct. 13, Oct. 18	8 a.m. to 5 p.m.	Baldwin EMS One Readshaw Way Pittsburgh, PA 15236
Annual ALS Skills Review	Nov. 11	6:30 to 9:30 p.m.	Parkview EMS 200 Margery Drive Pittsburgh, PA 15238
Last Chance Skills Review	Dec. 9	6 to 10 p.m.	UPMC McKeesport Kelly Conference Center
Case Review	Dec. 9	6:30 to 8:30 p.m.	Parkview EMS 200 Margery Drive Pittsburgh, PA 15238
eMERgenCY Mini-Conference for EMS	Dec. 16	6 to 9 p.m.	UPMC Mercy St. Ferdinand Clark Auditorium 1400 Locust St. Pittsburgh, PA 15219

Preregistration is required for all classes listed above. You can preregister or cancel a registration by calling **412-647-9077, ext. 1**, or by completing the prehospital online registration form at **http://prehospitalcare.upmc.com/classes.htm**.

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Editor
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