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 (90.0%) 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 spinal injuries 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.5,6,9 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%.8,9 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

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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 ≤ 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%) 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 = 0.770) 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 = 0.770).

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

| Parameter                      | Overall | Treatment Group |
|-------------------------------|---------|-----------------|
|                               | N (%)   | No Spine Board | Spine Board |
| Number of observations        | 277 (83.9) | 252 (91.0%) | 25 (9.0%)  |
| Glasgow Coma Scale (GCS) score group |         | 0.052          |
| ≤ 8                           | 22 (7.9) | 7 (2.8%) | 3 (12.0%)  |
| ≥ 8                           | 255 (92.1) | 244 (97.2%) | 22 (88.0%) |
| Injury Severity Score (ISS) group |         | 0.001          |
| ≤ 15                          | 227 (82.7) | 16 (64.0%) | 16 (64.0%) |
| ≥ 16                          | 50 (17.3) | 25 (99.0%) | 9 (36.0%)  |
| Positive alcohol test         | 61/231 (26.4%) | 10/23 (43.5%) | 0.082      |
| Spine injury                  | 50/232 (21.8%) | 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 | Treatment Group |
|-------------------------------|---------|-----------------|
|                               | N (%)   | No Spine Board | Spine Board |
| Significant history           | 35 (12.6%) | 33 (13.1%) | 2 (8.0%)  | 0.752          |
| Pre-extrication deficit1      | 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 |

1Based 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 | Overall | No Spine Board | Spine Board | P Value
| --- | --- | --- | --- | --- |
| | Post Extraction N (%) | Trauma Bay N (%) | P | Post Extraction N (%) | Trauma Bay N (%) | P |
| Motor deficit | 11 (4.5%) | 21 (8.5%) | 0.01 | 7 (29.2%) | 6 (25%) | 1.00 |
| Sensory deficit | 16 (6.5%) | 14 (5.7%) | 0.59 | 5 (21.7%) | 3 (13%) | 0.50 |
| Any deficit | 21 (8.5%) | 27 (11%) | 0.20 | 7 (30.4%) | 6 (26%) | 1.00 |

1Based on McNemar’s test of proportions in dependent groups.

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

| Parameter | Overall N (%) | Treatment Group N (%) | P Value
| --- | --- | --- | --- |
| | No Spine Board | Spine Board |
| Number of observations | 277 (100%) | 252 (91%) | 25 (9.0%) | --- |
| Surgical procedures (excluding spine) | 181 (65.3%) | 160 (63.5%) | 21 (84%) | 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%) | --- |
| Complication1 | 19 (6.9%) | 16 (6.4%) | 3 (12.0%) | 0.395 |

PEG = Percutaneous endoscopic gastrostomy.

1For 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 was also 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 vertebral tenderness,9 and therefore, increased imaging and cost of care.4,12 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.2 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.1,3,9,10,11,13,14 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 agreement with the spinal immobilization protocols as ER physicians. Browne et al.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 neurologic outcomes for spinal restriction versus immobilization using a larger sample size and more consistent documentation of pre-extrication (EMS) examination.

REFERENCES

1. Wesley K, Wesley K. Spinal immobilization. Can we throw away our backboards yet? JEMS 2013; 38(1):30-31. PMID: 24475615.
2. Fischer PE, Perina DG, Delbridge TR, et al. Spinal motion restriction in the trauma patient - A joint position statement. Prehosp Emerg Care 2018; 22(6):659-661. PMID: 30091939.
3. Clemency BM, Bart JA, Malhotra A, Klun T, Campanella V, Lindstrom HA. Patients immobilized with a long spine board rarely have unstable thoracolumbar injuries. Prehosp Emerg Care 2016; 20(2):266-272. PMID: 27002350.
4. Tello RR, Braude D, Fullerton L, Froman P. Outcome of trauma patients immobilized by emergency department staff, but not by emergency medical services providers: A quality assurance initiative. Prehosp Emerg Care 2014; 18(4):544-549. PMID: 24878221.
5. Feld FX. Removal of the long spine board from clinical practice: A historical perspective. J Athl Train 2018; 53(8):752-755. PMID: 30229981.
6. White CC 4th, Domicer IM, Millin MG, Standards and Clinical Practice Committee, National Association of EMS Physicians. Spinal immobilization and the use of the long backboard - Resource document to the position statement of the National Association of EMS Physicians and the American College of Surgeons Committee on Trauma. Prehosp Emerg Care 2014; 18(2):306-314. PMID: 24559236.
7. Oosterwold JT, Sagel DC, van Grunsven PM, Holla M, de Man-van Ginkel J, Berben S. The characteristics and pre-hospital management of blunt trauma patients with suspected spinal column injuries: A retrospective observational study. Eur J Trauma Emerg Surg 2017; 43(3):313-324. PMID: 27277072.
8. Leonard JC, Mao J, Jaffe DM. Potential adverse effects of spinal immobilization in children. Prehosp Emerg Care 2012; 16(4):513-518. PMID: 22712615.
9. March JA, Ausband SC, Browne LH. Changes in physical examination caused by use of spinal immobilization. Prehosp Emerg Care 2002; 6(4):421-424. PMID: 11789648.
10. Burton JH, Dunn MG, Harmon NR, Hermanson TA, Bradshaw JR. A statewide, prehospital emergency medical service selective patient spine immobilization protocol. J Trauma 2006; 61(1):161-167. PMID: 16832265.
11. Domicer RM, Frederiksen SM, Welch K. Prospective performance assessment of an out-of-hospital protocol for selective spine immobilization using clinical spine clearance criteria. Ann Emerg Med 2005; 46(2):123-131. PMID: 16046941.
12. Clemency BM, Tanski CT, Gibson Chambers J, et al. Compulsory use of the backboard is associated with increased frequency of thoracolumbar imaging. Prehosp Emerg Care 2018; 22(4):506-510. PMID: 29447489.
13. Paterek E, Isenberg DL, Schiffer H. Characteristics of trauma patients with potential cervical spine injuries underimmobilized by prehospital providers. Spine 2015; 40(24):1898-1902. PMID: 26352743.
14. Gonzalez RP, Cummings GR, Baker JA, et al. Prehospital clinical clearance of the cervical spine: A prospective study. Am Surg 2013; 79(11):1217-1217. PMID: 24162600.
15. Browne LR, Schwartz H, Ahmad FA, et al. Interobserver agreement in pediatric cervical spine injury assessment between prehospital and emergency department providers. Acad Emerg Med 2017; 24(12):1501-1510. PMID: 28921731.

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