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CERVICAL SPINE INJURY: ANALYSIS AND COMPARISON OF PATIENTS BY MODE OF TRANSPORTATION

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Abstract

Background—Cervical spine injury (CSI) studies have identified different factors contributing to CSI, but none compares the incidence and pattern of injury of patients arriving at the Emergency Department (ED) by private vehicle (PV).

Objective—We compared the characteristics and injury patterns in CSI patients who were transported to the ED via Emergency Medical Services (EMS) versus PV.

Methods—We conducted a three-hospital retrospective review of patients with CSI from January 1, 2000 to December 31, 2007. We excluded transfers and followup visits. Using a standardized data collection form, we reviewed demographics, mode of transport, mechanism of injury, imaging results, injury type and level, and neurologic deficits. Means and proportions were compared using *t*-tests and chi-squared as appropriate.

Results—Of 1174 charts identified, 718 met all study criteria; 671 arrived by EMS and 47 by PV. There was no difference between groups in age or gender. Ground-level fall was more likely in PV patients (32%, 95% confidence interval [CI] 20–46% vs. 6%, 95% CI 4–9%), whereas motor vehicle collision was less likely (32%, 95% CI 20–46% vs. 67%, 95% CI 63–70%). PV patients more often sustained a stable injury (66%, 95% CI 52–78% vs. 40%, 95% CI 36–44%), and were more often triaged to a lower-acuity area (25%, 95% CI 15–40% vs. 4%, 95% CI 3–6%). The incidence of neurologic deficit was similar (32%, 95% CI 20–46% vs. 24%, 95% CI 21–28%), though more PV patients had spinal cord injury without radiographic abnormality (21%, 95% CI 12–35% vs. 5%, 95% CI 4–7%).

Conclusion—A small proportion of patients with CSI present to the ED by PV. Although most had stable injuries, a surprising number had unstable injuries with neurologic deficits, and were triaged to lower-acuity areas in the ED.

Keywords

cervical spine injury; mode of transportation; private vehicle; emergency medical services; SCIWORA

INTRODUCTION

Patients who suffer a cervical spine injury (CSI) present to the Emergency Department (ED) in a variety of ways, ranging from complete quadriplegia to neurologically intact (1,2). The majority of CSI patients are transported to the ED in full spinal immobilization by Emergency Medical Services (EMS) providers, though many systems use selective immobilization protocols in the prehospital setting (3–6). Trauma patients who are transported to the ED in full spinal immobilization are evaluated for potential CSI and often undergo imaging studies (7).

However, some trauma patients who sustain CSI are not transported to the ED by EMS, but instead walk in, or are brought by friends and family. CSI epidemiology studies have identified at-risk groups based on age, gender, race, and most common mechanisms of injury (8,9). To our knowledge, no previous studies have focused specifically on the incidence and pattern of injury of patients arriving at an ED by private vehicle (PV).

PV-transported patients might have different demographic characteristics, injury patterns, and subsequent lower triage acuity scores than those who arrive via ambulance. Because these patients do not arrive in full immobilization, they might be falsely assumed to be uninjured and consequently receive less urgent and less intensive ED management. The rapid identification and proper spinal immobilization of patients with traumatic CSI who present to triage by PV may prevent significant patient morbidity.

Our objective was to compare the characteristics and injury patterns of trauma patients with CSI who arrive via PV to those transported by EMS.

METHODS

We conducted a multicenter, retrospective, structured chart review adhering to the recommended methodology in the planning, execution, and completion of the study (10). This study was approved by the Community Medical Centers' Institutional Review Board.

The study group included all patients who presented at one of three hospitals in central California and were diagnosed with CSI between January 1, 2000 and December 31, 2007. The surrounding metropolitan area has a population of approximately 1.5 million, with a mix of urban, suburban, and rural communities and diverse ethnicities. The EMS system serves a four-county area with an annual transport census of approximately 175,000, of which 27% have trauma complaints. The three study hospitals were all part of the Community Medical Center system, sharing a common electronic medical record. One of the study hospitals represented the only Level I trauma and burn center serving the entire region. Triage was staffed by registered nurses in all three facilities, with physician consultation when requested. Different ED provider groups staff each institution. Providers included attending physicians, most of whom were board-certified in Emergency Medicine (EM), EM residents, and physician assistants.

We defined CSI using the International Classification of Disease (ICD)-9 and ICD-10 codes for the following injuries: cervical spine fracture, cervical spine subluxation or dislocation, spinal cord injury, central cord syndrome, and spinal cord injury without radiologic abnormality (SCIWORA) syndrome. We reviewed all medical records matching the ICD-9 and ICD-10 codes in both electronic and paper forms to collect the necessary study information. We excluded patients with any of the following criteria: transfer from an outside facility, injury previously identified, and injury not related to cervical spine or spinal cord injury.

Investigators and research assistants were trained to use a standardized data collection form to review medical records. We defined cervical spine stability a priori. We classified a CSI as unstable if the neurosurgeon determined that the injury required fixation, either by external fixator or operative repair. The following data points were recorded: medical record number, age, gender, mode of transport to ED, mechanism of injury, evidence of intoxication, ED disposition, need for operative repair, cervical spine stability, and evidence of neurologic deficit. Neurologic deficit was defined as any new motor or sensory deficit documented by the ED provider, trauma team, or neurosurgeon, ascribed to a CSI. SCIWORA was defined as a documented neurologic deficit (for example, central cord syndrome) and no injury noted on plain films or CT scan (many patients had abnormal spinal cord findings on magnetic resonance imaging).

This information was obtained by reviewing ED visit records, final attending radiology reports (a single radiology group provided the final read for all three study institutions, and the group consists of a mixture of general radiologists and a neuroradiologist), consultation service notes (Trauma, Orthopedics, and Neurosurgery), and final discharge summaries. If conflicting data were found through the chart review process, the final discharge summary was used as the ultimate determinant of study inclusion. We entered the data into an electronic database (Microsoft Excel 2007; Microsoft Corporation, Redmond, WA) and removed all patient identifiers. We subsequently excluded patients for whom we could not determine the mode of transport to the ED.

We estimated a necessary total sample size of 700 patients based on previous work (10). This sample size would have yielded a power of 82% for detecting an absolute difference of 5% in the percentage of patients with a CSI, with the following assumptions: percentage of EMS-transported patients with cord injury = 8%, percentage of PV arrival with cord injury = 3%, and $\alpha = 0.05$. We compared group means using the Student's *t*-test and proportions using chi-squared testing. We calculated descriptive statistics and 95% confidence intervals using online statistical programs (www.graphpad.com/quickcalcs).

RESULTS

We identified 1174 records that met the aforementioned ICD-9 and ICD-10 codes. Of these, 448 were excluded based upon the exclusion criteria, leaving 726 patients as our study population. Eight additional cases were excluded due to inability to determine mode of transport to the ED. EMS transported 671 (93%) patients, and 47 (7%) arrived by PV.

The groups were similar demographically (Table 1), with no significant differences in age or gender. The distribution of CSI location was similar between the two groups, with the C2 region being the most common site of injury in both groups (Figure 1). Ground-level fall was more likely in PV patients, and motor vehicle collision was less likely (Table 2). PV patients were more likely to sustain a stable injury, and were more often triaged to a low-acuity area in the ED. The incidence of neurologic deficit was similar between groups, though more PV patients had spinal cord injury without radiographic abnormality.

DISCUSSION

To our knowledge, this is the first study to investigate differences between ED patients with traumatic CSI that are transported by EMS or PV. As anticipated, those transported by EMS were more often involved in a motor vehicle collision and more likely to have an unstable CSI, whereas those arriving by PV more often sustained a ground-level fall. This seems intuitive because EMS likely responded to most major collisions with injuries. However, a surprising number of PV patients had unstable injuries and neurologic deficits.

Mode of arrival does have an effect on triage, as expected. Over 25% of PV patients were initially triaged to a low-acuity area, compared to only 4% of EMS transports. Fortunately, the large majority of patients with an unstable injury were triaged to a higher-acuity area (93%). Unfortunately, four of the 24 unstable injuries triaged to a low-acuity area arrived by PV, which represents 9% of all PV patients with CSI. Triage staff and ED providers should not assume that arrival by PV excludes a significant CSI. These patients must also be carefully screened, and liberal use of cervical collars in patients with midline tenderness or concerning signs and symptoms is recommended. Furthermore, triage personnel should be empowered to appropriately triage trauma patients with a neurologic deficit to higher-acuity areas where strict spinal precautions are maintained, regardless of mode of arrival. Surprisingly, we found no difference between the two groups with regard to the presence of a neurologic deficit, even though the PV group was found to have a higher rate of stable CSI. This should serve as a reminder to ED providers to maintain a high vigilance for CSI, and to take similar precautions once the PV patient arrives in the ED. However, we did note that the patients with a neurologic deficit who arrived by PV more often had sensory-only lesions, and two-thirds with a deficit had SCIWORA. Although it is not surprising that PV patients had less devastating deficits than their EMS counterparts, it is unclear why SCIWORA was so prevalent.

Limitations

This study was a retrospective chart review and was subject to the inherent limitations of missing data and incomplete charting. Documentation was also an impediment in determining neurologic deficit, as detailed examinations were not universally documented or consistent between examiners. Although we lack some details on the specific neurologic deficit for both PV and EMS patients, the dichotomous determination of whether a deficit was present or not provides a more reliable comparison.

Physician bias plays an interesting role in the determination of cervical spine stability. As mentioned earlier, we defined the stability of the CSI upon whether the neurosurgeon determined that the CSI required fixation. This decision is not purely objective and depends upon not only the injury itself, but also other variables, including resource availability, demands on operating room time, comorbidities, social factors, and patient consent. Although bias in this area might change the total number of patients classified as unstable, it is unlikely to change the comparison between groups.

There is the potential for referral bias, as one of our sites was the regional Level I trauma center, and EMS services should bring more seriously injured patients to that facility. However, we attempted to mitigate this bias by using the multicenter design that included two additional regional, non-trauma centers, and we excluded transfer patients who might further add to referral bias. We hoped to capture an exhaustive and diverse cohort of both EMS- and PV-transported patients.

CONCLUSION

In conclusion, we examined a previously unstudied trauma population, and this report offers insight into the similarities and differences in patients with CSI who arrive by PV or by EMS. PV patients were more likely to be triaged to a low-acuity area, even though many had CSI, and some had unstable injuries. Our report provides an opportunity to remind all ED personnel to exercise the same caution and diligence when evaluating trauma patients for potential CSI, regardless of mode of arrival.

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ARTICLE SUMMARY

1. Why is this topic important?

Some patients with cervical spine injury (CSI) bypass Emergency Medical Services (EMS) and present to the Emergency Department by private transportation. Knowing key epidemiological factors can assist providers in the triage and evaluation of patients presenting with potential CSI.

2. What does this study attempt to show?

There are important differences in CSI patients who present by EMS compared to those who present by private transportation.

3. What are the key findings?

Private-vehicle patients more often sustained a stable injury (66% vs. 40%), were more often triaged to a lower-acuity area (25% vs. 4%), and had more spinal cord injury without radiographic abnormality (21% vs. 5%).

4. How is patient care impacted?

A surprising number of patients who arrive by private vehicle with a chief complaint of cervical spine pain have significant CSI.

Figure 1. Frequency of cervical spine injuries by vertebral level (%). EMS = Emergency Medical Services.

Table 1

Baseline Characteristics for Patients Transported by Emergency Medical Services (EMS) and Private Vehicle (PV)

	EMS		PV	
	n (%)	95% CI	n (%)	95% CI
Total		671		47
Median age (years)	42	40–44	45	39–51
Female gender	234 (34.9%)	31–39%	14 (29.8%)	18.5–44.1%
Mechanism of injury				
Motor vehicle collision *	449 (66.9%)	63.3–70.4%	15 (31.9%)	20.3–46.2% *
Sports	25 (3.7%)	2.5–5.5%	4 (8.5%)	2.8–20.1%
Fall from height	57 (8.5%)	6.6–10.9%	6 (12.8%)	5.6–25.6%
Fall from ground level *	43 (6.4%)	4.8–8.5%	15 (31.9%)	20.3–46.2% *

CI = confidence interval.

* Statistically significant.

Table 2

Comparison of Injuries in Patients Transported by Emergency Medical Services (EMS) and Private Vehicle (PV)

	EMS (n = 671)		PV (n = 47)	
	n (%)	95% CI	n (%)	95% CI
Triaged to lower acuity *	29 (4.3%)	3.0–6.2%	12 (25.5%)	15.1–39.6% *
Injury classification				
Stable *	271 (40.4%)	36.7–44.2%	31 (66.0%)	51.6–77.9% *
Unstable *	355 (52.9%)	49.1–56.7%	14 (29.8%)	18.5–44.1% *
Unknown	45 (6.7%)	5.0–8.9%	2 (4.3%)	0.4–15.0%
Neurologic deficit				
Any deficit	164 (24.4%)	21.3–27.8%	15 (31.9%)	20.3–46.2%
Complete deficit	29 (4.3%)	3.0–6.2%	1 (2.1%)	0.0–12.1%
Incomplete deficit	76 (11.3%)	9.1–14.0%	6 (12.8%)	5.6–25.6%
Sensory-only deficit *	13 (1.9%)	1.1–3.9%	5 (10.6%)	4.1–23.0% *
SCIWORA *	36 (5.4%)	3.9–7.4%	10 (21.3%)	11.8–35.1% *
Level of deficit				
Quadriplegia	82 (12.2%)	9.9–14.9%	2 (4.3%)	0.4–15.0%
Paraplegia	27 (4.0%)	2.7–5.8%	3 (6.4%)	1.5–17.8%

CI = confidence interval; SCIWORA = spinal cord injury without radiographic abnormality.

* Statistically significant.