

# Thoracolumbar Immobilization for Trauma Patients With Torso Gunshot Wounds

## Is It Necessary?

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**Background:** Previous studies have suggested that patients transported by emergency medical services (EMS) following major trauma had a longer injury-to-treatment interval and a higher mortality rate than their non-EMS-transported counterparts.

**Hypothesis:** There is little actual benefit of thoracolumbar immobilization for patients with torso gunshot wounds (GSW).

**Design:** Retrospective analysis of prospectively gathered data from the Maryland Institute for Emergency Medical Service Systems State Trauma Registry from July 1, 1995, through June 30, 1998.

**Settings:** All designated trauma centers in Maryland.

**Patients:** All patients with torso GSW.

**Main Outcome Measures:** (1) A patient was considered to have benefited from immobilization if he or she had less than complete neurologic deficits in the presence of

an unstable vertebral column, as shown by the need for operative stabilization of the vertebral column; (2) mortality.

**Results:** There were 1000 patients with torso GSW. Among them, 141 patients (14.1%) had vertebral column and/or spinal cord injuries. Two patients (0.2%) (95% confidence interval, -0.077% to 0.48%) required operative vertebral column stabilization, while 6 others required other spinal operations for decompression and/or foreign body removal. The presence of vertebral column injury was actually associated with lower mortality (7.1% vs 14.8%,  $P < .02$ ).

**Conclusions:** This study suggests that thoracolumbar immobilization is almost never beneficial in patients with torso GSW, and that a higher mortality rate existed among those GSW patients without vertebral column injury vs those with such injuries. The role of formal thoracolumbar immobilization for patients with torso GSW should be reexamined.

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**W**ITH CERTAIN types of trauma, it has been estimated that for every 10 minutes of delay in definitive treatment, survival drops by 10%. This suggests that prolonged injury-to-treatment intervals are deleterious for critically injured patients.<sup>1</sup> In a previous retrospective study, trauma patients transported by emergency medical services (EMS) to an urban level I trauma center had a higher mortality rate than their non-EMS-transported counterparts.<sup>2</sup> The authors speculated that the difference in mortality were due to the difference in the lengths of prehospital times for the 2 groups. In a prospective, multidisciplinary follow-up study, non-EMS-transported critically injured trauma patients (Injury Severity Score  $\geq 13$ ) were

found to arrive at the hospital earlier after their injury than their EMS-transported counterparts.<sup>3</sup>

Thus, procedures in the EMS protocol, which might be associated with increased time, must be assessed not only for their potential benefits, but also in consideration of the potentially negative effect of the time required for their performance. Our multidisciplinary study was undertaken to examine one such procedure, thoracolumbar immobilization, for patients with torso gunshot wounds (GSW).

## RESULTS

### DEMOGRAPHIC INFORMATION

A total of 4247 patients with GSW were found in the State Trauma Registry dur-

## PATIENTS AND METHODS

A retrospective analysis of prospectively gathered multi-institutional data from the Maryland Institute for Emergency Medical Service Systems State Trauma Registry was performed. The registry is managed by the Collector software from Tri-Analytics (Bel Air, Md), and it includes all levels I, II, and III trauma centers (total of 9) in the state of Maryland. The analysis covered a 3-year period from July 1, 1995, through June 30, 1998.

The registry was queried by *International Classification of Diseases, Ninth Revision (ICD-9)* codes for patients with GSW to the torso and with vertebral column and/or spinal cord injuries (**Table**). The accuracy of the ICD-9 code assignment for the vertebral column and spinal cord injuries was confirmed by a review of the exact injury texts. Among patients who survived with incomplete spinal cord lesions, the registry was queried further for all procedures performed during the hospital stay.

In Maryland, the written protocol for patients with severe trauma calls for spinal stabilization as the first maneuver to be performed.<sup>4</sup> We defined patients who could have theoretically benefited from spinal immobilization as those who did not have complete neurologic deficits and who required a vertebral column stabilization procedure while in the hospital (either halo traction or operative intervention). Patients (1) with no vertebral column injury, (2) with less than complete neurologic deficits but with stable vertebral columns and who did not require vertebral column stabilization while in the hospital, or (3) with complete neurologic deficits, were considered to not have benefited from thoracolumbar immobilization.

Statistical significance values were calculated using the Fisher exact test using Stata software, version 5 or 6 (Stata Corp, College Station, Tex).

ing the 3-year study period, with a total of 1000 patients sustaining penetrating injury in the torso. The patient population was predominantly young (median age, <25 years) and male (90.8%). About two thirds (67.0%) of these injuries occurred in Baltimore. A slow downward trend was noted in the number of GSW patients during the 3 years, from 1572 in fiscal year (FY) 1996, to 1375 in FY 1997, and 1300 in FY 1998.

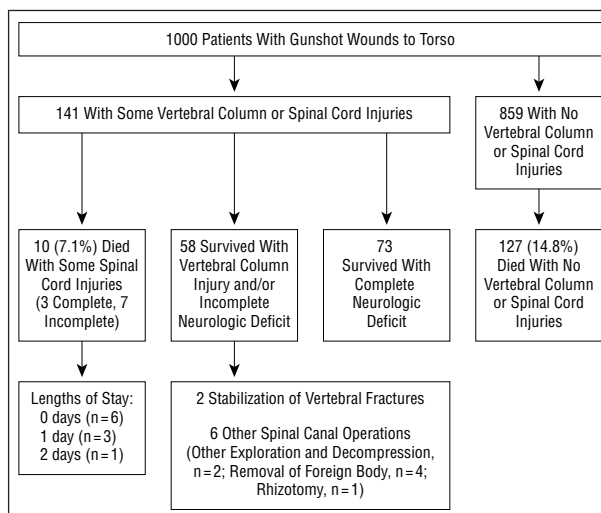
### PATTERN OF INJURIES

Among the 1000 patients with torso GSW (**Figure**), 141 (14.1%) had sustained some vertebral column and/or spinal cord injuries. Of these 141 patients, 73 survivors had complete neurologic deficits, while 58 survivors sustained no deficits or an incomplete lesion such as anterior cord syndrome or central cord syndrome. Of the 58 patients who survived with less than complete spinal cord injuries, only 2 patients required

### List of ICD-9 Codes Used in This Study\*

Description	ICD-9 Codes
Open wounds to neck and trunk	874.x, 875.x, 876.x, 877.x, 879.x
Open vertebral column and spinal cord injuries	806.1x, 806.3x, 806.5, 806.7x, 806.9, 852.x
Complete spinal cord lesions	806.11, 806.16, 806.31, 806.36, 806.71, 952.01, 952.06, 952.11, 952.16
Operations on spinal canal structures	Procedure codes 0.30x

\*ICD-9 indicates International Classification of Diseases, Ninth Revision.



Distribution of patients.

operative vertebral column stabilization, and no patient required halo traction. Six other patients had undergone other spinal operations, including removal of foreign body (n=4), exploration and decompression (n=2), and rhizotomy (n=1).

The rate of vertebral column injuries severe enough to require operative stabilization was 0.2% (2/1000; 95% confidence interval [CI], -0.077% to 0.48%) among all patients with torso GSW, and was 1.4% (2/141; 95% CI, -0.53% to 3.4%) among patients with some vertebral column injury.

### MORTALITY

The total death rate among the 1000 patients with torso GSW was 13.7%. The death rate in the subgroup of patients who had no vertebral column injury was 14.8% (127/859), while it was 7.1% (10/141) in the other subgroup who had sustained some vertebral column injuries ( $P < .02$ ) (Figure).

There were 10 patients who died with spinal cord injuries, 9 in the first 24 hours from associated intra-abdominal, intrathoracic, or intracranial injuries, and a 10th patient who died on day 2 from an associated GSW to the head in addition to a complete transection at T9 from his torso GSW. Three of the 10 patients had complete transection of their spinal cords.

Although spinal immobilization has never been shown to alter outcome, the practice is commonly employed in patients who have been shot in the head, neck, torso, and upper thighs.<sup>5</sup> In Maryland, the written protocol for severely injured trauma patients calls for spinal stabilization as the first maneuver to be provided by respondents.<sup>4</sup> However, with longer prehospital times possibly associated with negative outcome, it is important to determine the true extent of the benefits of immobilization for patients with torso GSW.

Though the exact time required for thoracolumbar immobilization is unknown, it has been estimated that cervical immobilization requires approximately 5.5 minutes and a minimum of 2 trained personnel even in a practice environment.<sup>6</sup> Immobilization is of no benefit to patients with stable vertebral columns, nor to those who have complete transection of their spinal cords. Therefore, the time spent in pursuing thoracolumbar immobilization may only be justified if there is reasonable clinical suspicion for an unstable vertebral column in the presence of a less-than-complete neurologic deficit.

A larger, prospective, registry-based study will be necessary to more precisely address the issue of time. The time required for formal thoracolumbar immobilization could be assessed, and comparative analyses from jurisdictions with differing philosophies could address whether the potential for saving minutes at the scene is beneficial to patients without unstable injuries. In the meantime, evidence of the rarity of benefit of immobilization with torso GSW (however long it may take) is mounting.

The typical pattern of injury to the bony and neurologic components of the spine in GSW patients has been well described. The stability of the vertebral column is supported by a 3-column architecture, and injury to 2 of the 3 columns is necessary to render the vertebral column unstable.<sup>7</sup> Several studies from both the civilian<sup>7-9</sup> and the military<sup>6,10</sup> arenas have found that the number of patients with unstable vertebral columns following GSW is extremely small. Simpson et al<sup>8</sup> had found only 3 of 142 nonsurgically managed GSW patients with spinal instability. Yoshida et al<sup>9</sup> reported that in a series of 1300 cases of civilian GSW to the spine, none had demonstrated instability. In the military literature, Aarabi et al<sup>10</sup> concluded that in the Iran-Iraq conflict, "spinal instability does not seem to be a major problem in patients with vertebral column gunshot wounds, whether treated surgically or not." Similarly, in a retrospective review of casualties from the Vietnam conflict, Arishita et al<sup>6</sup> found no confirmed cases where cervical immobilization had provided a documented benefit, and found only 1.4% who might have "possibly" benefited from the care. They further suggested that since about 10% of their casualties were incurred while helping other casualties, mandatory immobilization of all patients with penetrating neck wounds sustained in a hazardous environment has an unfavorable risk-benefit ratio. Given the social conditions often associated with civilian GSW injuries today, it is

worthwhile to consider the experience and risk-benefit assessment as documented in the military literature.

In this study, we have identified only 2 patients (0.2%) of a total of 1000 patients with torso GSW during a 3-year period who required vertebral column stabilization in the hospital following their injuries (Table 2). These 2 patients are the only individuals who would have benefited from thoracolumbar immobilization in the field. Placement on a long board without formal 4-point fixation for injured patients in this category would facilitate a shorter injury-to-treatment interval, while preserving the benefit to these 2 patients. Formal immobilization would not have benefited the 73 survivors who had complete lesions of their spinal cords, nor the 859 patients who had no vertebral column injury. One could perhaps argue that those 10 patients who died with some injuries to their vertebral columns may have also benefited from the immobilization. However, all of the 10 patients died in the early postinjury period from associated intrathoracic, intra-abdominal, or intracranial injuries.

The assumption has been made here that paraplegia occurred secondary to bullet injuries rather than from inadequate immobilization. Though our methods cannot confirm this with certainty, it should be pointed out that none of the 73 patients with complete neurologic deficit had an unstable vertebral column.

Interestingly, the presence of a vertebral column injury in this dataset was associated with a lower mortality rate (7.1% for those with vertebral column injury, vs 14.8% for those without such injuries;  $P < .02$ ). One might speculate that this mortality rate difference may be because the vertebral column is serving as a protective factor in GSW patients, absorbing some of the kinetic energy of the projectile and thus protecting vital internal organs from damage. Close analysis of the mortality rates observed among the 8045 patients with GSW (to all body regions) in the Major Trauma Outcome Study revealed a death rate of 19.2% among patients with GSW with spinal cord injury, vs 21.0% among GSW patients without spinal cord injury, although the difference was not statistically significant ( $P = .44$ ).<sup>11,12</sup>

Our data, when combined with previous work regarding EMS transport,<sup>2,3</sup> may have potential policy implication in the prehospital arena. The case has been made in the urban trauma setting that prolonged prehospital time may be associated with increased mortality. Given the extremely low incidence of vertebral column instability among torso GSW patients (note that the observed value in our study is not statistically significantly different from zero), the time demand of thoracolumbar immobilization procedure may not be justifiable.

In summary, given the rarity of unstable vertebral column injuries following torso GSW, the role of formal thoracolumbar immobilization should be reexamined.

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## REFERENCES

1. Brill JC, Geiderman JM. A rationale for scoop and run: identifying a subset of time-critical patients. In: Brill KC, Geiderman JM, eds. *Topics in Emergency Medicine*. Rockville, Md: Aspen Systems Corp; 1981:37-43.
2. Demetriades D, Chan L, Cornwell E, et al. Paramedic vs private transportation of trauma patients: effect on outcome. *Arch Surg*. 1996;131:133-138.
3. Cornwell EE, Belzberg H, Hennigan K, et al. Emergency medical service (EMS) vs non-EMS transport of critically injured patients: a prospective evaluation. *Arch Surg*. 2000;135:315-319.
4. Trauma protocol: multiple/severe trauma. *The Maryland Medical Protocols for Emergency Medical Services Providers*. Baltimore, Md: Maryland Institute for Emergency Medical Services Systems; 1999:III-KK-1.
5. Pepe PE, Wyatt CH, Bickell WH, et al. The relationship between total prehospital time and outcome in hypotensive victims of penetrating injuries. *Ann Emerg Med*. 1987;16:293-297.
6. Arishita GI, Vayer JS, Bellamy RF. Cervical spine immobilization of penetrating neck wounds in a hostile environment. *J Trauma*. 1989;29:332-337.
7. Amar AP, Levy ML. Surgical controversies in the management of spinal cord injury. *J Am Coll Surg*. 1999;188:550-566.
8. Simpson RK, Venger BH, Narayan RK. Treatment of acute penetrating injuries of the spine: a retrospective analysis. *J Trauma*. 1989;29:42-46.
9. Yoshida GM, Garland D, Waters RL. Gunshot wounds to the spine. *Orthop Clin North Am*. 1995;26:109-116.
10. Aarabi B, Alibai E, Taghipur M, Kamgarpur A. Comparative study of functional recovery for surgically explored and conservatively managed spinal cord missile injuries. *Neurosurgery*. 1996;39:1133-1140.
11. Champion HR, Copes WS, Sacco WJ, et al. The Major Trauma Outcome Study: establishing national norms for trauma care. *J Trauma*. 1990;30:1356-1365.
12. Burney RE, Maio RF, Maynard F, Karunas R. Incidence, characteristics, and outcome of spinal cord injury at trauma centers in North America. *Arch Surg*. 1993;128:596-599.

## Invited Critique

In this retrospective analysis of data from the Maryland Institute of Emergency Medical System State Trauma Registry 1995 to 1998, Cornwall and colleagues found that of 1000 patients with gunshot wounds to the torso, 141 sustained injury to the vertebral column and/or spinal cord. The authors conclude that just 2 patients (0.2%) benefited from spinal immobilization applied in the field. Interestingly, the frequency of torso gunshot wounds decreased during this period by nearly 20%.

This report is strengthened by the data, which give a fair assessment of the incidence and potential for the use of spinal immobilization for torso gunshot wounds, and by the supposition that the time involved in spinal immobilization and intervention prior to hospital transport could result in overall adverse patient outcomes. However, this report does not definitively conclude that spinal immobilization is unnecessary, owing to the very low number of patients who had spinal instability.

To determine the role of spinal immobilization, it would be necessary to determine the relative benefit and cost of either course of action. The cost of providing immobilization includes the potential threat to life that could result from delayed treatment. What is the frequency of such delays? What are the potential mortality and morbidity rates if treatment is delayed because of the time involved in immobilization? What are the additional costs associated with these delays? If patients with vertebral injuries are not formally stabilized, is there a risk that their condition will worsen?

Patients without vertebral column injuries had a 2-fold increase in mortality when compared with those with vertebral column injuries. The authors speculate that this difference is related to the protective effect provided by the energy absorbed by the vertebral column. They give an alternative hypothesis that the delay required to carry out full immobilization and stabilization of patients with significant visceral injuries adversely affected patient outcome. A retrospective analysis of delay lengths with and without formal spine stabilization could lend further credence to this consideration.

Cornwall and colleagues conclude that the incidence of vertebral column injuries following torso gunshot wounds and the need for formal thoracolumbar immobilization should be reexamined. I agree. However, their conclusion does not ultimately answer the question "Is it necessary?"

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