Prehospital Clinical Findings Associated with Spinal Injury

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Abstract

Objective. The objective of this study was to identify clinical findings that are associated with spinal fracture and/or spinal cord injuries in prehospital trauma patients. **Methods.** A retrospective chart review was performed at three tertiary referral centers in Southeastern Michigan. All charts of patients with spinal fractures or spinal cord injuries during 1992 and 1993 were reviewed. Patients with available prehospital records were included in the study analysis. Prehospital data points included documentation of head injury; altered mental status; neurologic deficit; evidence of intoxication; cervical, thoracic, and lumbar pain or tenderness; nonspecified back pain or tenderness; and a narrative for all other documented injuries. Hospital data collected included type and level of spinal injury and age and sex of the patient. **Results.** Of 867 injury patients identified, 536 were excluded, leaving 346 analyzable fractures in 331 patients. The 346 spinal fractures/spinal cord injuries were distributed as: 100 (29%) cervical, 83 (24%) thoracic, 128 (37%) lumbar, and 35 (10%) sacral. Prehospital documentation of altered mental status, neurologic deficit, evidence of intoxication, spinal pain, or suspected extremity fracture was found for every patient with a cervical injury, 82/83 patients with thoracic injuries (99%), and 124/128 patients with lumbar injuries (97%). All five patients who were not documented as having one of the predictors had stable injuries. **Conclusion.** Prehospital clinical findings of altered mental status, neurologic deficit, evidence of intoxication, spinal pain, and suspected extremity fracture were documented for all patients with significant spinal injuries in this series. These findings may be useful to identify patients who require prehospital spinal immobilization. **Key words:** trauma; spinal fracture; spinal cord injury; spinal immobilization; predictors.

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Spinal immobilization of trauma patients is one of the most frequently performed prehospital procedures. The decision to perform immobilization has traditionally been based largely on mechanism of injury. Many EMS systems use a broad mechanistic interpretation, immobilizing any patient with even a minor mechanism that might lead to spinal injury. In the Washtenaw/Livingston County Medical Control Authority in Michigan, 80% of all trauma patients are immobilized prior to transport.[1]

The use of criteria identifying which emergency department (ED) patients do not require spine radiographs, thereby clearing the spine clinically, is becoming accepted. This is largely based on ED studies of radiographically examined trauma patients.[2–15] In some areas, prehospital providers are using clinical criteria to clear the spine of the trauma patient.[16] The two questions that have not been studied in the prehospital setting are whether the commonly used ED clinical criteria are the correct criteria for field use and whether prehospital personnel can apply or be trained to apply these criteria. The objective of this study was to identify clinical findings that are associated with spinal fracture and/or spinal cord injuries in prehospital trauma patients. Absence of these findings could be used as criteria to identify prehospital trauma patients who do not need spinal immobilization.

Methods

Study Design

A retrospective hospital and prehospital medical record review was performed to assess the frequencies of documentation of various clinical findings in patients with identified spinal fracture or spinal cord injury.

Population and Setting

All patients had been treated at three tertiary referral centers in Southeastern Michigan. The study centers included St. Joseph Mercy Hospital in Ann Arbor, the University of Michigan Medical Center in Ann Arbor, and William Beaumont Hospital in Royal Oak. Patients of all ages were included in the study. Patients who had sustained spinal fractures or spinal cord injuries and had been brought to one of the study hospitals by ambulance were included. Patients transferred to one of the study centers with initial prehospital records included in the transfer documentation were also included. Patients who had not been brought to the hospital by ambulance, did not have available prehospital records, had remote injuries, or had pathologic injuries were not eligible for inclusion in the study. A remote injury was defined as an injury that had been treated by a physician prior to the EMS patient evaluation.

The levels of licensure of the ambulance-service providers were not tabulated. ALS services had treated

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TABLE 1. Most Common Prehospital Clinical Findings in Patients with Cervical, Thoracic, or Lumbar Injuries*

Prehospital Finding	No. of Patients	Findings by Fracture Level		
		Cervical	Thoracic	Lumbar
Lumbar pain	120	5	37	80
Head injury	119	59	24	36
Altered mental status	102	50	26	26
Cervical pain	51	35	11	7
Neurologic deficit	48	24	14	10
Back pain	44	9	12	23
Intoxication	40	19	6	15
Thoracic pain	35	10	15	10
Spinal tenderness	26	2	8	17

*Rows may not equal numbers of patients due to multiple levels of injury in some patients.

TABLE 2. Numbers of Patients with Isolated Clinical Findings in Spinal Injury

Prehospital Finding	Present as *Only* Clinical Finding
Lumbar pain	66
Altered mental status	46
Neurologic deficit	14
Suspected extremity fracture	14
Cervical pain	11
Thoracic pain	10
Back pain	10
Head injury	2
Intoxication	2
Spinal tenderness	0

the majority of patients transported directly to the participating institutions. The study was approved by the institutional review boards of the participating centers.

Experimental Protocol

Medical record reviews were performed to evaluate all patients with the diagnosis of spinal fracture or spinal cord injury treated in 1992 and 1993 at three area tertiary referral centers. ICD-9 codes 805.0 through 806.9 and 952.0 through 953.0 were used to identify patients who had had spinal fractures or spinal cord injuries. All available medical records were reviewed to determine patient eligibility. When the EMS records were not included in the medical records and the prehospital ambulance services could be identified, available records were obtained from the transporting ambulance services.

Measurements

Hospital data collected included type and level of spinal injury and age and sex of the patient. Prehospital information was taken only from the transport-run records. The data points were abstracted from the chief complaint and narrative sections of the run records. Prehospital data points included documentation of head injury, altered mental status, neurologic deficit, evidence of intoxication, and cervical, thoracic, and lumbar pain or tenderness. Separate data points for nonspecified level of back pain and nonspecified back tenderness were also recorded. All other injuries documented on the prehospital record but not captured by the above data points were recorded as narratives.

The data points spine pain or tenderness, neurologic deficit, altered mental status, evidence of intoxication, and distracting painful injury were selected using published ED cervical spine clinical clearance criteria.[2,3,6,7] The additional data point, head injury, was felt by the investigators to be a potentially frequent finding in spinal injury and was included in the data collection. All other documented injuries were recorded to determine which would be considered distracting painful injuries when no other clinical finding associated with spinal injury was present.

Head injury was considered present if any type of injury to the head, even minor injury without loss of consciousness or altered mental status, was documented. Patients with the specific documentation "AO × 3," signifying alert and oriented times three, were considered to have normal mental status. Any patient who was documented with the specific term "AO × 2" or less, or who was documented as dazed, confused, or asking repetitive questions, was considered to have altered mental status. Neurologic deficit was defined as any loss of motor or sensory function attributable to a potential spinal cord injury. Evidence of intoxication was considered to be present if there was a documented indication of drug or alcohol use, either by odor, patient history, or physical evidence of alcohol consumption. Cervical pain was considered positive if any mention of cervical or neck pain was indicated. Thoracic pain was considered positive if thoracic or upper back pain was indicated. Lumbar pain was positive if lumbar or lower back pain was indicated. Positive tenderness was defined as documentation of tenderness or pain with palpation. Findings were coded as present, absent, unknown, or undocumented.

Data Analysis

The cumulative frequency of each clinical finding was determined. Those individual clinical findings that were present only in association with other clinical findings were identified. Each case in which the only clinical finding present had been a potentially distracting painful injury was examined individually to determine what type of painful injury had been present. The medical management of cases in which no significant prehospital clinical findings were documented was examined. Injuries were grouped by region as affecting the cervical, thoracic, or lumbar spine. Fracture level

as classified by the highest level of spinal injury. Multiple levels of injury were considered present when there was one or more normal vertebra between injuries. Isolated sacral fractures were not included in the analysis of clinical findings. Average ages for males and females were compared using Student's t-test for equality of means.

RESULTS

A total of 867 spine fractures or cord injuries were identified from the medical record registry review. Forty-six charts were unavailable, leaving 821 charts reviewed. Of the charts reviewed, 60% were not eligible for inclusion in the study, including those of: 129 patients transported to the hospital by private car (16%); 193 (24%) without obtainable prehospital records, the majority of these being transferred patients without prehospital records included in the transfer documentation; 103 (13%) with remote injuries; 44 (5%) with pathologic injuries; and 21 (3%) who were not eligible for other reasons. There were 331 eligible cases with complete hospital and prehospital records (40%).

The 331 patients had had a total of 346 spinal injuries: 100 cervical, 83 thoracic, 128 lumbar, and 35 sacral. There were 12 cases with spinal cord injury without fracture, all were cervical. Fifteen of the patients (4.5%) had had injuries in multiple regions. There were 166 male patients and 162 female patients in this series. The average age for males was 37.5 years and that for females was 53.8 years ($p < 0.005$). The age distribution for females had a bimodal distribution, with peaks at 25 and 85 years. The age distribution for males peaked at 25 years and trailed gradually without a similar higher age peak.

Lumbar pain, head injury, and altered mental status were the most common findings documented on the prehospital records (Table 1). No spinal fracture patient was identified with spinal tenderness as the sole clinical finding (Table 2). Similarly, head injury and intoxication were isolated findings in only two cases each. No significant spinal injury was identified by the presence of head injury alone, even considering the broad definition of head injury used for this study. Fourteen patients had a distracting painful injury as the only indicator. In each case, a suspected extremity fracture proximal to the hand or foot was documented on the prehospital record and later confirmed in the ED.

All 100 of the 100 patients who had sustained cervical injuries (100%) had either altered mental status, neurologic deficit, intoxication, spinal pain, or suspected extremity fracture. Eighty-two of the 83 with thoracic injuries (99%) had at least one of the same five findings. One hundred twenty-four of the 128 with lumbar injuries, 124 (97%) also had one of the same five findings. The five patients having none of these five clinical findings documented had four lumbar and one thoracic compression fractures. All of these were stable injuries and were treated primarily with pain management. All five had back pain documented on emergency department records.

TABLE 3. Spinal Regions of Pain Documented for Each Injury Region

	Spinal Region of Pain		
	Cervical	Thoracic	Lumbar
Injury region			
Cervical	35	5	3
Thoracic	7	15	31
Lumbar	5	4	80

Although a complaint of spinal pain was frequently present, often the region of pain did not correlate with the area of injury. The level of pain described in the prehospital record was not in the area of injury for eight of 44 cervical injuries (18%); 38 of 60 thoracic (63%); and nine of 105 lumbar (9%) injuries with spinal pain documented (Table 3). Patients with multiple levels of pain including the area of injury are not listed in Table 3 as having pain outside the level of injury. Also, patients with nonspecified back pain only are not included. Findings of pain were documented more often than tenderness, with pain documented for 206 patients (62%) and tenderness for only 26 (8%). Only two of the 26 patients documented as having tenderness did not also have pain documented. Both of these patients had other clinical findings present. No patient had tenderness as the only finding.

DISCUSSION

Spinal immobilization is known to have potential complications. Discomfort related to spinal immobilization has been well documented.[17–20] The head and low back pain produced might alter the emergency clinical presentation and management. There are also potential complications due to respiratory compromise and risk of aspiration associated with supine immobilization.[21] Spinal immobilization on a rigid board has been associated with the development of pressure ulcers.[20] Potential lifting injuries of prehospital personnel and equipment costs must also be considered.

The rate of deterioration of spinal fractures due to improper prehospital immobilization of trauma patients, resulting in secondary cord injury, is quoted at between 3% and 25%.[22] However, there is no good documentation to support these statistics. There has also been a supposition that the decrease in spinal cord injuries over the last 20 years has been due to prehospital spinal immobilization.[23] However, this claim is made without controlling for improved auto safety engineering.

In our study, we found that 129 (16%) of the initial 867 patients whose spine injuries were reviewed had been brought to the ED by private vehicle. With the common emphasis placed on prehospital spinal immobilization to prevent cord injury, it is interesting to see the number of patients who presented on their own without spinal immobilization. These injuries were not examined separately to determine their stability.

Clinical spine clearance in the ED is becoming more established. Hoffman et al. identified midline neck tenderness, evidence of intoxication, altered level of alertness, and severely painful injury elsewhere as 100% sensitive and 37% specific screening criteria for injuries of the cervical spine in x-rayed trauma patients.[2] In a review of thoracic and lumbar spine x-rayed trauma patients, Samuels and Kerstein found that all patients with fractures had clinical findings in the ED.[24] In a study of clinical documentation in the prehospital setting, Pennardt and Zehner found that most prehospital providers routinely assessed the findings used to clear the spine clinically in the ED.[25] Our study analysis required that neurologic deficit be added to the Hoffman criteria to capture the most injuries. We also found a high frequency of documentation of pain in the prehospital setting, instead of tenderness as Hoffman found in the ED. This difference may have arisen from variations in the forms of documentation used and the clinical practices of prehospital personnel. Prehospital personnel are not trained to routinely examine the spines of trauma patients by palpation. They are trained to immobilize the spine based on mechanism of injury, not on clinical findings. Also, tenderness may be documented as pain in the prehospital record as a semantic error. If these criteria become proven through prospective validation, there may be a need to train prehospital personnel to perform an adequate spinal examination, including attention to the presence of tenderness to palpation.

There were two patients each with documentation of an injury to the head or intoxication as the only clinical finding present in spinal fracture. We used a broad definition to determine the presence of a head injury, making it one of the most common clinical findings. Both patients in whom head injury was the only finding had stable lumbar compression fractures. Considering the high frequency of head injuries and the absence of significant associated fractures, we felt justified in excluding head injury as an important prehospital clinical finding in spinal injury. Of the two patients for whom intoxication was the only finding, one had a lumbar injury and the other had an unstable cervical injury, which necessitated inclusion of intoxication in the group of important clinical findings in order to capture all significant spinal injuries.

In some areas of the country, clinical findings are being used to determine the need for spinal immobilization.[16] These practices are being initiated without systematic evaluation of the potential factors that might confound completion of a reliable prehospital spinal assessment. Time proximity of assessment to injury, the variable skills of prehospital providers, and potential scene-associated distractions make a prehospital spinal assessment quite different from an ED assessment. Without prospective study, the validity and safety of prehospital clearance schemes cannot be extrapolated from ED studies.

LIMITATIONS

The present study was retrospective. Although prehospital personnel know the components of an appropriate spinal exam, they are trained to immobilize based on mechanism of injury and may not routinely examine the spine for clearance criteria. This could be reflected in part by the limited documentation of spinal tenderness. Even with this limitation, in this series there was a high degree of documentation of clinical findings that are recognized in the ED as being indicators of potential spinal injury.

Another limitation is the high number of fractures in patients without prehospital records, which reduced the number of fractures available for analysis. The majority of these patients were either patients who had not been transported to the hospital by ambulance or who had been transferred from hospitals other than the participating hospitals without prehospital records in the transfer documentation.

Information from a variety of prehospital services was used and included multiple levels of care by prehospital transporting providers, the majority being ALS services. Non-transporting first-responder information was not obtained, and in many cases the patients had been immobilized prior to arrival of the transporting unit.

The mechanisms of injury were not examined, other than to determine which injuries had been acute. Although a significant mechanism of injury will increase the likelihood of spinal injury, once present, the injury should have clinical findings that are independent of the mechanism. ED studies of injuries of the cervical spine do not separate patients by mechanism of injury.[2–15] An additional limitation is that the characteristics of what defined a distracting painful injury were not defined prior to the chart review, but were determined by the characteristics of the injuries that served as the sole prehospital findings in several patients.

CONCLUSION

On the prehospital record, at least one of the five findings of altered mental status, neurologic deficit, spinal pain, intoxication, and suspected extremity fracture is documented for every patient with a cervical injury and nearly all patients with thoracic or lumbar spine injuries. The absence of these clinical findings might be useful to select

prehospital trauma patients who do not need spinal immobilization. Further prospective validation of this criteion is essential before it can be recommended for use in the out-of-hospital management of trauma victims.

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