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Pre-Hospital Spinal Immobilization: Neurological Outcomes for Spinal Motion Restriction Versus Spinal Immobilization

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ABSTRACT

Introduction. New recommendations for emergency medical services spinal precautions limit long spinal board use to extrication purposes only and are to be removed immediately. Outcomes for spinal motion restriction against spinal immobilization were studied.

Methods. A retrospective chart review of trauma patients was conducted over a six-month period at a level I trauma center. Injury severity details and neurologic assessments were collected on 277 patients.

Results. Upon arrival, 25 (9.0%) patients had a spine board in place. Patients placed on spine boards were more likely to be moderately or severely injured [injury severity score (ISS) > 15: 36.0% vs. 9.9%, p = 0.001] and more likely to have neurological deficits documented by emergency medical services (EMS; 30.4% vs. 8.8%, p = 0.01) and the trauma team (29.2% vs. 10.9%, p = 0.02).

Conclusions. This study suggested that the long spine board was being used properly for more critically injured patients. Further research is needed to compare neurological outcomes using a larger sample size and more consistent documentation. ***Kans J Med 2022;15:119-122***

INTRODUCTION

Spinal column injuries can be catastrophic events if missed. To prevent such an occurrence, pre-hospital spine immobilization (SI) has been the gold-standard for patients with suspected spine injuries after trauma for decades until the National Association of Emergency Medical Services (EMS) Physicians and the American College of Surgeons Committee on Trauma published a change in protocol.[1,2] The rationale behind the practice of SI was to prevent motion of the spinal column to prevent injury to the spinal cord. Interestingly, with so much importance placed on total SI, only 0.5% of the reported one million blunt traumas each year in the U.S. resulted in spinal cord injury.[3]

Adequate spinal immobilization involves securely strapping a patient to a long spine board (LSB), thereby limiting thoracolumbar movement.[4] This is not without risk, as prolonged immobilization can lead to increased risk for pressure ulcers, shortness of breath, respiratory compromise, increased intracranial pressures, tissue breakdown, pain, and anxiety or combativeness.[4-7] Furthermore, these patients are subjected to unnecessary radiation and healthcare costs, because of needless LSB or cervical collar usage.[5,6,8,9] In a study by Tello et al.[4], additional imaging costs occurred when emergency departments (ED) initiated SI, even when EMS deemed it unnecessary. In their study examining 101 blunt force trauma patients that presented to the ED without cervical SI, none had true acute injuries, but 94 received CT scans and 9 received cervical spinal radiographs.

After recognizing these risks and costs, there was a change in SI protocol in 2013 by the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma (later endorsed by the American College of Emergency Physicians and many other national organizations), providing more autonomy to prehospital personnel.[2] It distinguished between the previous traditional method of SI and what now is called spinal motion restriction (SMR). According to this protocol statement, one should have judicious use of LSB during transport weighing risks against potential benefits; however, cervical collar use and maintenance of the spine in a neutral position were to be continued for patients who met criteria. Previously, selective SI protocols have been shown to decrease spine immobilization in trauma patients by 40%.[10,11] This new recommendation limits LSB use to extrication purposes only, with LSB to be removed immediately after, including patients with known spinal fractures or injuries. The Medical Society of Sedgwick County has been working to implement the protocol change for all trauma patients in the county. This study aimed to determine neurological outcomes for SMR and SI patients using LSB under the revised protocol guidelines. A comparison was made between LSB and SI patients to see if implementation of the revised protocol was being used correctly. It was hypothesized that the SI is being implemented correctly and that its implementation has not impacted patient outcomes negatively.

METHODS

Patients and Settings. The Institutional Review Board of Ascension Via Christi Hospitals Wichita, Inc. approved this study for implementation. A retrospective chart review was conducted of all trauma patients with a documented spinal injury, under the care of the multi-disciplinary trauma team at an American College of Surgeons Committee on Trauma (ACSCOT) verified level I trauma center between January 1, 2014 to August 31, 2014. The trauma registry was queried to obtain a list of trauma patients with documented spinal injuries within the specified time frame. The resulting list was filtered by age, EMS provider, and trauma activation level.

Neurologic Examination Protocol. The EMS conducted a brief neurologic examination in the field both before and after injury victim extraction. In the trauma bay, the trauma team conducted an in-depth examination of the patient upon arrival evaluating both sensory and motor function to all limbs.

Data Collection. Data collected included: patient demographics (i.e., age, gender, race); trauma activation level; past medical history; spinal injury details; if the patient was placed on an LSB; any significant neurological medical history (i.e., paraplegia, neuromuscular diseases, neurological injury, ligament injury, disc injury, Parkinson's); motor and sensory assessments conducted at pre-extrication, post-extrication, and in the trauma bay; injury severity score (ISS) on admission; Glasgow Coma Scale (GCS) score on admission; vital signs (i.e., blood pressure, heart rate, respiratory rate); blood alcohol level; intensive care unit (ICU) admission and length of stay; the use of mechanical ventilation and number of days on a ventilator; procedures performed [i.e., tracheostomy, gastrostomy or percutaneous endoscopic gastrostomy (PEG) placement, and nasogastric or Dobhoff tube placement]; any delays in diagnosis; do not resuscitate and/or code status; comfort care; hospital length of stay; disposition status (i.e., home, rehabilitation, acute care hospital, skilled nursing facility); and mortality.

Data Analysis. Continuous data were reported as the mean ± the standard deviation of the mean or median (interquartile range) when continuous data were not distributed normally. Frequencies were reported for categorical data. Continuous variables were compared using t-tests and categorical data were compared using chi-square analysis or the Fisher's exact tests when appropriate. McNemar's tests were used to compare the concordance of neurological assessments done by EMS and emergency department staff. All tests were two-tailed and a $p \leq 0.05$ was considered statistically significant. All statistical analyses were conducted using SPSS software, version 19.0 (IBM® Corp., Somers, New York).

RESULTS

Records from 330 trauma patients initially were included based upon the registry search. Of these, 53 were excluded as these patients did not have adequate documentation in the chart to include in the study, leaving 277 (83.9%) patients in the study. Upon arrival to the trauma bay, 25 patients (9.0%) had an LSB in place. Patients placed on an LSB were, on average, younger than those not placed on an LSB (35.2 ± 21.5 vs. 46.9 ± 22.9 years; p = 0.015). Patients placed on an LSB were comparable to those not on an LSB regarding gender (male: 68.0% vs. 65.1%, p = 0.770) and race (Caucasian: 84.0% vs. 85.7%; p = 0.768). Patients placed on an LSB were more likely to be moderately or severely injured (ISS > 15, 36.0% vs. 9.9%; p = 0.001) and tended to have a GCS score of eight or less (12.0% vs. 2.8%), but this was not statistically significant (p = 0.052; Table 1). As expected per protocol, many patients who presented on LSB tested positive for ethyl alcohol (ETOH; 43.5%, n = 10). Interestingly, 26.4% (n = 61) of patients without SI also had a positive ETOH finding. There was no difference in proportion of patients with spinal injury between the groups and no patient in either group suffered spinal paralysis.

Thirty-five patients (12.6%) had a documented pre-injury history of a neurologic deficit/diagnosis (Table 2). Patients that were placed on an LSB were more likely to have a neurological deficit documented pre-extrication; however, the documentation of pre-extrication neurological assessments was inconsistent in the EMS run sheets. An increase in neurologic and motor deficits pre-extrication to post-extrication were seen for both patients not on an LSB (3-fold, 7 patients to 22 patients) and for those on an LSB (almost 2-fold, 4 patients to 7 patients). However, an in-depth chart review was completed, which revealed poor, inconsistent documentation in pre-extrication to post-extrication evaluation and patients with peripheral nerve injury from fractures were documented as worsening nerve injury. No central neurologic progression of injury was identified in any patient. Patients placed on an LSB were more likely to have neurological post-extrication deficits documented by EMS (30.4% vs. 8.8%; p = 0.006) and the trauma team (29.2% vs. 10.9%; p = 0.018) compared to those not on LSB.

Table 1. Injury severity and characteristics for patients who arrived on a spine board or without spinal immobilization.

Parameter	Treatment Group		p Value
	No Spine Board N (%)	Spine Board N (%)	
Number of observations	252 (91.0%)	25 (9.0%)	---
Glasgow Coma Scale (GCS) score group			0.052
≤ 8	7 (2.8%)	3 (12.0%)	
> 8	244 (97.2%)	22 (88.0%)	
Injury Severity Score (ISS) group			0.001
≤ 15	227 (90.1%)	16 (64.0%)	
≥ 16	25 (9.9%)	9 (36.0%)	
Positive alcohol test	61/231 (26.4%)	10/23 (43.5%)	0.082
Spine injury	50/252 (19.8%)	5/24 (20.8%)	1.000
Spine paralysis	0 (0.0%)	0 (0.0%)	---

Table 2. Neurological deficits for patients who arrived on a spine board or without spinal immobilization.

Parameter	Overall N (%)	Treatment Group		p Value
		No Spine Board N (%)	Spine Board N (%)	
Significant history	35 (12.6%)	33 (13.1%)	2 (8.0%)	0.752
Pre-extrication deficit[1]	11 (4.0%)	7 (2.8%)	4 (16.0%)	0.011
Post-extrication deficit (any)	29 (10.7%)	22 (8.8%)	7 (30.4%)	0.006
Post-extrication motor	18 (6.5%)	11 (4.4%)	7 (29.2%)	< 0.001
Post-extrication sensory	22 (8.1%)	17 (6.8%)	5 (21.7%)	0.027
Trauma deficit (any)	34 (12.5%)	27 (10.9%)	7 (29.2%)	0.018
Trauma motor	27 (9.7%)	21 (8.5%)	6 (24.0%)	0.025
Trauma sensory	18 (6.6%)	14 (5.6%)	4 (16.7%)	0.062

[1]Based on text information on EMS run sheets; considered to have deficit if sensory or motor deficits were mentioned. For some patients, injuries were described with no mention of neurological assessment.

Neurological assessments within individual patients were similar at post-extrication and in the trauma bay for overall deficits and sensory deficits (p > 0.05; Table 3). Documented motor deficits by EMS were concordant with those documented by the trauma team for the LSB group (29.2% vs. 25.0%; p = 1.00). However, for patients not placed on a spine board, a greater number of patients were recorded as having motor deficits in the trauma bay when compared to their EMS assessments (8.5% vs. 4.5%; p = 0.01). A review of the injury details for those with discordant motor assessments revealed poor documentation and only peripheral nerve injury due to fractures, but no central cord injury progression.

Table 3. Concordance of post-extraction neurological assessments and assessments done in the trauma bay.

Parameter	Patients with Deficit by Treatment Group					
	No Spine Board			Spine Board		
	Post Extraction N (%)	Trauma Bay N (%)	p Value[1]	Post Extraction N (%)	Trauma Bay N (%)	p Value[1]
Motor deficit	11 (4.5%)	21 (8.5%)	0.01	7 (29.2%)	6 (25.0%)	1.00
Sensory deficit	16 (6.5%)	14 (5.7%)	0.59	5 (21.7%)	3 (13.0%)	0.50
Any deficit	21 (8.5%)	27 (11%)	0.20	7 (30.4%)	6 (26.1%)	1.00

[1]Based on McNemar's test of proportions in dependent groups.

Those presenting on an LSB were subjected to more invasive, non-spinal procedures during their hospital stay compared to those who were not presenting on an LSB (84% vs. 63.5%, Table 4). These were primarily nasogastric and Dobhoff tube placements. No patient in either group suffered a delay in diagnosis of injuries. Complications between these two groups were comparable and not statistically significant.

Table 4. Procedures and complications for patients who arrived on a spine board or without spinal immobilization.

Parameter	Overall N (%)	Treatment Group		p Value
		No Spine Board N (%)	Spine Board N (%)	
Number of observations	277 (100%)	252 (91.0%)	25 (9.0%)	---
Surgical procedures (excluding spine)	181 (65.3%)	160 (63.5%)	21 (84.0%)	0.040
Nasogastric or Dobhoff tube	11 (4.0%)	8 (3.2%)	3 (12.0%)	0.066
PEG tube	7 (2.5%)	6 (2.4%)	1 (4.0%)	0.488
Tracheostomy	3 (1.1%)	3 (1.2%)	0 (0.0%)	1.000
Gastrostomy tube	3 (1.1%)	2 (0.8%)	1 (4.0%)	0.248
Delayed diagnosis	0 (0.0%)	0 (0.0%)	0 (0.0%)	---
Complication[1]	19 (6.9%)	16 (6.4%)	3 (12.0%)	0.395

PEG = Percutaneous endoscopic gastrostomy.
[1]For complications, n = 276 for overall and n = 251 for patients not on the spine board.

As would be expected due to higher ISS and lower GCS scores, patients placed on an LSB were admitted more often to the ICU (12.0% vs. 1.6%), spent more time in the ICU (2.0 vs. 1.2 days), more often required mechanical ventilation (28.0% vs. 7.1%), and required greater time on mechanical ventilation (1.2 vs. 0.4 days; Table 5). Mortality also was greater for patients arriving on an LSB (16.0% vs. 2.4%; p = 0.008) as was the proportion of patients placed on comfort care (12.0% vs. 1.6%; p = 0.18).

DISCUSSION

Of the one million blunt traumas each year in the U.S., only 0.5% results in a spinal cord injury.[4] The rarity of spinal cord injury has brought into question the need for placing most trauma patients on LSB. Subsequently, revised protocols for EMS spinal precautions limit LSB use to extrication purposes only, or for those with known or suspected neurologic injury. Such protocols are followed easily and accurate for predicting need of SI.[4] Burton and colleagues[10] performed a study of 31,885 trauma patients using an EMS SI protocol for trauma patient spine assessment and selective patient immobilization. Of these patients, 154 were identified by hospital records as having acute spine fractures. They identified only one non-immobilized patient with an unstable spine fracture, but this patient suffered no long-term sequelae. In this single center, retrospective review, there were no patients found to meet criteria for SI that were not placed on LSB. This protocol application limited patients presenting on an LSB to only 9% of those studied, significantly lower than the reported 87% national average prior to the new SI guidelines.[10]

Table 5. Hospital utilization and discharge destination for patients who arrived on a spine board or without spinal immobilization.

Parameter	Overall N (%)	Treatment Group		p Value
		No Spine Board N (%)	Spine Board N (%)	
Number of observations	277 (100%)	252 (91.0%)	25 (9.0%)	---
Comfort care	7 (2.5%)	4 (1.6%)	3 (12.0%)	0.018
Intensive care unit admission	91 (32.9%)	77 (30.6%)	14 (56.0%)	0.010
Intensive care unit days	1.2 ± 3.5	1.2 ± 3.5	2.0 ± 2.9	0.003
Mechanical ventilation	25 (9.0%)	18 (7.1%)	7 (28.0%)	0.003
Ventilator days	0.5 ± 2.4	0.4 ± 2.4	1.2 ± 2.4	0.001
Hospital length of stay (days)	4.2 ± 7.2	4.1 ± 7.2	5.7 ± 6.8	0.083
Mortality	10 (3.6%)	6 (2.4%)	4 (16.0%)	0.008
Discharge destination[1]				1.000
Home or home with health care	181 (74.2%)	167 (74.2%)	14 (73.7%)	
Other facility or AMA[2]	63 (25.8%)	58 (25.8%)	5 (26.3%)	

[1]For discharge destination, only patients that survived hospitalization were included: N=244 for overall, N=225 for patients not on the spine board, and N=19 for patients on a spine board.
[2]AMA: against medical advice.

The current study's findings suggested an acceptance of the revised guidelines potentially could lower the cost of working up trauma patients. As previous studies have suggested, patients on an LSB for periods of time report increased pain, tissue breakdown, and respiratory compromise, which led to "false-positive exams for midline vertebral tenderness",[9] and therefore, increased imaging and cost of care.[4,8,12] Clemency et al.[12] in 2018 observed that patient charts before and after the implementation of the new SMR protocol demonstrated the decrease in backboard utilization was associated with a decrease in spine imaging in the ED.

Prehospital handling of trauma patients has been the primary focus of a possible cause of secondary cord injury.[3] In the presented study, for patients not placed on a spine board, a greater number of patients were recorded as having motor deficits in the trauma bay when compared to their EMS assessments. Upon further review of charts, however, consistent documentation on-site by EMS pre- and post-extrication and trauma team assessment was lacking. The neurologic disparities were due to fractures or other peripheral injuries, not to spinal column injuries resulting in neurologic sequelae. No patients in this study had paralysis from a spinal cord injury. As 0.5% of all trauma patients have spinal injury, a much larger study involving multiple trauma centers is necessary to assess adequately how SI affects the number of spinal column or spinal cord injuries.

Several studies showed a low rate of prehospital personnel failing to provide SI where it was needed.[4,10,13,14] For example, Paterek et al.[13] examined 18 months of charts from an EMS service dispatched as "motor vehicle crash" or "fall". Their results revealed 0.3% (4/1,075) to have been under-immobilized. Furthermore, all four had altered mentation or intoxication, and presented no cervical spine injuries. Additionally, there was evidence suggesting EMS personnel were just as accurate and in agreeance with the spinal immobilization protocols as ER physicians. Browne et el.[15] showed EMS and ED providers were similar in their assessments of important predictive factors of cervical spine injuries in pediatric blunt trauma patients. The current study also demonstrated EMS and ED agreement, seeing that no patients were placed in SI after arriving as a trauma. Given the low rate of prehospital missed cervical spinal injury cases and the current study's findings, it was recommended that emergency services in the field were immobilizing patients properly as necessary per revised EMS protocol for SI.

The trauma services community can take much from this study. It suggested patients were arriving to trauma centers adequately treated in the field and appropriate patients were immobilized based on protocol. However, it has become apparent through the presented study that consistent documentation of patient injuries in the field pre- and post-extrication versus in-hospital trauma care providers needed to be improved. A more consistent, standard approach to documenting between the two groups may provide better patient care and guide future research efforts.

Limitations. This study had several limitations. As a retrospective review from one trauma center during a six month period, the findings were limited to the validity and reliability inherent in retrospective reviews. Of the approximately one million trauma patients in the U.S. seen annually, this study included only 277. Thus, the findings may not generalize to every trauma system and patient population. A larger, multicenter review spanning several years after these new EMS guidelines were implemented is needed to compare neurologic outcomes in spinal column injury patients who were placed on an LSB for immobilization versus those treated without LSB immobilization. Furthermore, 26.4% of patients arriving to the trauma bay without an LSB were positive for ETOH. This finding can be explained as EMS providers were unable to detect ETOH on patients due to either poor screening or more likely due to the patient having a small concentration of ETOH which was clinically undetectable. All trauma patients had blood ETOH screening upon arrival to the trauma bay, regardless of suspicion of ETOH presence. The ETOH positive category labels all patients who have a blood ETOH level > 0, many patients of which cannot be identified clinically as having previous ETOH intake.

CONCLUSIONS

The LSB was being used properly for more critically injured patients. Further research is needed to compare neurological outcomes for spinal restriction versus immobilization using a larger sample size and more consistent documentation of pre-extrication (EMS) examination.

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