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Brian M. Clemency, Joseph A. Bart, Abhigyan Malhotra, Taylor Klun, Veronica Campanella & Heather A. Lindstrom

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EDUCATION AND PRACTICE

PATIENTS IMMOBILIZED WITH A LONG SPINE BOARD RARELY HAVE UNSTABLE THORACOLUMBAR INJURIES

Brian M. Clemency, DO, MBA, Joseph A. Bart, DO, Abhigyan Malhotra, Taylor Klun, Veronica Campanella, Heather A. Lindstrom, PhD

ABSTRACT

Most Emergency Medical Services (EMS) protocols require spine immobilization with both a cervical collar and long spine board for patients with suspected spine injuries. The goal of this research was to determine the prevalence of unstable thoracolumbar spine injuries among patients receiving prehospital spine immobilization: a 4-year retrospective review of adult subjects who received prehospital spine immobilization and were transported to a trauma center. Prehospital and hospital records were linked. Data was reviewed to determine if spine imaging was ordered, whether acute thoracolumbar fractures, dislocations, or subluxations were present. Thoracolumbar injuries were classified as unstable if operative repair was performed. Prehospital spine immobilization was documented on 5,593 unique adult subjects transported to the study hospital. A total of 5,423 (97.0%) prehospital records were successfully linked to hospital records. The subjects were 60.2% male, with a mean age of 40.6 (SD = 17.5) years old. An total of 5,286 (97.4%) subjects had sustained blunt trauma. Hospital providers ordered imaging to rule out spine injury in 2,782 (51.3%) cases. An acute thoracolumbar fracture, dislocation, or subluxation was present in 233 (4.3%) cases. An unstable injury was present in 29 (0.5%) cases. No unstable injuries were found among the 951 subjects who were immobilized following ground level falls. Hospital providers ordered at least one spine x-ray or CT in most patients, and a thoracolumbar imaging in half of all patients immobilized. Only 0.5% of patients who received prehospital spine immobilization had an unstable thoracolumbar spine injury. **Key words:** Emergency Medical Services; spine immobilizations; long spine board; thoracolumbar injury.

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Address correspondence to Brian M. Clemency, University at Buffalo, Department of Emergency Medicine, 462 Grider Street, Buffalo, NY 14215, USA. E-mail: bc34@bufalo.edu

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INTRODUCTION

Long spine boards have been widely adopted along with cervical collars as the mainstay of prehospital treatment for patients with suspected spine injuries.[1,2] Spine immobilization with a long spine board is not a benign process. Multiple studies have shown adverse effects of transport on a long spine board such as respiratory compromise, pain, tissue ischemia, and unnecessary imaging.[3–9] No clinical trials to date have shown this practice to be beneficial.[2]

Theoretically, a patient with a highly unstable spine injury could be at risk for a secondary mechanical injury if exposed to significant movement. Prehospital providers may be unable to definitively determine if their patient has such an injury at the time of initial contact. This uncertainty results in many patients being immobilized on a long spine board and unnecessarily exposes those patients to the risks associated with that procedure. In a 2013 position paper, the National Association of EMS Physicians (NAEMSP) and the American College of Surgeons (ACS) recommended the "judicious" use of the long spine board.[10] Establishing what percentage of patients immobilized with a long spine board have unstable thoracolumbar injuries would provide a context to compare the relative risk and benefits of this procedure.

The goal of this research was to determine the prevalence of unstable thoracolumbar spine injuries among patients receiving prehospital spine immobilization.

METHODS

Study Design and Setting

A 4-year retrospective review of prehospital and hospital records was conducted. The study period was from January 1, 2010 through December 31, 2013.

Data was obtained from a single large private EMS agency that utilizes both ALS and BLS ambulance crews. The agency serves a mixed urban, suburban and rural region in Western New York. The agency re-

sponds to approximately 130,000 requests for service each year. Prehospital records are maintained using an electronic patient care record (ePCR) system (RescueNet ePCR, ZOLL Medical Corporation). At the time of the study, prehospital care for suspected spine injuries was governed by a statewide "Suspected Spinal Injury" protocol. Providers were instructed to "always use complete spine immobilization" if a spine injury is "suspected". Providers were further advised: "when in doubt immobilize." The flow chart that accompanied the protocol is shown in Figure 1.[11]

Corresponding hospital data was obtained from a single urban academic hospital. This hospital is the only adult Level-1 trauma center in an eight county region. The state protocols instruct prehospital providers to transport patients meeting major trauma criteria to a regional center. The hospital's emergency department has approximately 65,000 visits per year. Emergency department records are maintained in a hybrid electronic medical record (MEDITECH) and paper system.

Selection of Participants

Subjects were included in the analysis if they received prehospital spine immobilization by the study prehospital agency and were transported to the study hospital during the study period.

Study Approval

The University's Institutional Review (IRB) Board approved this study and waived the requirement to obtain informed consent. All study personnel with access to patient records completed IRB training and were approved by both the IRB and the hospital prior to the start of study.

Study Procedures

An electronic query of the prehospital records was performed for subjects with documented spine immobilization that were transported from the scene to the study hospital during the study period. At the time of the patient encounter, providers documented spine immobilization by selecting the procedure from a list of predefined procedures. The prehospital agency requires providers to utilize this process for logging this procedure. Patients transferred from another hospital to the study hospital were excluded. The following data points were obtained for each subject: name, date of service, date of birth, and gender. Subjects under the age of 18 were excluded.

Next, screeners electronically searched for a corresponding study hospital record using each prehospital subject's name, date of birth and date of service. Screeners were medical students, emergency medicine residents or attendings. They were trained by the primary investigator in the study procedures, the electronic medical record systems and classification of spine injuries. If a subject's corresponding hospital record could not be found, the case was referred to a second screener. If the second screener also failed to find the corresponding hospital record, the subject was excluded.

Once the corresponding hospital record was found, screeners reviewed the subject's hospital electronic medical record to determine the mechanism of injury and if x-rays or computerized topography (CT) scans of the spine were performed. Falls from height were recorded in feet and grouped in 5 foot intervals. Falls from height included both vertical falls and falls down inclines such as steps or hills. Unless otherwise noted in the medical record, the height of a single step, a flight of stairs, and a building story were recorded as 0.5, 8, and 10 feet, respectively. Motorcycle collisions and all-terrain vehicle collisions were grouped with motor vehicle collisions because they were frequently classified that way in the medical record.

The ordering of spine x-rays or CTs by the emergency department providers was recorded. If performed, the radiologist's CT interpretation was reviewed for the presence of acute fractures, dislocation or subluxation of the thoracolumbar spine. If a possible or definite acute fracture, dislocation, or subluxation of the thoracolumbar spine was noted, the case was referred for review.

Two reviewers (BC, JB) independently reviewed all cases referred by the screeners. Reviewers were emergency medicine physicians who worked at the study hospital and specialized in emergency medical services. Hospital records were reviewed to confirm the acute nature of the spine injury and determine if the injury resulted in surgical intervention. All fractures, dislocations, or subluxations were recorded as acute unless otherwise noted in the medical record. The performance of thoracolumbar spine surgery during the hospitalization, as documented in the medical record, was used as a marker for an unstable thoracolumbar spine injury. Discrepancies between the reviewers were resolved by consensus.

Outcomes

The primary study outcome was the percentage of patients who sustained blunt trauma, underwent prehospital spine immobilization, and had an unstable thoracolumbar injury as indicated by performance of thoracolumbar surgery.

Secondary study outcomes include rates of imaging and stable and unstable injuries by mechanism.

Analysis

Rates of imaging, fractures, and unstable fractures were calculated based on mechanism of injury.

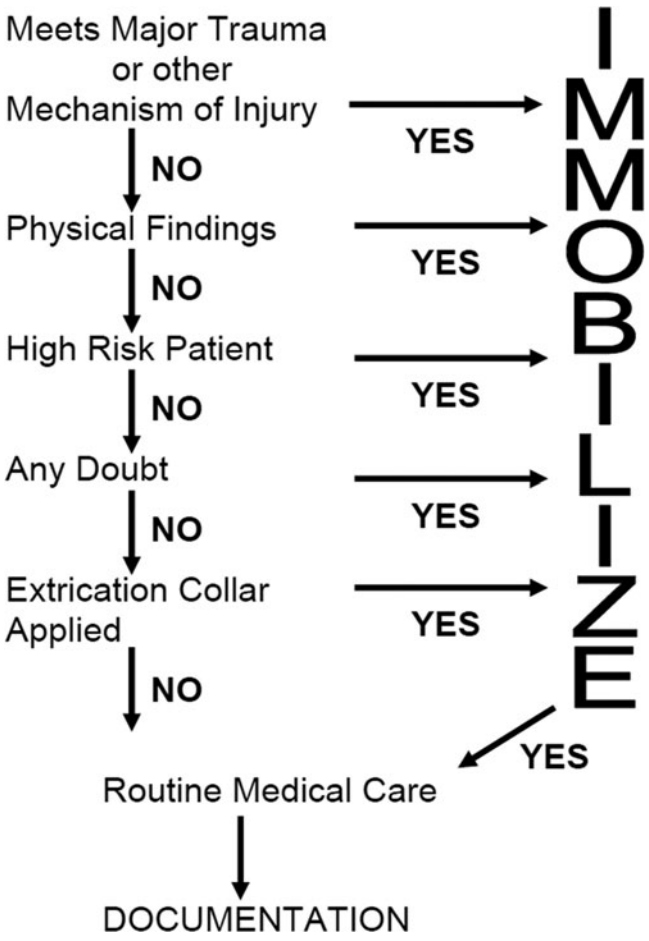

FIGURE 1. Spinal Injury Protocol flow chart.

RESULTS

Prehospital spine immobilization was documented on 5,593 unique adult subjects who were transported from the scene to the study hospital from January 1, 2010 to December 31, 2013. Data was extracted from June 2014 to August 2014. A total of 5,423 (97.0%) prehospital records were successfully linked to hospital records and included in the analysis. Subject inclusions/exclusions and findings are demonstrated in Figure 2. The subjects were 60.2% male, with a mean age of 40.6 (SD = 17.5) years old.

A total of 5,286 (97.4%) subjects had sustained blunt trauma (Table 1). Imaging was ordered by hospital providers to rule out any spine injury in 4,475 (82.5%) subjects and thoracolumbar spine injury in 2,782 (51.3%) subjects. An acute thoracolumbar fracture, dislocation, or subluxation was present in 233 (4.3%) subjects. An unstable thoracolumbar injury was present in 29 (0.5%) subjects as indicated by performance of thoracolumbar surgery.

Rates of imaging, injuries, and unstable injuries broken down by mechanism are demonstrated in Table 1. Falls from heights greater than 20 feet had the greatest chance of causing any fractures and unstable injuries as indicated by the performance of thoracolumbar surgery in 10% of subjects who fell from this height. No unstable thoracolumbar injuries were found among the 951 subjects who were immobilized following ground level falls.

LIMITATIONS

This study relied on the treating physicians' identification and treatment of spine injuries. It is possible that these physicians could have failed to identify and treat an unstable spine fracture. If that were to happen, we believe, it is unlikely that movement in the prehospital phase would have been a significant cause of long term morbidity, compared to subsequent unprotected movement. This study utilized thoracolumbar spine surgery, regardless of type of cord injury as marker for unstable thoracolumbar injuries. This is distinct from the radiological definition of an unstable spine fracture, which is based on disruption of at least 2 of the three columns. Presumably, patients who require surgical stabilization of an injury are at greatest risk for deterioration from secondary mechanical injury. However, in some cases surgery may have been performed for indications other than spine stabilization such as

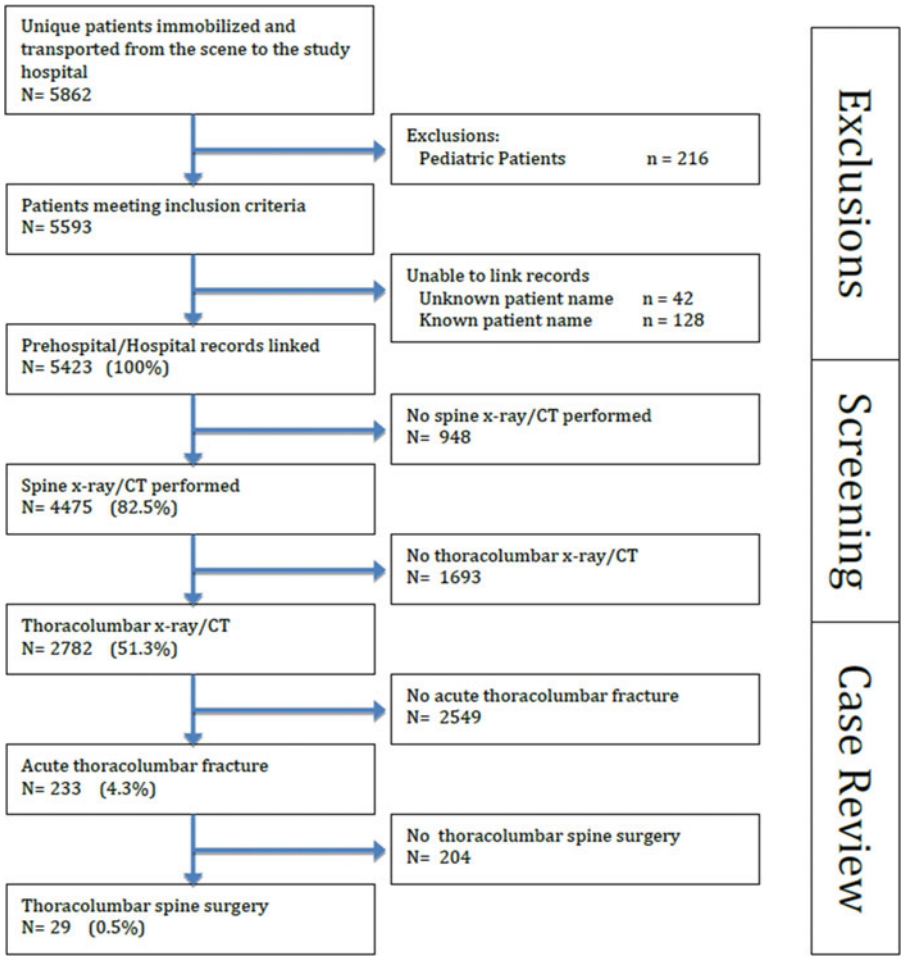

Figure 2. Study flow chart.

pain control. The study methods were more conservative than those used by Haut et al. who did not include cases of complete cord injury in their study of patients' immobilized following penetrating trauma.[7]

This study has the typical limitations of a retrospective review.[12] It is possible that prehospital providers did not perform complete spine immobilization with both a backboard and cervical collar in all cases. Such a treatment is inconsistent with the statewide BLS protocol, and anecdotally occurs infrequently in this system. Some patients may have had unstable fractures, but failed to survive long enough to obtain imaging and, thus, were not identified in our analysis. Cardiac and respiratory functions are innervated primarily by the cervical spine, so a primary thoracolumbar injury would not be expected to cause a prehospital death. However, the increased on scene time required to perform immobilization, or the movement needed to position the patient on the board may contribute to increased morbidity or mortality.[13–15]

This analysis was limited to patients who received prehospital spine immobilization. It is possible that unstable fractures were present in patients who were not immobilized.

Discussion

The American College of Emergency Physicians (ACEP) states that "spinal motion restriction" should be the preferred practice, and that "true spinal immobilization is impossible."[16] Many prehospital providers feel that spine immobilization is often performed unnecessarily.[17] One likely cause for unnecessary immobilization is fear of neurologic deterioration in the absence of full spine immobilization and the subsequent professional and medical-legal consequences. Even under ideal circumstances, secondary injuries unrelated to spine manipulation may occur.[18–21] These factors were likely unknown to Geisler, who in 1966 concluded that a patient with late development of neurologic deficits "would surely have been protected from the paraplegic condition had the spinal instability been recognized and precautions taken."[22] Today, there are at least 26 different mechanisms other than vertebral instability thought to contribute to secondary spinal cord injury.[23,24] Prehospital handling is a convenient source of blame, but only one of many potential causes for neurologic deterioration.

For every 200 subjects exposed to spine immobilization with a long spine board, 199 did not meet the

TABLE 1. Subjects and findings by mechanism

	Subjects	Any Spine Imaging		TL Imaging		Acute TL Fracture		TL Surgery	
Blunt Trauma									
Assault	506	430	(85.0%)	142	(28.1%)	9	(1.8%)	0	(0.0%)
Fall 0	951	760	(79.9%)	265	(27.9%)	11	(1.2%)	0	(0.0%)
Fall 1-4	163	149	(91.4%)	94	(57.7%)	6	(3.7%)	0	(0.0%0
Fall 5-9	172	159	(92.4%)	117	(68.0%)	15	(8.7%)	2	(1.2%)
Fall 10-14	68	60	(88.2%)	44	(64.7%)	9	(13.2%)	0	(0.0%)
Fall 15-19	22	22	(100%)	20	(90.9%)	4	(18.2%)	1	(4.5%)
Fall > 20	80	76	(95.0%)	69	(86.3%)	23	(28.8%)	8	(10.0%)
Falls – Unknown Height	46	43	(93.5%)	28	(60.9%)	6	(13.0%)	0	(0.0%)
Hanging	30	22	(73.3%)	6	(20.0%)	0	(0.0%)	0	(0.0%)
Motor Vehicle Collision	2635	2195	(83.3%)	1610	(61.1%)	97	(3.7%)	12	(0.5%)
Pedestrian/Bicyclist Struck	438	364	(83.1%)	284	(64.8%)	38	(8.7%)	1	(0.2%)
Other Bicyclist Accident	47	36	(76.6%)	12	(25.5%)	1	(2.1%)	1	(2.1%)
Sports Injury *	44	33	(75.0%)	10	(22.7%)	1	(2.3%)	1	(2.3%)
Other/Unknown	84	65	(77.4%)	42	(50.0%)	4	(4.8%)	0	(0.0%)
All Blunt	5286	4414	(83.5%)	2743	(51.9%)	224	(4.2%)	26	(0.5%)
Penetrating Trauma									
STAB	29	13	(44.8%)	9	(31.0%)	0	(0.0%)	0	(0.0%)
GSW	108	48	(44.4%)	30	(27.8%)	9	(8.3%)	3	(2.8%)
All Penetrating	137	61	(44.5%)	39	(28.5%)	9	(6.6%)	3	(2.2%)
Total	5423	4475	(82.5%)	2782	(51.3%)	233	(4.3%)	29	(0.5%)

TL = Thoracic or Lumber Spine. All percentages are based on tatal subject with same mechanism. Motor vehicle collisions include motorcycles and all tertian vehicles. Sports injuries excluded bicycle/motorized vehicles.

study criteria for an unstable thoracolumbar fracture. Study data was obtained from a single prehospital agency and trauma center. Due to selection bias, we surmise that patients transported to a trauma center were more likely to have serious injuries compared to those transported to a non-trauma center. This would lead to an underestimation of the number needed to treat in our region. An even smaller subset of subjects may have actually suffered harm due prehospital movement of their unstable thoracolumbar spine motion during the prehospital phase of their care. Therefore, the finding of 0.5% of subjects with unstable thoracolumbar injuries is likely an overestimate of the true population risk.

Falls from at least 20 feet constituted the greatest risk for both thoracolumbar fractures and unstable thoracolumbar injures. This is the cut off for a long fall used by the Centers for Disease Control trauma triage guidelines.[25] Providers should be aware of the risk of unstable thoracolumbar spine injury in this subgroup, but this does not necessarily necessitate the use of a long spine board in all patients with this mechanism of injury.

No subjects who fell from ground level had an unstable thoracolumbar injury. This included patients with mechanical falls, and those who collapsed from medical issues such as syncope, seizure or cardiac arrest. Eliminating thoracolumbar immobilization in this subgroup would have decreased long spine board use by 18%, without missing any unstable thoracolumbar fractures. Some other subgroups did not include unstable thoracolumbar fractures, but their sample sizes may have been insufficient to draw a definitive conclusion.

More than 80% of patients who were immobilized had at least one spine x-ray or CT ordered in the hospital. This may suggest that providers were prudently applying the principals of the selective spine immobilization. Selective spine immobilization protocols, like the one in this state have been shown to reduce prehospital spine immobilization among trauma patients by 40%.[26,27] It is equally possible that spine immobilization led to additional imaging. March described increased midline spine tenderness in as little as 40 minutes on a long spine board.[8] This study shows that over time, standard immobilization causes a false-positive exam for midline vertebral tenderness.[8] Emergency department providers were not blinded to long spine board use and may be influenced by the fact the patient was placed on a long spine board or by backboard induced pain when ordering imaging.[8,28] The growing liberal use of whole body imaging for major trauma may have also contributed to this finding.[29,30]

The number of patients receiving thoracolumbar spine imaging was 31% less than the number of patients receiving any spine imaging. This suggests that many patients received whole spine immobilization when only a cervical spine injury was suspected. Pre-

hospital whole spine immobilization protocols are often based on decision rules designed for in hospital cervical spine clearance. Long spine boards are not utilized for cervical spine motion restriction in the hospital, even for patients with diagnosed unstable cervical spine injures. Restricting cervical spine movement in patients with suspected cervical spine injures using a well-fitting cervical collar and a firm mattress would be rational approach to the care of these patients and would be consistent with the hospital care of patients with confirmed cervical spine fractures.[31]

When performed as traditionally taught, spine immobilization with a long spine board and straps can limit thoracolumbar movement.[32,33] However, Peery found that upon arrival at the hospital, most patients secured to a long spine board were secured incorrectly.[33] As is the case of cervical motion restriction, it is unknown what amount of movement is seen in patients or is clinically relevant. The harm from the additional spine motion introduced while positioning a patient on the long spine board must also be considered.[13,34] Furthermore, the use of a long spine board in prehospital care has been associated with higher mortality in penetrating trauma.[7,35–38] With this in mind, the ACEP recommended that "Backboards should not be used as a therapeutic intervention or as a precautionary measure."[16]

CONCLUSION

Hospital providers ordered images in most trauma patients immobilized and transported to a single trauma center. Only 0.5% of patients who received prehospital spine immobilization had an unstable thoracolumbar spine injury. A prospective study of patients randomized to spine immobilization with a long spine board vs. no immobilization, or cervical collar immobilization only, would further elucidate the risks and benefits of spine immobilization.

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