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Injury, Int. J. Care Injured 31 (2000) 305–309

INJURY
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Prehospital stabilization of the cervical spine for penetrating injuries of the neck — is it necessary?

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Accepted 21 October 1999

Abstract

The purpose of this study was to assess the specific indications, benefits and risks associated with cervical spine stabilization during pre-hospital care of penetrating neck injuries. We retrospectively reviewed hospital charts and autopsy reports of 44 military casualties in Israel with a penetrating neck injury during a period of 4.5 years. A review of the literature was also carried out. In eight of 36 hospitalized casualties (22%) a life-threatening sign was diagnosed in the exposed neck — large or expanding haematoma, or subcutaneous emphysema. Surgical stabilization of the cervical spine was not performed for any of the casualties. It was concluded that life threatening complications due to penetrating neck injury are common and may be overlooked if the neck is covered by a stabilization device. It is extremely rare for a penetrating injury to result in an unstable cervical spine. New management guidelines concerning pre-hospital stabilization are suggested.

1. Introduction

The question of whether to stabilize the cervical spine during the initial management of a trauma victim who has sustained a penetrating neck injury, has recently stirred debate and controversy among trauma surgeons and neurosurgeons in our country. The trigger was a few cases in which a semi-rigid collar was applied over a penetrating injury, usually due to high velocity bullets or projectiles. Findings such as continuous oozing, subcutaneous emphysema and especially expanding haematoma were initially missed.

Current literature does not directly address the indications, benefit and risk concerning so-called immobilization for penetrating neck injuries. This is true for both journals [1–7] and major trauma textbooks [8–12]. Most authors simply recommend that all patients with such injuries should be immobilized, or merely state that such is the practice in their emergency department and pre-hospital trauma care. Even the manual of the ATLS® [13] does not make a distinction between blunt and penetrating neck trauma, generally stating that "...any patient with a suspected spine injury must be immobilized above and below the suspected injury site until injury has been excluded by roentgenograms". In addition it stresses that "...cervical spine injury requires continuous immobilization of the entire patient with a semi-rigid cervical collar, backboard, tape and straps before and during transfer to a definite-care facility". In depth analysis of the text following these statements reveals that the author is referring only to casualties from blunt injury!

In this study we try to assess the benefit and risk of cervical spine stabilization in penetrating neck injury. New management guidelines for penetrating neck injuries at the pre-hospital setup are suggested.

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0020-1383/00/$ - see front matter
PII: S0020-1383(99)00298-3

2. Materials and methods

During the period from January 1993 to June 1997, 54 soldiers of the Israeli army were diagnosed in the field as having a penetrating neck injury. All injuries involved gunshot, projectiles or stab wounds. Military physicians on site performed the initial assessment and began treatment.

Current guidelines in the Israeli Army Medical Corps, based on ATLS, call for early stabilization of the cervical spine for every suspicion of significant neck injury. Accordingly, in all cases in this series a stabilizing apparatus was applied to the neck, either a semi-rigid collar, a rolled blanket, or both.

We conducted a retrospective review of the casualties' hospital charts or autopsy reports. Of the 14 casualties who had died before reaching hospital, eight underwent an autopsy. Forty casualties were evacuated to seven trauma centers, 37 of them to a level-one trauma center; 36 hospital charts were available for study. Thus, anatomical details of injury were available in 44 cases of the total of 54 (81.5%). The available data were analyzed for details of neck injury, associated injuries and treatment procedures. Specifically, we looked for diagnoses and treatment of cervical spine instability, cases that would have benefited from prehospital stabilization; and conditions that could be masked by a collar.

Table 1
Signs and injuries in the neck among 44 patients with penetrating neck trauma

Significant local signs in the neck	
Total	8
Expanding haematoma	2
Subcutaneous emphysema	3
Large haematoma	3
Major neck injuries	
Total	63
Superficial fragment only	20
Spinal canal penetration by fragment/bullet	10
Transection of cord	4
Fracture of single vertebra	7
Fracture of multiple vertebrae	5
Fracture of cricoid	1
Major arterial laceration	4
Major venous laceration	4
Pneumomediastinum	1
Perforated esophagus	1
Hypopharynx perforation	2
Mandibular fractures	1
Brachial plexus injury	1
Laceration of greater auricular nerve	1
Epidural spinal haematoma	1

Table 2
Neurological findings and associated injuries among 44 patients with penetrating neck wounds

Major neurological findings upon hospital admission	
Total	9
Complete tetraplegia/Severe tetraparesis	5
Partial/focal neurological deficit	3
Horner's syndrome	1
Major associated injuries	
Total	26
Long bone fracture	3
Extremity vascular/neurological injury	3
Burn	1
Chest wound requiring chest tube	3
Abdominal wound requiring surgery	4
Intracranial injury	4
Skull fracture	2
Eardrum perforation	1
Eye injury	3
Mandibular fracture requiring surgery	1
Nose fracture requiring surgery	1

3. Results

Forty-four hospital and autopsy charts were available for analysis, out of a total of 54 injuries during the study period of 4.5 years. Most injuries were due to projectiles (38), or bullets (13). Knife injuries (2 cases), and direct missile hits were a rare occurrence. Tables 1 and 2 show the distribution of injuries and important signs for the 44 cases we studied. Table 3 shows the treatment performed for the 36 cases that were transported to a hospital.

All patients who were admitted to a hospital survived. Of those, 20 patients (56%) suffered only superficial wounds. The remaining neck injuries were diverse. In eight cases (22%) the emergency room staff identified a significant sign in the exposed neck after removal of the stabilization apparatus, a large/expanding haematoma, or subcutaneous emphysema.

None of the patients underwent internal surgical

Table 3
Procedures performed on 12 patients with penetrating neck wounds

Procedure	*n*
Exploration of neck (only)	6
Traction (Crutchfield)	1
Stabilization with Philadelphia collar	2
Repair left common carotid	1
Ligation left internal jugular vein	1
Debridement and removal of metal and bone fragments in spinal canal	1
Laminectomy	1
Left hemilaminectomy	1
Exploration of brachial plexus	1
High dose corticosteroids	2

stabilization of the cervical spine. Of the 12 patients with vertebral fracture, a Crutchfield traction device was applied in one case; the injury caused a comminuted fracture of C7 lamina, fracture of posterior arc of C6, chip fractures of D1, D2, D3, with fragments in the spinal canal and complete tetraplegia. No dislocation was noted.

In two of the cases the patients remained with a Philadelphia collar. One case had a comminuted fracture of part of the lateral mass of C1, without joint movement, and was neurologically intact. The second suffered injury to the body of C6 and the lamina of C7, with slight opening of C5–C6 joint and minimal posterior displacement of C5, with complete tetraplegia at the C7 level.

Twelve patients were operated on for indications unrelated to cervical spine stability — Table 3. Of the eight fatalities studied, four had complete transection of the spinal cord. In these cases the vertebral injuries were as follows: (a) bullet passage through the body of C7; (b) comminuted fracture of bodies of C1, C2; (c) complete tear of cartilage between C2 and C3; and (d) fracture of bodies of C3–C5. Furthermore, two casualties died of laceration of major neck vessels. Finally, two fatalities had only superficial neck wounds and died of unrelated injuries.

Ten casualties, in whom penetration of the spinal canal occurred, included four who died of cord transection (diagnosed on autopsy). Three others presented with complete tetraplegia on hospital admission and one had severe tetra-paresis. Two had partial neurological damage — one with left hypaesthesia below the nipple and one with lower extremity paralysis and upper extremity paresis.

4. Discussion

Some trauma surgeons question the indications for cervical spine stabilization during the initial management of a penetrating neck injury. Apparently there is no definite answer in the literature. We believe that the current "standard of care", the application of a rigid or semi-rigid cervical collar, has evolved inadvertently from the universally accepted procedure for blunt trauma casualties. The risks of rigid/semi-rigid collar application over a penetrating injury justify, to our understanding, the revision of management guidelines for penetrating neck injuries at the pre-hospital setup. Life threatening complications of penetrating neck injury manifest as visible or palpable signs in the neck and may be overlooked if the neck is covered by a device such as a semi-rigid collar. These signs are sometimes indicators for urgent treatment in the pre-hospital setting and the need for immediate surgery in the Emergency Department. Signs such as a large or expanding haematoma, tracheal deviation, subcutaneous emphysema and diminished or absent carotid pulsation are indicators of an impending catastrophe that endangers the victim's airway and life. Overlooking these signs even for a few minutes may severely affect the outcome. In our review, eight casualties (22%) had developed one of those signs.

In order to characterize penetrating neck injuries, Carducci et al. [2] performed a meta-analysis encompassing 1830 gunshot and stab wounds to the neck. It showed a 40% incidence of damage to a major blood vessel and an 18% damage to the hollow structures in the neck — pharynx, trachea, larynx, and esophagus. In comparison, the cervical spine was injured in 2.7% and the spinal cord in 1.9%. The authors did not correlate the precise association between skeletal and cord injuries. Although they emphasize the need for a complete and detailed physical examination of the neck, they recommend the routine immobilization of the cervical spine at the immediate onset of management with no specific reasoning.

Ordog et al. [3], in their series of 110 gunshot wounds to the neck, reported that 24 patients (21.8%) had endotracheal intubation, three underwent cricothyroidotomy, and two had tracheotomy performed due to massive neck swelling. The authors report a 23% incidence of major arterial and venous injury, all of which required surgical repair.

It should be added that the necessity to keep the neck straight makes endotracheal intubation more difficult [14]. Often, multiple attempts are required, subjecting the patient to longer hypoxia. In the dramatic setting of neck injuries it may lead to more cases of surgical airway, which is especially difficult in penetrating neck injuries because of the haematoma. This is aggravated in military settings where the treating personnel are less experienced. The acceptance that cervical spine control in such a specific circumstance is unnecessary, if not detrimental, can greatly assist the provider of care and give him a more favorable setup.

Common belief maintains that movement of the non-immobilized patient with an *unstable* vertebral column injury places the spinal cord at risk of primary or worsening damage. It is generally agreed that injuries in which the column remains stable or there is a complete cord injury will not benefit from neck stabilization, but proponents of stabilization state that these diagnoses cannot be made during the initial management of the victim and thus the neck must be splinted. Based on the following data, we challenge this logic and recommend a re-appraisal of this practice.

Arishita et al. [15] reviewed the Wound Data and Munitions Effectiveness Team (WDMET) computer database containing 4555 cases of patients injured in Vietnam over a 3 year period, among them 472 cases of penetrating neck injury. None of them had their spine immobilized before transport. Of the 472, 296 (81%) survived long enough to receive first aid and only 11 (3.7%) of these had cervical spinal column injuries. The authors concluded that of these 11 cases, seven would have had no benefit from neck stabilization — they either had stable fractures or, in one case, complete severance of the spinal cord caused by the original wound. There were four casualties (1.4%) who might have benefited from stabilization as could be inferred from the type of injury and the circumstances surrounding the injury. None of them survived and no definite conclusion could be made. There was no case in which a definite benefit could be attributed to stabilization of the neck prior to movement of the victim. The authors conclude that it is neither prudent nor practical to stabilize all patients with penetrating neck injury under such conditions.

Hammoud et al. [16] reviewed their experience with spinal cord injuries from bullets and shell fragments during the Lebanese civil war. Over the course of 10 years they treated 24 injuries to the cervical spinal cord. In none of the cases had dislocation occurred, and spine instability was not encountered. The authors state that spinal instability occurs very rarely in such spinal cord injuries because the bone architecture is only a little disturbed.

In another series, Kupcha et al. [17] retrospectively reviewed the charts and radiographs of 28 patients with low-velocity gunshot wounds to the cervical spine who were admitted to their center over a 10 year period. In this series too, no case of vertebral instability was observed.

In our series, surgical stabilization was not performed on any of the hospitalized casualties. Traction was applied to one patient whose injury involved multiple laminar fracture and bone fragments in the canal, with complete tetraplegia on admission to hospital. It is very unlikely that pre-hospital stabilization could have prevented the neurological outcome in this case. Of the eight dead casualties studied, four had complete transection of the spinal cord. Autopsy findings suggested no benefit from pre-hospital stabilization.

4.1. Anatomical considerations

Benzel defines instability as the inability to limit excessive or abnormal spinal displacement [11]. This is the reverse definition of White and Panjabi's definition of stability [12]. Several instability definition schemes use scoring systems to measure the extent of spinal integrity [17]. These schemes are usually based on a "column" concept of spinal structural integrity, such as the two-column theory of Bailey, Holdsworth, Kelly and Whitesides [18–20] and three-column theory of Denis [21]. We should emphasize that all the above literature concerning spinal instability is based on experiments and theories of blunt trauma. When we evaluate penetrating injuries to the spine using the methods mentioned above, it is very rare to find unstable penetrating injury. Moreover, it is conceptually impossible for a penetrating injury to cause such substantial spinal damage leading to instability without completely destroying the cord. We have not found in the literature a report describing a missile or fragment (or knife) injury that caused an unstable injury and left an *incomplete* neurological lesion which might deteriorate.

In our study, there were three cases that suffered partial neurological deficit, all with little skeletal involvement. The deficit was caused in two cases by fragments penetrating the spinal canal and in one case by bilateral large haematomas around the brachial plexuses.

5. Conclusions

We, therefore, conclude that the current routine of pre-hospital stabilization of the neck in penetrating trauma using a collar and additional devices should be seriously re-evaluated. Avoiding the collar should be the rule, and a very good point should be made for applying the device to justify the risk.

The following guidelines are hereby suggested:

1. In penetrating injury to the neck without a clear neurological deficit, there is no place for using a collar or any other device for neck stabilization.
2. Neck stabilization devices may be used when there is overt neurological deficit or the diagnosis cannot be made (i.e. unconscious victim). However, in this case it is obligatory to expose the neck by removing the anterior portion of the device every few minutes, at least in the initial phase of treatment.
3. Neck stabilization devices may be used for the *unusual* occurrence of a penetrating injury which is combined with blunt trauma. The stabilization is then for the blunt mechanism only and not for the penetrating one.

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Prehospital Spinal Immobilization Does Not Appear to Be Beneficial and May Complicate Care Following Gunshot Injury to the Torso

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Background: Prehospital spinal immobilization (PHSI) is routinely applied to patients sustaining torso gunshot wounds (GSW). Our objective was to evaluate the potential benefit of PHSI after torso GSW versus the potential to interfere with other critical aspects of care.

Methods: A retrospective analysis of all patients with torso GSW in the Strong Memorial Hospital (SMH) trauma registry during a 41-month period and all patients with GSW in the National Trauma Data Bank (NTDB) during a 60-month period was conducted. PHSI was considered potentially beneficial in patients with spine fractures requiring surgical stabilization in the absence of spinal cord injury (SCI).

Results: Three hundred fifty-seven subjects from SMH and 75,210 from NTDB were included. A total of 9.2% of SMH subjects and 4.3% of NTDB subjects had spine injury, with 51.5% of SMH subjects and 32.3% of NTDB subjects having SCI. No SMH subject had an unstable spine fracture requiring surgical stabilization without complete neurologic injury. No subjects with SCI improved or worsened, and none developed a new deficit. Twenty-six NTDB subjects (0.03%) had spine fractures requiring stabilization in the absence of SCI. Emergent intubation was required in 40.6% of SMH subjects and 33.8% of NTDB subjects. Emergent surgical intervention was required in 54.5% of SMH subjects and 43% of NTDB subjects.

Conclusions: Our data suggest that the benefit of PHSI in patients with torso GSW remains unproven, despite a potential to interfere with emergent care in this patient population. Large prospective studies are needed to clarify the role of PHSI after torso GSW.

Key Words: Spinal cord injury, Gunshot wound, Spinal immobilization, Prehospital care.

(*J Trauma.* 2009;67: 774–778)

Gunshot injury remains a significant public health problem, accounting for almost 20% of all trauma deaths in the United States.[1] The management of gunshot wounds (GSW) is frequently initiated at the scene of injury, with the routine application of prehospital spinal immobilization (PHSI). Although commonly used, the role of the cervical collar, rigid backboard, and spinal precautions after GSW to the torso is not clear and may, in fact, interfere with other treatment modalities.

The role of PHSI is not controversial after blunt trauma, where patients felt to be at risk for spinal cord injury (SCI) are immobilized to prevent the manipulation of a potentially unstable vertebral column during subsequent transport and treatment. The literature, however, reports the occurrence of unstable spine fractures after GSW to be extremely rare, and some have questioned the role of spinal immobilization in this patient population.[2–6] The purpose of this study was to evaluate whether PHSI afforded any benefit after torso GSW and, furthermore, whether its application in this patient population complicated or delayed early treatment efforts.

MATERIALS AND METHODS

Two data sets were examined during this analysis (Fig. 1). First, the trauma registry at Strong Memorial Hospital (SMH), a New York State designated level I trauma center, was retrospectively reviewed to identify all subjects sustaining a torso GSW during a 41-month period from January 1, 2003, to June 1, 2007. Subjects were excluded if they were noted to have concurrent blunt mechanism of injury or isolated GSW to the head, neck, or extremities. Data regarding prehospital times, immobilization, airway management, emergency department (ED) disposition, and need for non–spine-related emergent surgical intervention (ESI) were collected. Medical records were further reviewed to identify all subjects in this group who sustained injury to the spine. Specific characteristics related to spine injury were further collected, including presence or absence of neurologic deficits, indication for decision to proceed with surgical stabilization of the spine, and any changes in neurologic status during hospitalization. The theoretic benefit of PHSI is to prevent secondary SCI caused by excessive manipulation of an unstable spinal column. Thus, PHSI was regarded as potentially beneficial in subjects without complete SCI who went on to require surgical stabilization of an unstable vertebral fracture.

Second, to assess similar variables in a larger national sample, the National Trauma Data Bank (NTDB) version 6.2 was queried using International Classification of Diseases (ICD)-9 E-codes to identify all subjects who sustained a GSW between the years 2001 and 2005 (Table 1). Any subject with a primary injury type of "blunt" was excluded. From this group, the following variables were collected—age, sex, injury severity score (ISS), ED disposition, and intubation type. The need for ESI was defined as an ED

Submitted for publication September 11, 2008.
Accepted for publication July 3, 2009.

From the Department of Surgery, University of Rochester School of Medicine, Rochester, New York.
Presented as a poster at the 67th Annual Meeting of the American Association for the Surgery of Trauma, September 24–27, 2008, Maui, Hawaii.
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DOI: 10.1097/TA.0b013e3181b5f32e

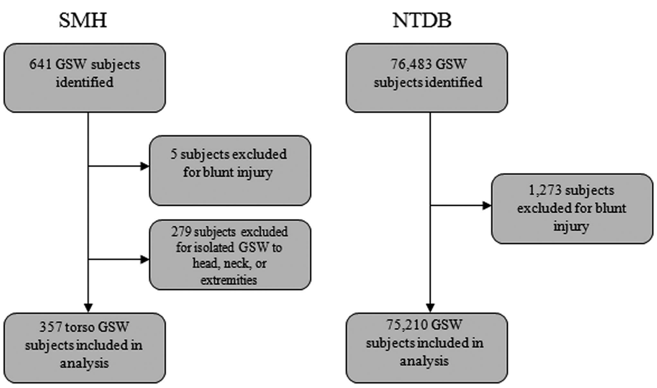

Figure 1. Study samples included from the Strong Memorial Hospital trauma registry (SMH) (January 1, 2003, to June 1, 2007) and the National Trauma Databank (NTDB) (2001–2005).

TABLE 1. ICD-9 E Codes, Diagnosis Codes, and Procedure Codes Used to Identify Groups

Identification of gunshot wounds	
E922.0–E922.3	Accident caused by firearm
E922.8–E922.9	
E955.0–E955.4	Suicide and self-inflected injury by firearms
E965.0–E965.4	Assault by firearms
E970	Injury due to legal intervention by firearm
E985.0–E985.4	Injury by firearms, undetermined whether accidentally or purposely inflicted
Identification of spine injury	
805	Fracture of vertebral column without mention of spinal cord injury
806	Fracture of vertebral column with spinal cord injury
Identification of surgical spine stabilization	
03.53	Repair of vertebral fracture
81.0	Spinal fusion
81.62–81.64	Fusion or refusion of 2–9+ vertebrae

disposition to the operating room or death in the ED in this sample. Of subjects who sustained a spine injury, presence of SCI and those undergoing operative spinal stabilization were also identified using ICD-9 codes (Table 1). The NTDB does not allow reliable identification of the anatomic location of GSW, therefore, this sample contained all subjects with isolated GSW. In addition, immobilization status and surgical specifics regarding decision for spinal stabilization were not reliably available in the NTDB data. Thus, the potential benefit of PHSI could not be directly assessed from the NTDB sample. We instead identified subjects coded as sustaining a vertebral fracture without SCI who also underwent operative spinal stabilization surgery during that admission.

Missing data for each field of the NTDB sample were assessed within the final group of study subjects. All variables were missing <4% of entries, with the exception of intubation type where 48.3% of subjects were missing these data and adjusted results are reported.

Data were analyzed using SAS JMP version 6.0 (Cary, NC) and GraphPad Prism version 4.0 (San Diego, CA). Means are reported as ±SD. Means were compared using a Mann-Whitney test. Proportions were compared using the χ^2 test, with calculation of odds ratios. A p value ≤ 0.05 was considered significant.

This study was approved by the University of Rochester Research Subjects Review Board. The American College of Surgeons granted approval for the use of the NTDB v6.2 data.

RESULTS

From the SMH trauma registry, 641 subjects with GSW were initially identified during the study period. Of these, five subjects were excluded because of concomitant blunt injury and 279 subjects were excluded for nontorso GSW, leaving 357 subjects with torso GSW for analysis (Fig. 1). This sample had an average age of 28 years ± 11 years, average ISS of 15 ± 13, and 90.4% were male. All subjects with available prehospital records (54%) underwent PHSI. There were 33 (9.2%) subjects who had gunshot injury to the spine. Within this group, 51.5% were found to have neurologic deficits consistent with SCI, in addition to a vertebral fracture, whereas 39.4% had isolated spinal fractures with no evidence of SCI, and 9.1% died before the neurologic status could be determined. Subjects with any spinal injury were 9.4 times more likely to be shot in the back (confidence interval, 4.2–21.1, $p < 0.01$).

All SMH subjects with SCI who went on to require surgical stabilization of the spine had evidence of complete neurologic injury on presentation. No subject who presented with neurologic deficits improved or worsened by hospital discharge, and no subject developed a new deficit during hospitalization. Intubation was required in 40.6% of SMH subjects and 54.5% required ESI (Fig. 2). The average prehospital scene time was 13.1 minutes ± 8 minutes, whereas the average transport time was 9.4 minutes ± 7 minutes. The average ratio of time on scene to time in transit calculated for each patient is 1.71.

The NTDB was used to identify 76,483 patients who suffered GSW during the study period. Of these, 1,273 subjects were excluded because of concurrent blunt injury, leaving 75,210 subjects for analysis. This sample had an average age of 30 years ± 13 years, average ISS of 13 ± 13, and 89.7% were male. There were 3,216 (4.3%) subjects coded as having a spine injury after GSW. Within this group, 32.3% were coded as spinal fracture with SCI, and 67.7% were coded as spinal fractures alone with no evidence of SCI. The most common area of combined spinal injury with SCI was the thoracic spine, whereas the most common area of isolated spinal fracture was the lumbar spine (Table 2).

The NTDB data included 26 subjects (0.03%) who were found to have spinal fractures requiring operative stabilization in the absence of SCI. Specifics regarding immobilization techniques used as well as surgical indications were not available for these cases. Intubation was required in

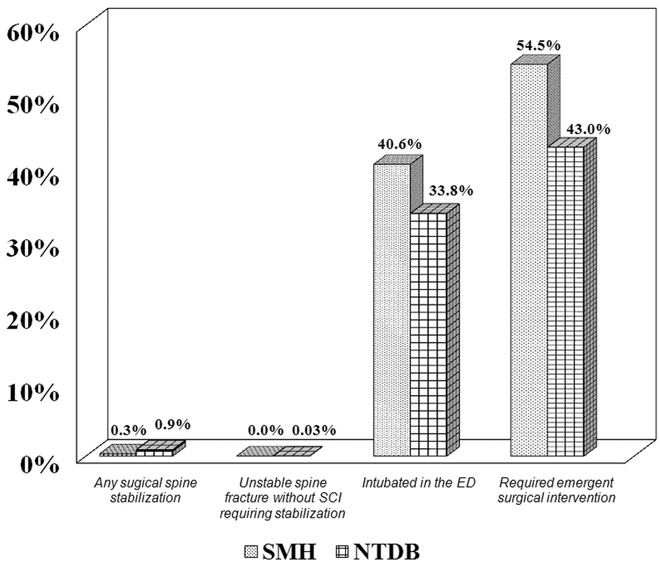

Figure 2. Percent of subjects requiring spine stabilization, intubation, and emergent surgical intervention in patients with GSW from both study samples. SMH, N = 357; NTDB intubation, N = 38,892; overall NTDB intubation rate was 17.5% (N = 75,210); NTDB emergent surgical intervention, N = 72,472.

TABLE 2. Distribution of Spine Injuries After GSW

	SMH*		NTDB†	
	Isolated Fracture, n (%)	Fracture With SCI, n (%)	Isolated Fracture, n (%)	Fracture With SCI, n (%)
Cervical	0 (0)	0 (0)	525 (24.1)	253 (24.3)
Thoracic	7 (43.8)	8 (47.1)	676 (31.1)	500 (48.1)
Lumbar	7 (43.8)	8 (47.1)	716 (32.9)	244 (23.5)
Sacral	2 (12.4)	1 (5.8)	220 (10.1)	22 (2.1)
Unspecified	0 (0)	0 (0)	39 (1.8)	21 (2)
Total	16 (100)	17 (100)	2176 (100)	1040 (100)

* Torso GSW patients.
† All GSW patients.

33.8% of NTDB subjects and 43% required ESI (Fig. 2). NTDB subjects who were missing intubation data had lower ISS and were less likely to require ESI than subjects with intubation data ($p < 0.01$). The overall rate of intubation for all NTDB subjects was 17.5%.

DISCUSSION

On the basis of our analysis, PHSI seems to be of little or no benefit to those with GSW to the torso. No subject in the SMH sample potentially benefited from PHSI as defined above. Because the presence of an unstable spine fracture in the absence of a SCI is extremely rare after a gunshot injury, it is unlikely that manipulation during early treatment would cause further SCI. In addition, patients who present with complete SCI or those with stable vertebral fractures without evidence of SCI would also not seem to benefit from PHSI. Our findings support those of similar studies, which have found that SCI caused by GSW is more likely the result of direct injury to the cord itself, as opposed to blunt force fracture of the supporting vertebral column. Waters and Sie[7] have found that patients with spinal injury after GSW have complete SCI 50% to 70% of the time, with a lack of neurologic progress at 1 year postinjury. Other reports have similarly demonstrated lack of neurologic recovery in patients sustaining SCI after a GSW.[4,8] Although PHSI may prevent further neurologic injury in patients with unstable spinal fractures after blunt trauma, it seems likely that the damage to the cord after penetrating trauma is not related to manipulation of the spine but rather the direct damage done by the projectile.[9]

Early studies that argued for spinal immobilization after trauma did not include patients with penetrating trauma and concluded that improper handling led to neurologic deterioration that was observed after initial injury[10,11]; however, the role of ischemia and edema in secondary SCI[12,13] was not recognized at that time. Data from our institution indicated that no patient with SCI after GSW had any change in neurologic status by time of discharge, further suggesting an immediate and permanent injury caused by the missile resulting in a lasting deficit. It is unlikely that these patients would benefit from PHSI, even if an unstable fracture was present.

The NTDB sample revealed only 26 patients with vertebral fracture and no SCI who subsequently underwent surgical spine fixation. Although indications for surgery in these cases were not clear, they represent 0.03% of all patients with GSW in this national sample. Similarly, no patient in the SMH registry was found to require surgical stabilization of the spine to prevent SCI after GSW. Only one subject with torso GSW in the SMH sample required surgical stabilization of the spine, but that was done to facilitate wheelchair use.

Our results are consistent with previous studies that examined the prevalence of spinal injuries after GSW. Cornwell et al.[2,3] reviewed two large populations of >4,000 patients with GSW, and they found only two patients without complete neurologic deficit who required surgical spinal stabilization, concluding that PHSI was of almost no benefit. Rhee et al.[4] reported 4 of 12,559 patients with GSW without SCI who required stabilization for an unstable fracture. Klein et al.[14] found only three patients with GSW over 10 years with an incomplete SCI, requiring spinal stabilization. In a review of Vietnam Conflict casualties, Arishita et al.[6] found that only 1.4% of immobilized patients may have potentially benefited from spinal immobilization.

Airway management is technically more challenging with PHSI in place.[10,15–17] The SMH data showed that a significant proportion of those with torso GSW were intubated in the ED. Similarly, a considerable number of subjects from the NTDB sample required intubation, even when adjustments are made for missing data. Spinal immobilization has been significantly associated with more attempts at intubation[15] and failure to properly place an endotracheal tube.[18] Failed airway management was reported as the second leading error resulting in the death of trauma patients, accounting for 16% of mortality in one study.[19]

The potential need for emergent operative intervention is also significant among patients with torso GSW.[12,20] This emphasizes the need to minimize delay in transporting patients with GSW to a trauma center capable of providing definitive surgical care. Both the NTDB and the SMH subjects demonstrated a high need for ESI. Furthermore, SMH data imply that nearly twice as much time is spent at the scene with these subjects, which includes time to apply PHSI, compared with actual transport time to the trauma center. Proper PHSI is a labor-intensive intervention that increases prehospital times. PHSI is estimated to take at least 5.5 minutes when applied by two experienced prehospital care providers under optimal conditions.[6] For trauma centers in urban settings, GSW often occur in close proximity to the hospital, allowing very short prehospital times if rapid transport is initiated. Several studies have demonstrated the value of a "scoop and run" approach to the prehospital care of critically injured trauma patients, with increases in mortality for each prehospital procedure, including cervical collar application, as well as each additional minute of prehospital time.[21–23]

It should be noted that the sample from SMH included only torso GSW because these patients are at highest risk for a spine injury.[14] The NTDB sample, however, included all subjects coded for GSW because of the inability to reliably determine the location of a GSW from available data. For this reason, patients with nontorso wounds who are less likely to suffer a potential spine injury are included in this group. This is likely responsible for the lower ISS, the lower rate of spine injury, the decreased need for surgical intervention, and the decreased rate of intubation in the NTDB group compared with the SMH population. Furthermore, few details were available about the spinal injuries and surgical indications. Thus, to indirectly evaluate the theoretical benefit of PHSI in this sample, we had to rely on ICD-9 coding that could only identify subjects sustaining spinal fracture without SCI who underwent surgical fixation of the spine during admission. Despite this, the absolute number of subjects in the NTDB who would theoretically benefit from PHSI remains negligible, although the need for ESI and intubation in this sample is significant.

Currently, there are two different national prehospital trauma curricula: Prehospital Trauma Life Support (PHTLS), which calls for PHSI in penetrating trauma patients only if a neurologic deficit is present,[24] and Basic Trauma Life Support in which the indication for PHSI is a bullet wound in or near the spinal canal.[25] Because patients with neurologic deficits after GSW to the torso seem to have a permanent injury, it would seem that PHSI would be unnecessary in this setting. Similarly, an algorithm mandating PHSI based purely on anatomic location of GSW would require that 12% of the SMH population be immobilized, although none of these patients seem to benefit from this effort.

There are several limitations to this study. First is the retrospective nature of the study. The numbers contained in the SMH data are small and limit the conclusions that can be drawn, especially when outcomes of interest are exceedingly rare. Use of registry data relies on accurate and complete imputation of data for each record. The NTDB is a large registry containing nearly 1.5 million records from 640 contributing hospitals during the period of 2001–2005. The nature of the NTDB precludes it from containing a high level of detail; however, this is a trade-off for the large sample that can be obtained. Contributing hospitals may have variation in the quality of data acquisition. Prompted by the large volume of missing intubation data, analysis demonstrated that those subjects without data were less injured. Thus, we believe it is reasonable to assume that many of these subjects were not intubated in the ED and an adjusted rate is reported accordingly. It is also possible that these subjects represent less serious GSW, such as those to the extremities, and the intubation rate of 33.8% may be a better reflection of torso GSW, such as the sample represented in the SMH data. Finally, ICD-9 coding was used for identification of patient groups, which creates the possibility for improper or missed coding. However, we believe that the rates in both samples are reasonably similar and are likely a reliable representation, especially when considering the NTDB data includes subjects with lesser injuries and a decreased risk for spine injury.

Although injury to the spine after a GSW to the torso is not uncommon, the benefit of PHSI in these patients remains unproven. It seems clear, however, that patients sustaining GSW to the torso are more likely to require some form of emergent intervention that may be affected by the process of PHSI. The potential to delay definitive surgical treatment, the potential to complicate airway management, and the overall lack of neurologic improvement after gunshot injury to the spinal cord suggest that PHSI in this patient population may by unjustified. A prospective multicenter study would be beneficial to adequately define the role of PHSI after torso GSW and to help with the development of an evidence-based approach to this problem.

ACKNOWLEDGMENTS

Committee on Trauma, American College of Surgeons. NTDB Version 6.2, Chicago, IL, 2007. The content reproduced from the NTDB remains the full and exclusive copyrighted property of the American College of Surgeons. The American College of Surgeons is not responsible for any claims arising from works based on the original data, text, tables, or figures.

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PRELIMINARY REPORTS

Out-of-hospital Spinal Immobilization: Its Effect on Neurologic Injury

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ABSTRACT

Objective: To examine the effect of emergency immobilization on neurologic outcome of patients who have blunt traumatic spinal injuries.

Methods: A 5-year retrospective chart review was carried out at 2 university hospitals. All patients with acute blunt traumatic spinal or spinal cord injuries transported directly from the injury site to the hospital were entered. None of the 120 patients seen at the University of Malaya had spinal immobilization during transport, whereas all 334 patients seen at the University of New Mexico did. The 2 hospitals were comparable in physician training and clinical resources. Neurologic injuries were assigned to 2 categories, disabling or not disabling, by 2 physicians acting independently and blinded to the hospital of origin. Data were analyzed using multivariate logistic regression, with hospital location, patient age, gender, anatomic level of injury, and injury mechanism serving as explanatory variables.

Results: There was less neurologic disability in the unimmobilized Malaysian patients (OR 2.03; 95% CI 1.03–3.99; $p = 0.04$). This corresponds to a <2% chance that immobilization has any beneficial effect. Results were similar when the analysis was limited to patients with cervical injuries (OR 1.52; 95% CI 0.64–3.62; $p = 0.34$).

Conclusion: Out-of-hospital immobilization has little or no effect on neurologic outcome in patients with blunt spinal injuries.

Key words: injury; trauma; morbidity; spine; immobilization; back board; emergency medical services; spinal cord.

Acad. Emerg. Med. 1998; 5:214–219.

Immobilization of the spine in blunt trauma is thought to be a crucial intervention almost as essential as management of the airway.[1] Failure to diagnose and appropriately manage spinal injuries is a major concern for emergency physicians. A large number of papers address immobilization and management of spinal injuries in the emergency setting. Much is now known about these issues. Immobilization is improved by using a firm surface; addition of a hard cervical collar,[2] head blocks,[3] and lateral restraint[4,5] provides progressively more stability. The clinical importance of immobilization remains unknown. That is, how much spinal motion is permissible without harm during transport and during the initial workup remains unknown.

This issue is complex. The definition of instability is not standardized. The most conservative view is: "... the loss of the ability of the spine under physiologic conditions to maintain relationships between vertebra in such a way that there is neither damage nor subsequent irritation to the spinal cord or nerve root and, in addition there is no development of incapacitating deformity or pain from structural changes."[6] This definition, while appropriate to guide long-term management, is of little use in the emergency setting, where the question generally is: will motion

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Received: February 19, 1997; revision received: July 10, 1997; accepted: July 17, 1997; updated: October 23, 1997.

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make the neurologic lesion worse? Furthermore, neurologic lesions are dynamic, some deteriorate due to swelling and microvascular injury,[7,8] and some improve as edema and neuropraxia resolve, irrespective of immobilization. Other neurologic injuries are irrevocable at the time of the injury, and not affected by subsequent movement. In the face of these uncertainties and considerable medicolegal pressure, physicians have opted for extraordinarily conservative management. Patients are fully immobilized at the injury site if there is any suggestion that the neck or back could be injured.[1] Immobilization is usually continued in the ED until the spine is "cleared" by multiple imaging procedures.[9,10] Authors have claimed that without adequate long-term immobilization, 10% to 25% of all patients with spine injuries will deteriorate.[5,11] These claims, however, have little scientific support.

Conservative treatment is not necessarily benign. Immobilization is uncomfortable,[12,13] takes time, and delays transport. Immobilized patients are difficult to examine and treat. Immobilization increases the risk of aspiration and pressure sores. Cervical collars increase intracranial pressure.[14] Given these problems, it would be useful to know how often not immobilizing patients would result in increased neurologic injury. A low incidence of these "acutely unstable" injuries would justify more liberal guidelines for allowable spinal motion following trauma. A high incidence of injuries that might benefit from immobilization would require more a conservative approach.

Some spinal injuries are undoubtedly truly biomechanically and neurologically unstable and will develop increased neurologic injury with movement. Others are undoubtedly biomechanically stable but neurologically fragile; these will suffer more neurologic injury by delaying resuscitation. Standard practice assumes that immobilization is generally protective and that patients with spinal fractures will have a higher incidence of neurologic injuries if immobilization is not carried out. However, this hypothesis has never been tested. It is no longer possible to derive a meaningful estimate of effect of spinal immobilization in the developed world because of the universal adoption of early, preventive immobilization and widespread publicity regarding the "need" to protect the spine until ambulance personnel arrive. We derive this estimate by comparing the percentages of spine-injured patients who had neurologic injuries from 2 sites: the University Hospital, University of Malaya in Kuala Lumpur, Malaysia, which is not served by an out-of-hospital emergency medical services (EMS) system, and the University of New Mexico Hospital in Albuquerque, NM, which is served by an extensive EMS system.

METHODS

Study Design: A retrospective chart review of all patients admitted to the inpatient service or ED of our 2 hospitals with spinal or spinal cord injuries between January 1988 and January 1993 was performed. Permission for the study was provided by the Ethical Sub-Committee of the Medical Advisory Board of the University Hospital, Kuala Lumpur, Malaysia, and by the institutional review board of the University of New Mexico, School of Medicine, Albuquerque, NM.

Setting and Population: Study cases were identified by searching for bony spine or spinal cord injuries by International Classification of Disease Version 9 (ICD-9) codes contained in hospital computerized databases. Compression fractures due to osteopenia or other disease were excluded. Patients who died were included unless the cause of death was clearly unrelated to the spinal injury; these cases were almost exclusively patients with massive head or other injuries who died in the first 24 hours.

During the period 1988 through 1993, approximately 12,700 trauma patients were admitted to inpatient services at the U.S. hospital and 16,600 to the University of Malaysia. Both statistics include transfer patients. The U.S. figures exclude patients with burns, drownings, and isolated injuries who were admitted to services other than the trauma service. The Malaysian data include the latter cases. All the patients taken to the U.S. hospital, but none of those taken to the Malaysian hospital, had their spines immobilized at the injury site. The catchment area of the University of Malaya Hospital lacks emergency ambulance coverage. The hospital operates an ambulance, but it is used almost exclusively for medical patients. Trauma patients are transported by passersby, police, and coworkers, none of whom have training in spinal immobilization. None of the ED staff could remember any patients who had been immobilized in Malaysia. Other differences between our sites are small. The level of training of Malaysian physicians is comparable to that of their counterparts in the United States, particularly in the essential specialties where training was commonly outside of Malaysia until recently. The 2 hospitals have similar radiologic, resuscitative, and surgical abilities. All patients who were admitted to either facility after June 1990 with a neurologic deficit were treated with high-dose methylprednisolone.[15]

Study Protocol: All patients with blunt injuries to the spine or spinal cord who were transported directly from the injury scene to a study hospital were entered into the database. Compression fractures due to osteopenia or disease were excluded. Information regarding hospital, patient age, gender, level of deficit, mechanism of injury, and type of neurologic injury was collected. Ages were grouped by decade for use in the regression model. The level of injury was classified into cervical, thoracic, or lumbosacral depending on the highest vertebra injured. The mechanism of injury was grouped into 1 of 4 cate-

TABLE 1 Anatomic Distribution of Injuries

	Disability	No	Total
Cervical			
Immobilized (United States)	34 (30%)	79 (70%)	113 (100%)
Unimmobilized (Malaysia)	10 (25%)	30 (75%)	40 (100%)
Thoracic			
Immobilized (United States)	22 (21%)	85 (79%)	107 (100%)
Unimmobilized (Malaysia)	2 (6%)	31 (94%)	33 (100%)
Lumbosacral			
Immobilized (United States	14 (12%)	99 (88%)	113 (100%)
Unimmobilized (Malaysia)	1 (2%)	46 (98%)	47 (100%)

gories: falls from a height; motor vehicle crashes (MVCs); high-velocity–low-mass impacts (primarily patients assaulted with blunt objects and those struck by falling objects); and other.

The dependent variable, neurologic injury, was classified as disabling or not disabling based on the last hospital note. Patients with complete quadriplegia or paraplegia, inability to ambulate without assistance, incontinence, or the need for chronic catheterization, and those who died were classified as having disability. Patients with no neurologic injury were classified as not having disability. The remaining charts were reviewed by 2 physicians acting independently and blinded to the hospital of origin. These patients were classified into the 2 groups based on whether the physicians thought the injury would interfere with normal functioning.

Data Analysis: Comparison between patients from the United States (all who had spinal immobilization) and Malaysia (none of whom had spinal immobilization) was performed using χ^2 and 1-way analysis of variance as appropriate. Multivariate logistic regression of the association between the collected variables and disability was used for analysis.[16,17] The level of deficit and the mechanism of injury were coded as separate binary variables. All of the independent variables were included in the model. Odds ratios (ORs) and 2-sided 95% confidence intervals (CIs) were calculated. We also repeated the analysis using only patients with cervical injuries.

Data management was carried out using Quattro Pro version 5.00 spreadsheet software (Borland International, Scotts Valley, CA). Statistical computations were performed with Statgraphics Plus version 7.0 (Manugistics Inc., Rockville, MD) and LogXact-Turbo version 1.1 (Cytel Software Corporation, Cambridge, MA). We used 2-tailed tests and an α of 0.05 throughout.

RESULTS

The anatomic distributions of injuries were similar in the 2 sites and to that published in the literature (Table 1).[18]

Malaysian and US patients were similar in terms of age and level of injury. Patients in Malaysia were more likely to be male and to have been injured in a fall rather than an MVC (Table 2).

There were 24 patients who had injuries that required physician classification. The 2 physicians grouped these with complete agreement (Table 3), resulting in 21% of the patients (70/334) from the United States and 11% of the Malaysian patients (13/120) being classified as having disabling injuries.

The OR for disability was higher for patients in the United States (all with spinal immobilization) after adjustment for the effect of all other independent variables (2.03; 95% CI 1.03–3.99; p = 0.04). The estimated probability of finding data as extreme as this if immobilization has an overall beneficial effect is only 2%. Thus, there is a 98% probability that immobilization is harmful or of no value. The level of neurologic deficit was the only independent predictor of bad outcome (Table 4). We repeated this analysis using only the subset of patients with isolated cervical level deficits. We again failed to show a protective effect of spinal immobilization (OR 1.52; 95% CI 0.64–3.62; p = 0.34).

DISCUSSION

These results undoubtedly seem counterintuitive to most physicians who have been taught that spinal motion

TABLE 2 Characteristics of the Patients from the United States and Malaysia

	Immobilized	Unimmobilized	p-value
Number of patients	334	120	
Average age	34 yr	35 yr	0.31
Gender—male	256 (77%)*	106 (88%)	0.009
Level of injury			0.52
Cervical	113 (34%)	40 (33%)	
Thoracic	107 (32%)	33 (28%)	
Lumbosacral	113 (34%)	47 (39%)	
Mechanism			0.0001
Fall	66 (20%)	63 (53%)	
Vehicle crash	248 (74%)	45 (38%)	
Low-mass impact	9 (3%)	8 (7%)	
Other	11 (3%)	4 (3%)	
Significant disability	70 (21%)	13 (11%)	0.02

*Percentages are relative to each hospital's total.

causes neurologic injury. However, technically only the transfer of energy can physically alter material. Acute neurologic injury occurs when excessive energy is deposited in the spinal cord or its vascular structures. This energy is a product of force multiplied by time. "Excessive" energy is directly related to the failure strength of the material. Over the length of time experienced during an injurious event, the spine is quite strong and massive amounts of energy are required to fracture or otherwise significantly injure it. The cervical spine will fracture when >2,000–6,000 N (Newton or meter-kg/sec^2, 1 N = 0.225 pounds of force)[19] is applied; the lumbar spine requires >4,200 N to fracture, even in elder individuals.[20] Muscles and ligaments[21] reinforce the bone. Even the spinal cord itself is capable of absorbing significant energy without suffering damage.[22] Energy deposition during an injury is a complex process. Subjects ejected from vehicles, the most common cause of disability in our sample, undergo repetitive impacts. In most cases the maximal impact is early in the event as the victim contacts the vehicle structure or the ground. It is presumably at these times that most of the injury is inflicted. Subsequently, multiple impacts occur between the subject and the ground. Even in the simple case of a restrained subject and direct linear deceleration while in a sitting position, the initial acceleration is followed by a series of repetitive oscillatory movements.[23] In these circumstances the energy deposited by moving the patient after the event will be much less than the energy deposited at the scene by secondary impacts.

There are good physical and biomechanical reasons why immobilization immediately after the injurious event has little effect. Movement within the spine's normal range of motion requires little energy and is hence unlikely to result in significant energy deposition to the cord. Even the force generated across the spine by hanging a completely unimmobilized 4-kg head off the end of a stretcher is only equal to approximately 40 N, which is orders of magnitude less than that experienced during the original event.

As the spine is moved, changes in force vectors occur. The spinal elements (bone, ligament, muscle, and disc) interact to transfer energy to all the component parts.[24] This serves to minimize energy deposition to any one component. When force is applied rapidly, the energy is focused due to wave effects, thus enhancing injury.[25] However, the definition of instability that is used to guide long-term care of the patient is based on the risk of gradual slippage due to gravity and active motion. It is hardly surprising that this definition has little relevance in the acute setting when the biomechanical factors are completely different.

The difference in neurologic disability between immobilized patients in the United States and unimmobilized patients in Malaysia was statistically significant. It may be that immobilization increases the risk of neurologic injury secondary to tissue hypoxia, perhaps by delaying resuscitation or perhaps the benefit of immobilization is so small that it is unmeasurable given our sample size.

Previous studies have estimated that three fourths of cervical fractures are potentially unstable[26,27] based on ra-

TABLE 3 Physician-classified Patients—Verbatim Discharge Diagnosis

Neurologic Finding	Location
Injuries judged not disabling	
Moderate leg weakness, ambulatory	United States
Hypoesthetic thumb	United States
Paresthesias only	United States
Mild hypaesthesia 1/3 right leg	United States
Mild hand weakness	United States
Decreased right arm sensation	United States
Almost normal at discharge	United States
Weak deltoids	United States
Weak toe	United States
Mild diffuse hypaesthesia	United States
Paresthesias	United States
Mild weakness left leg	United States
Sacral 1 root injury	United States
Right foot drop	Malaysia
Slight right arm weakness	Malaysia
Right arm partial brachial palsy	Malaysia
Slight left arm weakness	Malaysia
Sensory change, no objective findings	Malaysia
Injuries judged disabling	
Right arm paralysis and anesthesia	United States
Severe right arm weakness	United States
Right hemiparesis	United States
Anesthetic left leg	United States
Severe hypoesthesia left leg	United States
Complete left cervical plexus injury	United States

TABLE 4 Logistic Regression Analysis

	Odds Ratio	95% Confidence Interval	p-value
Spinal immobilization	2.03	1.03–3.99	0.04
Gender—male	1.69	0.86–3.32	1.13
Age (by decade)	0.96	0.81–1.14	0.65
Level of injury			
Cervical	3.82	1.98–7.37	0.0001
Thoracic	1.99	0.98–4.00	0.06
Lumbosacral	0.34	0.19–0.62	0.0005
Mechanism			
Fall	0.60	0.14–2.54	0.49
Vehicle crash	0.91	0.23–3.56	0.90
Low-mass impact	0.38	0.03–4.77	0.45
Other	1.32	0.34–5.08	0.69

diographic criteria. The actual percentage of injuries that are likely to be made worse by lack of immobilization during the immediate post-injury period is much smaller. The risk of neurologic deterioration is greatly exaggerated.

LIMITATIONS AND FUTURE QUESTIONS

Our study has several shortcomings. Patients who died at the injury site or during transport are excluded. It is possible that some of these died as a result of high cord injuries, attendant loss of diaphragmatic function, and asphyxia. Most of these cord injuries are probably complete at the time of the injury and many of these patients have other fatal injuries, but it is possible that some partial lesions could have been completed during transport in Malaysia and resulted in death prior to admission. However, there were no survivors in Albuquerque with complete lesions above C_4 during this period, either.

We did not attempt to match patients for the severity of their nonspinal injuries. The University of Malaya does not routinely use injury severity scores, and retrospective calculation of them would have been difficult. The use of mechanism of injury in our regression analysis partly corrects for this omission as does our entry criteria, which required that adequate energy be deposited to injure the spine.

It is possible that the injuries from New Mexico were more unstable or more severe. Indeed, our initial plan was to match injuries from our 2 sites and then compare outcomes. This proved impossible. Spinal injuries are idiosyncratic and no 2 are identical. Many injuries were merely described verbally in the radiologic and discharge notes. The severity of injury was poorly predicted by the description; for example, some "compression fractures" were associated with severe neurologic injuries, while others caused no neurologic injury at all. Fracture classification schemes are not well standardized and systems of classification are based on estimates of long-term instability which may, as noted above, be unrelated to short-term stability. Even those injuries that were placed in discrete diagnostic categories were not matchable.

The number of patients available for comparison is relatively small. We chose to analyze only patients with injuries to the spine presenting to a single pair of medium-sized hospitals over a 5-year period. Inclusion of patients seen prior to 1988 or at other facilities would increase the differences in hospital treatment in our samples and make direct comparison more difficult. Although resources and clinical capabilities are similar in the 2 hospitals, they are not identical. We doubt that hospital care in Malaysia is significantly superior to that in the United States, but if this were the case, it would complicate our analysis. An important source of bias in our study is that only patients who proved to have spinal injuries were entered. The vast majority of trauma patients do not have a spinal injury and hence cannot benefit from spinal immobilization. As a result, our study design would tend to exaggerate any potential benefit of current protocols that require the immobilization of almost all trauma patients.

It is doubtful that this study can be duplicated in the future because Malaysia is now developing an EMS system and considerable publicity has recently been given to spinal immobilization in the mass media. Other population-based studies are urgently needed to confirm our data. Current spinal immobilization protocols have been developed without supporting clinical efficiency data. They may be overly conservative.

CONCLUSION

Comparison of spine injury patients from 2 study populations, one with out-of-hospital spinal immobilization and the other without, showed a higher rate of neurologic injury in the immobilized group. Acute spinal immobilization may not have significant benefit for the prevention of neurologic deterioration from unstable spinal fractures.

The authors acknowledge the assistance of the late Professor N. Subramanian, MBBS (Calc.), Head, Department of Orthopaedic Surgery, University Hospital, Malaysia, in the planning and data collection for this study.

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Emergency spine immobilization may do more harm than good, study says

January 11, 2010 | 3:57 pm

When emergency responders reach a gunshot or stabbing victim, they try to immobilize the spine to reduce the danger of paralysis upon movement of the victim. That effort, however, can have a fatal toll.

A study published in the Journal of Trauma has found that, among these types of trauma victims, those whose spines are held still are twice as likely to die as those whose spines aren't immobilized.

Time is the crucial factor, said the study's lead author, Elliott R. Haut, an assistant professor of surgery at the Johns Hopkins University School of Medicine. "For someone who was shot in the liver or has a collapsed lung," Haut said, "those extra five minutes might mean life or death for them."

The study cuts to the heart of a debate among trauma surgeons about the roles of paramedics and other first responders, says Dr. Larry J. Baraff, associate director of the UCLA Emergency Medicine Center. Many feel that time spent treating the patient in the field is often better spent on the operating table.

Immobilization is "a tradition that started decades ago," says Dr. Demetrios Demetriades, who directs the Division of Acute Care Surgery at USC. "There was never any scientific evidence that it works."
It can even worsen the situation, he says.

First responders typically fasten a cervical collar tightly around a victim's neck and then strap him or her to a plastic board to secure the spine. This takes time, and it can hide or exacerbate internal injuries.

The likelihood that the spine would be injured by a penetrating wound is pretty low, Baraff added. "Unless the bullet hits the spinal column in exactly the right way, it's extremely unlikely there's going to be an unstable spinal column," Baraff said.

In the new report, out of the more than 45,000 patients studied (about 2,000 of whom underwent spine immobilization), only 30 had some partial damage to the spine that may have benefited from the procedure. First responders would have to immobilize the spines of 1,032 patients before potentially benefiting one person, the study's authors wrote. But it only took 66 patients to potentially contribute to one death.

The best thing to do is get a patient to the hospital as fast as possible, doctors said -- the cervical collar usually serves no purpose other than to get in a surgeon's way.

"We remove it immediately," Demetriades said.

"We say to the paramedics, 'Thank you very much for taking care of them, you did a great job,' and immediately take [the collars] off and throw them away."

-- Amina Khan