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*Original Research***EMS Adherence to a Pre-hospital Cervical Spine Clearance Protocol**

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Abstract:

Purpose: To determine the degree of adherence to a cervical spine (c-spine) clearance protocol by pre-hospital Emergency Medical Services (EMS) personnel by both self-assessment and receiving hospital assessment, to describe deviations from the protocol, and to determine if the rate of compliance by paramedic self-assessment differed from receiving hospital assessment. **Methods:** A retrospective sample of pre-hospital (consecutive series) and receiving hospital (convenience sample) assessments of the compliance with and appropriateness of c-spine immobilization. The c-spine clearance protocol was implemented for Orange County EMS just prior to the April-November 1999 data collection period. **Results:** We collected 396 pre-hospital and 162 receiving hospital data forms. From the pre-hospital data sheet, the percentage deviation from the protocol was 4.0% (16/396). Only one out of 16 cases that did not comply with the protocol was due to over immobilization (0.2%). The remaining 15 cases were under immobilized, according to protocol. Nine of the under immobilized cases (66%) that should have been placed in c-spine precautions met physical assessment criteria in the protocol, while the other five cases met mechanism of injury criteria. The rate of deviations from protocol did not differ over time. The receiving hospital identified 8.0% (13/162; 6/16 over immobilized, 7/16 under immobilized) of patients with deviations from the protocol; none was determined to have actual c-spine injury. **Conclusion:** The implementation of a pre-hospital c-spine clearance protocol in Orange County was associated with a moderate overall adherence rate (96% from the pre-hospital perspective, and 92% from the hospital perspective, $p = .08$ for the two evaluation methods). Most patients who deviated from protocol were under immobilized, but no c-spine injuries were missed. The rate of over immobilization was better than previously reported, implying a saving of resources.

Introduction:

There has been criticism of the over implementation of rigid cervical spine immobilization by pre-hospital Emergency Medical Services (EMS) personnel on patients with traumatic mechanisms of injury. Complications such as decubitus ulcers and musculoskeletal strains, as well as complaints of

patient discomfort are common. It has been estimated that immobilization may lead to pressure ulcers within 40 minutes from time of immobilization. Given the practice of overuse of radiographs for c-spine clearance in the emergency department (1), many patients exceed this time frame. Furthermore, prolonged hospitalization, longer emergency department (ED) stays, unnecessary radiographs and use of c-spine immobilization materials lead to higher costs (2,3). Prior studies have shown that patients who meet certain criteria for mechanism of injury and physical assessment can be safely transported without c-spine immobilization, and radiographs may be unnecessary in the majority of these cases (3,4,5). Therefore, the development of a pre-hospital c-spine clearance protocol may reduce the morbidity and cost associated with over immobilization. Using a conservative approach and implementing an extensive training program for the protocol should minimize the risk of missing any serious c-spine injuries. The success of such a protocol would depend on the adherence to it by pre-hospital EMS personnel.

The purpose of this study was threefold: 1) to determine the degree of adherence to a c-spine clearance protocol by pre-hospital EMS personnel, based on paramedic self-assessment and receiving center assessment, 2) to describe deviations from the protocol and 3) to assess differences between pre-hospital self-assessment and receiving center assessment of paramedic compliance.

Methods:

This is a retrospective, descriptive study of pre-hospital patients with traumatic mechanisms of injury. We used standard data collection instruments to assess adherence to a field c-spine clearance protocol implemented in Orange County, California in 1999. Data collection took place from April-November 1999. The pre-hospital cases were from a consecutive sample while the receiving hospital data collection forms were from a convenience sample.

Orange County has a population of 3.0 million and is largely urban. There are 18 city and county fire services which participated in the countywide implementation of the clearance protocol which deliver patients to 25 paramedic receiving centers.

The study was based on a planned countywide change in the c-spine clearance protocol. The current study was an Orange County EMS quality improvement effort to assess compliance. Inclusion criteria were all patients involved in traumatic injuries that needed to be assessed by pre-hospital personnel for c-spine injuries. There were no exclusion criteria. A committee of EMS and ED providers developed criteria for the appropriateness of c-spine clearance in the pre-hospital setting after assessment of the current literature. A conservative approach was taken that included a large list of criteria that had to be met in order for a patient to be properly cleared in the field. The result of these sessions was the development of three instruments: a one-page clearance protocol for use by pre-hospital personnel, a pre-hospital data collection form, and a receiving hospital data collection form.

Additionally, the Orange County Fire Authority (OCFA) developed a specific teaching module consisting of a one-day "teach the teacher" session. These were conducted at the county's main educational area and were developed to teach senior EMS providers to instruct other paramedics within their respective cities about the new clearance protocol. These sessions occurred February-May 1999.

The protocol was made into a one-page form, designed as a flow sheet and requiring no memorization. A deviation was defined as either an improperly cleared patient or an improperly immobilized patient. Patients improperly cleared could be so either because of a

positive mechanism of injury, or by not meeting all of the required clinical assessment criteria. An improperly immobilized patient occurs when the mechanism of injury is "negative" and all of the criteria for clearance are met; yet the patient is still placed in full c-spine precautions.

The determination of mechanism of injury was both objective and subjective. There were 12 categories of mechanism which, if present, required clinical assessment for possible c-spine injury. These were high or unknown-speed motor vehicle accident, auto vs. pedestrian or bicycle, motorcycle accident, falls ≥ 8 feet, gunshot or stab wound, diving accident, passenger space intrusion, ejection from vehicle or same vehicle death.

There were 11 clinical assessment criteria to guide the need for immobilization. Firstly, the patient had to be reliable, defined as calm, cooperative, awake, alert, and oriented to person, place, time and situation. Given this, the other 10 criteria all had to be absent to obviate the need for c-spine immobilization: language or communication barrier, intoxication, acute stress reaction, altered mental status, distracting injuries, spine pain or tenderness and abnormal examinations of motor and sensory function. Extremes of age (>55 or <12) were not absolute immobilization criteria. EMS providers could make an individual determination of whether this played a significant part in patient assessment. This factor was added to remind EMS personnel to have a lower threshold to immobilize an otherwise cleared patient. Full c-spine immobilization was defined as rigid cervical collar with head taped down for lateral stabilization, rigid backboard with straps or tape and back padding.

A receiving hospital form was filled out by the triage RN or attending MD at the receiving ED. This was used to determine the adherence to the c-spine clearance protocol. A copy of the flow sheet protocol was attached to the receiving hospital data collection form for easy reference. This was a convenience sample and it was not possible to directly compare the pre-hospital and hospital receiving data form for any specific case.

Statistical analysis was done using Chi-square on True Epistat (Version 5.0, Richardson, TX). Statistical significance was arbitrarily set at .05, and 95% confidence intervals were calculated for appropriate odds ratios.

Results:

Pre-hospital data were collected on 396 consecutive EMS patients, while receiving hospital data were collected on a convenience subset of 162 patients. The percentage of deviation from the protocol by EMS providers was 4.0% (16/396). Only 1 of 16 deviations was for over immobilization (0.2%). The 15 deviations due to under immobilization (3.8%) were due to a positive mechanism of injury in six cases (37%) and in assessment of the patient in 9 cases (63%). The deviations due to clinical assessment were from the presence of spine tenderness (three cases, 34%), and one case each (11%) of alcohol intoxication, abnormal mental status, distracting injury, unreliable patient, abnormal sensory exam, and abnormal motor exam.

The receiving hospital identified 8.0% (13/162) of patients with improperly immobilized c-spines for which none had associated c-spine injuries. Deviations consisted of 6/13 (3.7% overall), which were over immobilized, and 7/13 (4.3% overall) that were under immobilized. The overall adherence rate from the receiving hospital's perspective was 92%.

There was no statistically significant difference between compliance as judged by the paramedics themselves (96%) vs. the

receiving center personnel (92%). (Chi square 2.93, $p = 0.09$, odds ratio 2.07 95% CI 0.91-4.7).

The percentage of under immobilized patients did not significantly differ between the pre-hospital and receiving hospital data (3.8% versus 4.3%), although the percentage of those over immobilized was found to be statistically significantly greater by the receiving hospitals than by the paramedics (3.7% vs. 0.2%, Chi square 8.4, $p = .0037$).

Discussion:

No studies have, thus far, reported adherence rates to pre-hospital c-spine clearance protocols. The adherence of pre-hospital providers to these protocols is paramount in the success of the safe care for patients. Preexisting attitudes of pre-hospital providers reflect a "better safe than sorry" mentality, and reflect a long-standing culture of immobilizing all trauma patients despite no clinical evidence of c-spine injury.

Unnecessary radiographs, prolonged hospitalization and ED and immobilization expenses were shown to total over \$242,000 in 549 patients, or \$440 per patient (3). Therefore, there could be significant cost savings to health care systems with proper implementation and usage of these protocols. It is estimated that 9-15% of patients are over immobilized (6,7). Studies have estimated that the cost of over immobilization is greater than \$75 million per year in the United States (2).

The complications of prolonged immobilization have been described, but have not been well studied. Decubitus ulcers can develop within one hour of prolonged immobilization on backboard and c-collar. Neck strains and musculoskeletal strains are common and patients report much discomfort while waiting to be radiographically cleared. It is possible that the pain due to prolonged immobilization may exceed that of the initial trauma. A study comparing outcomes between areas where pre-hospital immobilization is used (US) versus not used (Mexico) reports more neurological disability in immobilized patients (8).

We found that the deviation from the protocol due to over immobilization reported by EMS providers was very low, 0.2%. This is significantly lower than the historical rates of over immobilization reported in other studies (9.62 to 15%) (6,7). Previous studies, however, did not have a modern pre-hospital c-spine clearance protocol in place. We have no direct pre-implementation over immobilization rates to compare in Orange County.

There is always concern that such a protocol would increase the rates of under immobilization and lead to an increase in permanent disability or death. This concern is likely the main reason for over immobilization. We did not identify any adverse outcomes from under immobilization, although our follow up was limited to the report of any injury from the receiving hospital and this follow up was not standardized. The study was not powered to determine a pre-hospital "miss rate" for c-spine under immobilization. Even with no identified bad outcomes in the 22 patients judged to be under immobilized by the two assessment methods (15 by the EMS self-assessment and 7 by the receiving center personnel), the upper limit of the 95% confidence interval is approximately 14%, insufficient evidence to validate the safety of the protocol.

We also studied the receiving hospital's view of the appropriateness of immobilization. Prior studies report a significant disagreement in c-spine clearance between EMS providers and

emergency physicians (9), while others report excellent agreement (10). An attempt was made to be objective as possible; the triage nurse or physician had quick and easy access to the protocol to determine whether the patient was properly or improperly immobilized. The adherence rate from the receiving hospital's assessment was worse than the EMS perspective of adherence to the protocol (92% versus 96%), although the difference was largely due to the number of improperly over immobilized patients. Since the numbers of returned forms was less than those from EMS, there may be a bias toward reporting cases that the receiving hospital felt were improperly immobilized. This would artificially decrease the adherence rate. Another reason for this discrepancy may be the change in patient exam from the field to the hospital over time.

The percentage of under immobilized patients did not significantly differ between the pre-hospital and receiving hospital data (3.8% versus 4.3%), although the percentage of those over immobilized was less as judged by pre-hospital providers than receiving centers (0.2% versus 3.7%). This may be due to inherent bias of pre-hospital providers to over immobilize, or uncertainty in the field versus the controlled setting of the ED. EMS providers may also have a better understanding and first-hand witness to the mechanism of injury, and thus may account for the difference in rate of over immobilization. Interestingly, a study by Domeier, et. al. (11) has reported that the reliability of the pre-hospital clinical evaluation was not affected by the mechanism of injury.

Limitations of the study include the imbalance between the frequency of pre-hospital and receiving center assessment of compliance. As such we could not compare, pre-hospital and receiving center data on the same patients. We did not try to follow the clinical course of the patients to definitively exclude c-spine injury, or determine any complications from immobilization. Pre-hospital adherence to the protocol was self-judged, and therefore suspect. A prior study showed that while paramedics assess most, if not all, of the standard criteria of c-spine clearance, they are inconsistent in their documentation (12).

To increase adherence and success of pre-hospital c-spine clearance protocols, the attitudes of the EMS providers to such a protocol should be studied in the future. Development of specific teaching aimed at these attitudes may help to decrease the over immobilization of patients. The rate of under immobilization of patients needs to be studied over time in other EMS systems before and after implementation of a c-spine clearance protocol to determine whether this rate changes. Other future studies should be done to determine the cost savings and change in morbidity rates after pre-hospital c-spine clearance protocol implementation. However, lack of support from ED directors and a variation in the ED practice of clinically clearing c-spines may hinder development of pre-hospital c-spine clearance protocols (13).

Conclusions:

The implementation of a pre-hospital c-spine clearance protocol in Orange County was associated with a very good adherence rate from EMS providers. The rate of over immobilized patients was less than those under immobilized, and the rate of over immobilization was less than previously reported. Further studies should be done to determine reasons for protocol

deviation, whether its use reduces the morbidity and cost of over immobilization, and whether, if implemented perfectly, it reliably identifies all appropriate patients for immobilization.

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