

# Prehospital Spine Immobilization for Penetrating Trauma—Review and Recommendations From the Prehospital Trauma Life Support Executive Committee

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Spine immobilization in trauma patients suspected of having a spinal injury has been a cornerstone of prehospital treatment for decades. Current practices are based on the belief that a patient with an injured spinal column can deteriorate neurologically without immobilization. Most treatment protocols do not differentiate between blunt and penetrating mechanisms of injury. Current Emergency Medical Service (EMS) protocols for spinal immobilization of penetrating trauma are based on historic practices rather than scientific merits. Although blunt spinal column injuries will occasionally produce unstable vertebral injuries, which may result in subsequent neurologic propagation if not managed appropriately in the field, this has not been demonstrated to be the case with penetrating trauma.<sup>1</sup>

Patients with penetrating trauma have different management priorities than those with blunt mechanisms. In patients with penetrating wounds of the head and neck, cervical collars hinder provider assessment of the neck for evolving injuries, tissue edema, subcutaneous emphysema, hematoma development or expansion, and tracheal deviation—with many of these injuries often identified only after removal of the cervical collar.<sup>2,3</sup>

Airway management is a significant issue in the penetrating trauma population who have had their cervical spine immobilized by prehospital personnel. Endotracheal intubation is more difficult in patients with cervical immobilization.<sup>4</sup> More attempts at intubation occur in patients with cervical spine immobilization than occur without, and there is a higher incidence of esophageal intubation and tube dislodgement in this group.<sup>5</sup>

In the case of penetrating injuries, delays in transport prolong the time before patients receive the prompt surgical care needed to arrest hemorrhage. Even with experienced prehospital providers, spine immobilization is time consuming. The time required for experienced emergency medical technicians to properly immobilize a cervical spine has been reported to be 5.64 minutes ( $\pm 1.49$  minutes).<sup>6</sup> This scene delay can be catastrophic for a patient with penetrating trauma requiring urgent surgical intervention for airway compromise or hemorrhage.

Studies have demonstrated that cervical collars increase intracranial pressure in patients with head injuries.<sup>7-9</sup> The mechanism for this rise in intracranial pressure is unknown but has been postulated to be due to jugular venous compression by the cervical collar.<sup>10</sup> Finally, no study has demonstrated that penetrating trauma can produce an unstable spine injury. Progression of spinal cord injury has not been demonstrated to occur following penetrating trauma, which has a different mechanism of injury from blunt trauma.

The PreHospital Trauma Life Support (PHTLS) program is a national and international educational effort sponsored jointly by the National Association of Emergency Medical Technicians and the American College of Surgeons Committee on Trauma. The Executive Committee of PHTLS is comprised of surgeons, emergency physicians, and paramedics. The mission of PHTLS is to further the knowledge of prehospital providers of all levels in the management of victims of trauma. To that end, PHTLS publishes textbooks and offers educational courses for prehospital providers at both basic and advanced levels of training. The PHTLS program was modeled after the American College of Surgeons Committee on Trauma Advanced Trauma Life Support course for physicians.

## MATERIALS AND METHODS

A literature search was done of the National Library of Medicine and the National Institutes of Health MEDLINE database using PubMed ([www.pubmed.gov](http://www.pubmed.gov)). The search retrieved English language articles from 1989 through 2011 relevant to the identification and prehospital management of spine injuries as a result of penetrating trauma. MeSH search terms included “prehospital,” “cervical spine,” “spine injury,” and “penetrating trauma.” Letters to the editor were excluded. The Cochrane Library online database was also

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queried for systematic reviews of prehospital cervical spine immobilization and emergency intubation.<sup>11,12</sup>

Bibliographies of all reviewed articles were crossreferenced to locate any relevant articles not located in the MeSH search. Articles were selected by one reviewer and confirmed for relevancy by a second author. Final review was completed by a third author and any disagreement in selection of articles was arbitrated by this author. The questions posed by the reviewers in selecting the articles were (1) what is the incidence of unstable spine fracture and spinal cord injury in the penetrating trauma patient?; (2) what is the natural history of spinal cord injury in penetrating trauma (i.e., does the neurologic deficit worsen over time with or without spine immobilization)?; and (3) is spine immobilization necessary in cases of penetrating trauma?

The system for classification criteria for medical evidence (Table 1) proposed by Wright et al.<sup>13,14</sup> has been chosen by the PHTLS Executive Committee for our use to classify medical evidence. This system has also been adopted by the 8th edition Advanced Trauma Life Support course as well as several prominent journals. It is easy to interpret and has been shown to have a high rate of interrater agreement.<sup>15,16</sup>

## RESULTS

Twenty articles met criteria and were included in the study. These results are summarized in Table 2. Eight articles focused on isolated penetrating trauma to the neck.<sup>2,17–23</sup> One study of military combat casualties noted that 70% of patients with cervical spine fractures from penetrating trauma also had a major vascular injury.<sup>22</sup> Only 1 in 56 survivors (1.8%) had

an unstable spine fracture which ultimately required intervention. The neurologic examination on this patient is not documented in the article—he was in cardiac arrest at the time of arrival, resuscitated, had a Halo placed, and died 3 days later of an associated injury. Another review of 44 military casualties from Israel noted similar results.<sup>2</sup> An analysis of 24,246 trauma patients from 2 civilian centers noted 165 patients with a cervical spine fracture from a gunshot wound (GSW), of which 114 had a spinal cord injury.<sup>18</sup> They also noted nine patients with a stab wound to the neck, six of which had a spine injury. All patients in their series who had spinal cord injury had a noted neurologic deficit at presentation. Spine fixation, either surgically or with a Halo, did not improve their neurologic status. The frequency of a neurologically intact patient requiring cervical neck stabilization after a GSW was only 0.03%. A recent single center review of 1,069 patients sustaining penetrating neck trauma noted only a 0.4% incidence of unstable cervical spine injury.<sup>21</sup> Neck GSW's resulted in a less than 1% incidence of unstable cervical spine injury, and there were no documented unstable cervical spine injuries from stab wounds. All patients who had an unstable fracture had obvious neurologic deficits or an altered mental status on arrival.

Four articles focused specifically on penetrating trauma to the head.<sup>4,5,24,25</sup> In these studies, 524 total patients were reviewed who had an isolated GSW to the cranium, many of whom underwent spinal immobilization out of the concern for possible spine injury. No incidence of cervical spine injury was noted among these patients. Hypoxia is known to worsen neurologic injury in patients with head trauma. Endotracheal intubation was significantly more difficult in pa-

**TABLE 1.** Levels of Evidence<sup>13,14</sup>

Level of Evidence	Treatment	Prognosis	Diagnosis	Economic and Decision Analysis
1	RCT with significant difference or narrow confidence intervals  Systematic reviews of level 1 studies	Prospective study with single inception cohort and >80% follow-up  Systematic review of level 1 studies	Testing of previously applied diagnostic criteria in a consecutive series against a gold standard  Systematic review of level 1 studies	Clinically sensible costs and alternatives Values obtained from many studies Multiway sensitivity analyses Systematic review of level 1 studies
2	Prospective cohort, poor quality RCT  Systematic reviews of level 2 studies	Retrospective study  Untreated controls from a previous RCT Systematic review of level 2 studies	Development of diagnostic criteria on basis of consecutive patients against a gold standard  Systematic review of level 2 studies	Clinically sensible costs and alternatives  Values obtained from limited studies Multiway sensitivity analyses Systematic review of level 1 studies
3	Case control study  Retrospective cohort study Systematic review of level 3 studies		Study of non-consecutive patients (no consistently applied gold standard) Systematic review of level 3 studies	Limited alternatives and costs; poor estimates Systematic review of level 3 studies
4	Case series	Case series	Case control study Poor reference standard	No sensitivity analyses
5	Expert opinion	Expert opinion	Expert opinion	Expert opinion

RCT, randomized controlled trial.

**TABLE 2.** Review of Evidence

References	Study Description	Level of Evidence	Conclusion
Aryan et al. <sup>28</sup>	Retrospective review of 60 adolescent patients with penetrating injury to the spine with bony involvement	3	No patient had spinal instability and no surgical procedures were required. Two patients with two-column disruption radiographically had no evidence of spine instability on examination
Barkana et al. <sup>2</sup>	Retrospective review of 44 Israeli military casualties with penetrating neck injury	3	22% of trauma staff identified a significant finding (injury, hematoma, subcutaneous emphysema) in the exposed neck only after removal of the cervical collar Unstable cervical spine fractures are extremely rare in penetrating neck injuries
Brown et al. <sup>26</sup>	Retrospective review of 3,750 hospitalized patients with torso GSWs and 75,210 patients from the NTDB databank with any GSW	3	From the hospital registry—no patient with a spinal cord injury had an improvement or worsening of their neurological examination From the NTDB—only 0.03% of patients found to have spinal fractures without SCI required operative intervention Benefit of prehospital spinal immobilization is unproven in cases of penetrating torso trauma
Chong et al. <sup>24</sup>	Retrospective review of 53 patients with isolated GSW to the head	3	No incidence of cervical spine fracture
Connell et al. <sup>32</sup>	Retrospective analysis of the prospectively collected database of the Scottish Trauma Audit Group. 1,929 penetrating trauma patients were included	3	All 12 patients with SCI from penetrating trauma had obvious clinical evidence of SCI on presentation or were in cardiac arrest Fully conscious patients with isolated penetrating trauma and no neurologic defect do not require spinal cord immobilization
Cornwell et al. <sup>27</sup>	Retrospective review of the prospectively gathered database of the Maryland State Trauma Registry. 1,000 patients with torso GSW were included	3	The incidence of spinal fracture was 14.1% whereas spinal instability was only 0.2%. Those with a vertebral column fracture had a lower mortality than those without (all received immobilization) Thoracolumbar immobilization is almost never beneficial in those with torso GSW
DuBose et al. <sup>35</sup>	Retrospective study of 4,204 patients from a single trauma center with GSW to the head, neck, or torso, and an SCI	3	None of the 4,204 patients had spinal instability requiring operative intervention and only 0.6% required operation for bone fragment removal from the spinal cord Spinal instability after GSW is extremely rare and immobilization is not warranted in examinable patients with no symptoms of spine injury
Harrop et al. <sup>1</sup>	Retrospective review of 182 blunt and penetrating trauma patients with complete SCI	3	6% of blunt and none of the penetrating trauma patients showed a deterioration in neurologic function during their hospital stay
Haut et al. <sup>33</sup>	Review of 45,284 penetrating trauma patients from the NTDB	3	Only 0.1% had incomplete SCI and required operative intervention Prehospital spine immobilization was associated with a higher mortality in penetrating trauma and should not be routinely used in every patient with penetrating trauma
Kaups and Davis <sup>5</sup>	Retrospective review of 215 patients admitted with GSW to the head	3	Indirect spinal injury does not occur in patients with GSW to the head More intubation attempts were required in patients with cervical spine immobilization and there was a higher rate of ET tube malposition or dislodgement Protocols mandating cervical spine immobilization after a GSW to the head are unnecessary and may complicate airway management
Kennedy et al. <sup>4</sup>	Retrospective review of 105 patients with isolated GSW to the head	3	No cervical spine injuries were noted. Cervical spine immobilization during intubation may not be required
Klein et al. <sup>34</sup>	Retrospective review of 2,450 patients with solitary GSW to the head, neck, or trunk	3	10% of patients had spine fractures. 13% of fractures were unsuspected; operative intervention rate was 6%
Kupcha et al. <sup>23</sup>	Retrospective review of 28 patients with low-velocity GSW to the cervical spine and neurological deficit	3	No cases of spine instability were noted and no patient had neurologic deterioration

TABLE 2. Review of Evidence (continued)

References	Study Description	Level of Evidence	Conclusion
Lanoix et al. <sup>25</sup>	Retrospective review of 151 patients with an isolated GSW to the head and cervical spine imaging	3	No cervical spine injuries were identified Cervical immobilization is probably not necessary in patients with isolated GSWs to the head
Lustenberger et al. <sup>21</sup>	Retrospective review of penetrating neck trauma from a single center	3	Overall incidence of unstable cervical spine injury is 0.4% (<1% after GSW, none following a stab wound). All patients with an unstable fracture had neurologic deficits or altered mental status on arrival
Medzon et al. <sup>17</sup>	Retrospective review of 81 patients with GSW to the head or neck with potential cervical spine involvement	3	19 patients had a cervical spine fracture with acute airway treatment required in 84% of these Of the 65 alert, examinable patients without a neurological deficit, only 5% had a fracture and none were unstable fractures
Ramasamy et al. <sup>22</sup>	Retrospective review of 90 military casualties sustaining a penetrating neck injury. Mechanism of injury was explosion (73%) and GSW (27%)	3	Only 1 of 56 survivors (1.8%) to reach a surgical facility had an unstable fracture requiring operation Very unlikely that penetrating trauma or an explosive injury will cause an unstable fracture. In a hazardous environment, the risk/benefit ratio does not favor spinal immobilization and may place medical teams at risk
Rhee et al. <sup>18</sup>	Retrospective review of 24,246 blunt assault and penetrating trauma patients from 2 trauma centers	3	All patients with a CSCI had a neurologic deficit at the time of presentation. No penetrating injury patients with a CSCI regained significant neurological recovery during hospitalization. Neurologic deficits from penetrating injury were established and final at the time of presentation. Concern for protecting the neck should not hinder evaluation or life saving procedures
Vanderlan et al. <sup>20</sup>	Retrospective review of penetrating cervical trauma at a single center	3	Cervical spine immobilization was associated with an increased risk of death
Vanderlan et al. <sup>19</sup>	Retrospective review of penetrating cervical trauma at 2 trauma centers	3	Of 196 patients, only 2 presented with unstable cervical spine fractures and were already completely neurologically devastated by the injury No patient benefited from c-spine immobilization

SCI, spinal cord injury; CSCI, cervical spine cord injury; NTDB, National Trauma Data Bank.

tients with a GSW to the head who were immobilized.<sup>5</sup> In this group, a 42% failure rate of intubation was noted, as well as a statistically significant rate of reintubation in the Emergency Department (ED) for unrecognized EMS endotracheal tube malposition or dislodgement.

Similar results to these studies of penetrating head and neck trauma are found when reviewing data on GSWs to the torso. Two articles are found which review data from three varying trauma registries—a hospital registry, the Maryland state trauma registry, and the National Trauma Data Bank.<sup>26,27</sup> Neither article demonstrates a benefit of spine immobilization for penetrating torso trauma. In reviewing data from the Maryland State Trauma Registry, Cornwell et al.<sup>27</sup> noted that of 1,000 patients with a torso GSW only 141 had some vertebral column and/or spinal cord injury. Of those 141 patients, 73 survivors had complete neurologic deficit at the time of presentation, whereas 58 survivors had no deficits or an incomplete lesion. Of these 58 who survived with less than complete spinal cord injury only 2 patients (0.2% of all patients) required operative stabilization. Hospital data reviewed by Brown et al.<sup>26</sup> indicate that no patient with a spinal cord injury after GSW had any change in neurologic status by the time of hospital discharge, suggesting an immediate and permanent deficit occurred at the time of injury and these patients would not benefit from prehospital spinal immobilization. A review of 60 adolescents with a GSW to the spine with bony involvement

noted no cases of spinal instability or requirement of surgical intervention.<sup>28</sup> Finally, only a single case report could be found documenting a patient who sustained GSW of the neck resulting in an unstable cervical vertebra fracture without spinal cord damage.<sup>29</sup>

## DISCUSSION

No studies exist to support the use of spinal immobilization in patients with penetrating trauma, yet the practice is widespread among EMS agencies. A Cochrane review in 2001 of 4,453 potentially relevant articles found no randomized controlled trials to support the use of spinal immobilization in blunt or penetrating trauma.<sup>11</sup> Only one case report has been published in the literature documenting an unstable cervical spine injury from penetrating trauma in a patient without spinal cord injury.<sup>27</sup>

Although many of the articles reviewed indicated that their victims of penetrating injury underwent prehospital spinal immobilization, none defined their specific technique for accomplishing spinal motion restriction. The distinction between full spinal immobilization (cervical collar and rigid backboard) versus cervical collar placement alone could not be determined from these articles. PHTLS does not recommend placing a cervical collar without also subsequently immobilizing the patient fully on a rigid backboard.<sup>30</sup> Therefore, the terms “cervical immobilization” and “spinal immobilization” can be used interchangeably in this discussion.

The spine is divided into three columns for purposes of classification of injury—anterior, middle, and posterior. The anterior column consists of the anterior longitudinal ligament, the anterior annulus fibrosus, and the anterior vertebral body. The middle column includes the posterior longitudinal ligament, the posterior annulus fibrosus, and the posterior vertebral body. The posterior column is comprised of the posterior bony arch created by the laminae and pedicles and the ligamentous complex formed by the supraspinous ligament, interspinous ligament, facet joint capsule, and the ligamentum flavum.<sup>19,31</sup> Injury to two or more columns is considered to be an unstable fracture and generally mandates surgical intervention.

The theoretical advantage to immobilization in both blunt and penetrating trauma is to prevent displacement of an unstable fracture resulting in damage to a previously spared spinal cord. The three-column theory of spinal injury assumes an abrupt acceleration or deceleration mechanism to the spine, as occurs in blunt trauma. Therefore, the forces applied to the spine result in disruption of the bony and ligamentous anatomy of at least two of the three columns. However, with penetrating trauma, the body and spine are not in motion and the damage is instead caused by the penetrating object and, in the case of a missile (bullet), the explosive, and concussive force of the missile. Thus, the three-column theory of spine instability does not always apply to penetrating trauma situations. In their review of GSWs to the spine in adolescents, Aryan et al.<sup>28</sup> defined spinal stability as the ability of the patient to sustain physiologic loads without incurring structural deformations, painful alterations, or neurologic deficits. In their series of 60 patients, they noted two patients with radiologic two-column disruption who did not have spinal instability on dynamic radiographic imaging. The evidence seems to clearly suggest that the natural history of a penetrating injury to the spine is to remain stable and not propagate, because the damage is done at the initial impact. Those patients who demonstrate spinal cord injury after penetrating trauma do so at the moment of injury and those who do not have neurologic deficits do not subsequently develop signs of spinal cord injury. A review by Rhee et al.<sup>18</sup> reported that all patients who had a spinal cord injury had a neurologic deficit at the time of presentation. The authors concluded that neurologic deficits from penetrating trauma were established and fixed at the time of presentation and any concern for protecting the neck should not interfere with the evaluation process or life saving procedures. In addition, they found a 0.03% rate of neurologically intact victims of a neck GSW who later required operative stabilization of their fracture, most for facilitation of rehabilitation placement. A study by Harrop et al.<sup>1</sup> noted that in 1,904 patients with spinal trauma, no patients had deterioration after penetrating trauma. Connell et al.<sup>32</sup> conducted a retrospective analysis of data from the Scottish Trauma Audit Group and found that every patient with spinal cord injury from penetrating trauma had obvious on-scene signs consistent with spinal injury or were already in cardiac arrest. The authors concluded that fully conscious patients with isolated penetrating trauma and no neurologic deficits do not require spinal immobilization.

Of particular concern are two studies that suggest an increase in mortality from spine immobilization in victims of penetrating injury.<sup>20,33</sup> Vanderlan et al.<sup>20</sup> reviewed data from a single trauma center and noted cervical collar placement to be an independent risk factor for death. An analysis from the National Trauma Data Bank of 45,284 patients with penetrating trauma noted a twofold increase in mortality in patients who were immobilized compared with similar patients who were not.<sup>33</sup> Only 0.01% of patients with an incomplete spinal cord injury eventually required operative spine fixation, leading the authors to conclude that spinal cord damage from penetrating trauma is done at the time of injury, does not worsen, and does not benefit from immobilization. The increased mortality found in immobilized patients was attributed to increased scene times and the potential to miss signs of immediate life threat, such as tracheal deviation and subcutaneous emphysema.

Two reviews of hospital databases confirm a low incidence of spinal fractures from penetrating trauma which ultimately required surgical intervention.<sup>34,35</sup> Klein et al.<sup>34</sup> reviewed 2,450 patients with a head, neck, or torso GSW and noted a 9% incidence (244 patients) of spinal column fracture. Fifteen patients required operative intervention (0.6%) and two thirds of the patients (119 patients, 4.8%) required prolonged immobilization. The incidence of unsuspected spinal cord injury was higher in this single-center study than has been noted in other studies. Dubose et al.<sup>35</sup> reviewed 4,204 patients with a GSW to the head, neck, or torso. They noted a 7.8% incidence of bony spine injury (327 patients), with half of those having a spinal cord injury (173 patients, 4%). However, only two patients with spinal column injury (0.6%) required operative intervention, both for removal of foreign body bone fragments from the spinal canal. The authors concluded that spinal instability after penetrating trauma is extremely rare. They recommend against routine imaging studies in patients who are neurologically intact after penetrating trauma to the head, neck, or torso.

Current spine immobilization practices are not supported by military data, in which care under fire often requires rapid diagnosis and treatment of life-threatening injuries in suboptimal conditions. Data reviewed from the VietNam conflict noted only 1.4% of casualties who were candidates for immobilization potentially could have benefited from this care.<sup>6</sup> An analysis of penetrating neck trauma in the Israeli military noted that 8 of 36 casualties (22%) had a life-threatening neck injury (expanding hematoma or subcutaneous emphysema) diagnosed after removal of the cervical collar.<sup>2</sup> Unstable fractures of the spine were extremely rare and the theoretical benefit of spine immobilization was outweighed by the ability to diagnose a life-threatening injury. British data from Iraq and Afghanistan found similar results.<sup>22</sup> In their series, only 1.8% of patients with an unstable spine fracture from penetrating trauma required surgical intervention. The authors questioned the rationale of scene delay for spine immobilization in a hazardous environment.

A study conducted on unstable penetrating trauma patients who required emergency department thoracotomy found that patients who were transported by EMS had a lower survival than those transported by private vehicle.<sup>36</sup> The number of

prehospital procedures performed was among the factors cited for the increased mortality in patients transported by EMS, specifically delays for cervical collar placement and endotracheal intubation. Brown et al.<sup>26</sup> noted that prehospital spinal immobilization of penetrating trauma patients is labor intensive and delays transport to the hospital. When compared with patients who do not receive spinal immobilization, nearly twice as much time is spent on-scene with these patients, which is often longer than the actual transport time to the trauma center.

Management priorities of penetrating neck trauma for prehospital providers, as well as in-hospital trauma teams, focus on accurate physical examination, rapid assessment and correction of airway compromise, and control of life-threatening hemorrhage. Each of these priorities is hindered by the placement of a cervical collar.

Present prehospital management of penetrating injuries to the head, neck, and torso is based on the premise that the spine is injured until proven otherwise and full immobilization will prevent further propagation of any injury. A review of the trauma literature does not support this practice. Accurate physical examination and rapid intervention to treat life-threatening injuries are impaired by the presence of a cervical collar. If the spinal cord is injured, the damage has occurred at the moment of injury, is complete at the time of injury, and neurologic deterioration does not occur. Immobilization does not improve ultimate outcome but rather has been shown to increase scene times and mortality.<sup>6,26,33</sup> The miniscule potential benefit of spinal immobilization is often outweighed by the very real risk of airway compromise, difficult intubation, and loss of the ability to conduct an ongoing assessment of the neck for development of life-threatening conditions. Although providers should continue to follow local protocols, improved education on the indications for spinal immobilization in cases of penetrating trauma may ultimately improve outcomes in the future.

## PHTLS Recommendations

- There are no data to support routine spine immobilization in patients with penetrating trauma to the neck or torso.
- There are no data to support routine spine immobilization in patients with isolated penetrating trauma to the cranium.
- Spine immobilization should never be done at the expense of accurate physical examination or identification and correction of life-threatening conditions in patients with penetrating trauma.
- Spinal immobilization may be performed after penetrating injury when a focal neurologic deficit is noted on physical examination although there is little evidence of benefit even in these cases.

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## EDITORIAL COMMENT

Clinical practice is often based on standards of care that have been derived from practical experience and consensus of opinion. Actual scientific evidence to support best practices is often lacking. Despite a paucity of supporting evidence, changing standard practice is often difficult.

I applaud the authors of “Prehospital spine immobilization for penetrating trauma—review and recommendations from the Prehospital Trauma Life Support (PHTLS) Executive Committee” for questioning an established clinical practice. Stuke et al.<sup>1</sup> conducted a comprehensive literature review that summarizes >20 years of data on prehospital management of patients with spinal injuries secondary to penetrating trauma. The current, widespread practice of prehospital spinal immobilization of patients with penetrating injuries is based on a theoretical advantage that has been extrapolated from blunt trauma mechanisms. The results of the study by Stuke et al.<sup>1</sup> do not support this theoretical advantage and raise doubt as to the utility of prehospital spinal immobilization in this patient group.

Those of us who routinely care for trauma patients during their acute resuscitation are well aware of added difficulties in patient management that result from spinal immobilization. Definitive airway management is often hindered by application of a semirigid cervical collar. Mouth opening can be reduced<sup>2</sup> and optimal patient positioning may be impeded, thereby creating a difficult environment for endotracheal intubation. An additional operator is required to maintain manual inline cervical stabilization during intubation. Exposure of potentially life-threatening injuries is limited and hemostasis is more difficult. Greater difficulties in management coupled with delays in patient transport to definitive care may result in worsening patient outcomes. In fact, prehospital spinal immobilization in penetrating trauma patients has been associated with higher mortality.<sup>3</sup>

Over the past decade, our awareness of patient safety issues has heightened.<sup>4</sup> We are more cognizant of the need for an optimal care environment that will reduce the risk of potentially adverse outcomes. This is an important article in that it questions traditional dogma and highlights practices that may place patients at increased risk without obvious

benefits. The evidence-based Prehospital Trauma Life Support recommendations should serve to create a more user friendly resuscitation environment that optimizes patient care and may ultimately improve outcome.

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## EDITORIAL COMMENT

An essential function of providing optimal patient care is to examine our current methodology. Spinal immobilization of trauma patients is presently a routine (essentially mandatory) part of prehospital care. The current edition of ATLS states that “The stabilization equipment used to protect the patient’s spinal cord should be left in place until cervical spine injury has been excluded. Protection of the spine and spinal cord is a critically important management principle.”<sup>1</sup> However, reports are increasingly appearing describing the lack of benefit, as well as the potential harm, to patients from spinal immobilization.

Reviewing the literature describing prehospital management of patients with penetrating trauma, Stuke and other members of the Prehospital Trauma Life Support Executive Committee examined the incidence and natural history of spinal cord injury in patients with penetrating trauma as well as the necessity for spine immobilization in these patients. Immobilization was evaluated in the context of penetrating injury to the head, neck, or torso. Twenty articles met entry criteria; all were retrospective studies (Level III evidence). Unstable spinal column injuries were exceedingly rare, and patients with spinal cord injuries had neurologic injuries which were evident and “fixed” at the time of presentation. Immobilization seemed to contribute to longer on-scene times, delay in securing definitive airways, and potentially higher mortality. The authors conclude that “there are no data to support routine spine immobilization in patients with penetrating trauma to the neck or torso [or] cranium.”<sup>2</sup>

The findings and conclusions of the authors are supported by other studies. The rationale for immobilization is to prevent spinal column motion and theoretically prevent worsening of spinal cord injury. Evidence would suggest that immobilization does not provide these benefits. A number of studies have demonstrated that commonly used equipment and techniques allow significant cervical spine and spinal column motion. Studies also suggest that injuries due to penetrating

trauma are evident at the time of presentation and do not progress. Avoidance of secondary injury is essential but progression is more likely due to edema, hematoma progression, inflammatory response, hypotension, and hypoxia than mechanical injury. No randomized, controlled studies exist of the practice of spinal immobilization in trauma patients.<sup>3</sup>

In the meantime, data implicating immobilization in harming patients must be recognized. Application of prehospital immobilization prolongs scene time and delays transport to definitive care. National Trauma Data Bank data have demonstrated increased mortality in penetrating trauma patients treated with prehospital spinal immobilization.<sup>4</sup> Additionally, respiratory function has been shown to be reduced in immobilized, healthy volunteers, with the concern that this effect will be enhanced in the injured patient.<sup>5</sup> The likelihood of aspiration is increased.

With increased recognition of the devastating effects of hypoxia for both brain and spinal cord injury, the finding of prolonged time to establishment of definitive airway, as well as increased failure rates, in immobilized patients is particularly concerning.<sup>6</sup> Cadaver studies have also shown that cervical collars do not adequately restrict motion when endotracheal intubation is undertaken when an injury is present. Cervical spine collars have also been shown to increase intracranial pressure contributing to secondary brain injury.

The presence of a cervical collar may also delay evaluation and recognition of injuries because injuries may be

concealed by the device. Finally, in the patient with degenerative disease of the spine, the process of immobilization has been documented to cause spinal column (and cord) injury.

Although spinal immobilization has been strongly endorsed in the care of the trauma patient, examination of the literature would suggest that it provides little to no appreciable benefit and a progressively enlarging catalog of harm to trauma patients. The literature would suggest that we are beyond therapeutic equipoise and must thoughtfully address our management algorithms as the authors have done.

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