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Errors in cervical spine immobilization during pediatric trauma evaluation

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ABSTRACT

Background: The purpose of this study was to identify factors during trauma evaluation that increase the likelihood of errors in cervical spine immobilization ('lapses').

Materials and methods: Multivariate analysis was used to identify the associations between patient characteristics, event features, and tasks performed in proximity to the head and neck and the occurrence and duration of a lapse in maintaining cervical spine immobilization during 56 pediatric trauma evaluations.

Results: Lapses in cervical spine immobilization occurred in 71.4% of patients ($n = 40$), with an average of 1.2 ± 1.3 lapses per patient. Head and neck tasks classified as oxygen manipulation occurred an average of 12.2 ± 9.7 times per patient, whereas those related to neck examination and cervical collar manipulation occurred an average of 2.7 ± 1.7 and 2.1 ± 1.2 times per patient, respectively. More oxygen-related tasks were performed among patients who had than those who did not have a lapse (27.3 ± 16.5 versus 11.5 ± 8.0 tasks, $P = 0.001$). Patients who had cervical collar placement or manipulation had a two-fold higher risk of a lapse than those who did not have these tasks performed (OR 1.92, 95% CI 0.56, 3.28, $P = 0.006$). More lapses occurred during evaluations on the weekend ($P = 0.01$), when more tasks related to supplemental oxygen manipulation were performed ($P = 0.02$) and when more tasks associated with cervical collar management were performed ($P < 0.001$).

Conclusions: Errors in cervical spine immobilization were frequently observed during the initial evaluation of injured children. Strategies to reduce these errors should target approaches to head and neck management during the primary and secondary phases of trauma evaluation.

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Introduction

The initial evaluation is a critical phase in the care of injured patients. In several studies, more than 40% of preventable or potentially preventable deaths have been attributed to errors during this phase.[1,2] Although a standardized evaluation and management protocol (Advanced Trauma Life Support) has been shown to improve outcomes related to trauma evaluation,[3] studies using video review have found more than 10 deviations from the Advanced Trauma Life Support protocol per event.[4,5] Most of these deviations are variations addressing the unpredictability of injured patients and their response to treatment or occur because of acceptable provider preference in managing injured patients. Up to 40% of these deviations, however, can be classified as "errors" and may be directly associated with adverse outcomes, including long-term disability and death.[1,2,4] In a previous study, we identified failure to properly maintain in-line cervical spine immobilization ('lapse') as a frequent error during trauma evaluations at our hospital.[6] Although the benefits and potential harm of cervical immobilization after blunt trauma has been recently reassessed,[7,8] its use remains standard practice because of the lack of high-level evidence establishing the safety of restricting its use.[3,9]

Root-cause analysis is a common method for determining the potential causes of harmful events, but this approach has limited utility for determining risk factors associated with adverse events that are rare.[10,11] Analysis of near-miss events is an alternative approach to root-cause analysis when errors potentially leading to an adverse event are common but when direct harm to the patient from these errors is infrequently observed because of patient resilience, mitigation, or chance.[12] This strategy is appropriate for determining the potential causes of lapses because worsening neurological injury from improper cervical spine immobilization is rare despite lapses being common. As factors associated with near-miss events and events that propagate to the patient and cause harm may be similar, studying near-misses related to cervical spine immobilization may aid in the development of strategies that will reduce the risk associated with this type of error.[13]

The purpose of this study was to determine factors associated with errors in cervical spine immobilization during trauma evaluation. We used video review to identify process variables associated with these errors. Video review has benefits over retrospective chart review and even real-time observation because it provides insight into events that may not be documented in the chart or are difficult to identify by direct in-person observation. We used the results of this analysis to identify strategies for reducing or mitigating errors in cervical spine immobilization with the goal of preventing complications related to their occurrence.

Materials and methods

Study setting

Children's National Medical Center is a level I pediatric trauma center serving the greater Washington, DC region and verified by the American College of Surgeons, State of Maryland and the District of Columbia. About 600 injured children each year are evaluated in the emergency department by the trauma team based on pre-hospital triage criteria. The trauma rooms are equipped with a video recording system that records each event. The use of video recordings has been approved for research by the Institutional Review Board at Children's National Medical Center. Consent from patients or their parent or guardian is obtained before reviewing videos.

Data sources

During a 5-month period (August–December 2014), 197 children sustaining a blunt traumatic injury presented as trauma activations. Among these 197 evaluations, 68 were excluded from this study because of poor video quality or unintended erasure of the video, and an additional 35 were not reviewed because of inability to obtain consent. We further excluded 35 patients who were transferred from another hospital because of variability in pre-transfer cervical spine imaging and indications for cervical spine stabilization in this group. Three events were identified where members of the research team played a role in patient care and were therefore also excluded. The final data set for this study included videos from 56 events.

Video review was performed to identify errors in in-line stabilization of the cervical spine. The determination of the need for cervical stabilization was made by the surgical team leader based on mechanism of injury using an established cervical spine management protocol at our hospital. We assessed for the occurrence of lapses between the time of entry of the patient to the trauma bay until either the cervical spine was cleared for removal of the collar based on clinical or radiographic criteria or the patient departed the trauma bay if the cervical spine was not cleared. A complete lapse was defined as any time the patient's head and neck were not immobilized by a team member's hands or by an assistive device such as a cervical collar. Incorrect stabilization was defined as an attempt at immobilization that would not immobilize the neck in case of movement. Examples of incorrect stabilization included placing the hands on the crown of the head, stabilizing the neck with one hand or securing a cervical collar only on one side. When no team member was performing manual cervical spine immobilization, the team member at the head of the bed was identified as the person responsible for maintaining cervical spine immobilization. Videos were also reviewed for tasks performed near the head and neck that were potentially associated with lapses, including preparing, providing, maintaining, and removing passive supplemental oxygen, otoscopic examination, turning the patient to inspect the back ('log roll'), cervical spine examination, cervical collar placement or exchange and intubation. The occurrence of each task and whether it was performed during a lapse was determined by video review.

Error acknowledgment, compensation and impact were also assessed using video review. Error acknowledgment was defined as either verbal instruction to correctly stabilize the cervical spine or a non-verbal signal, such as placement of hands in the correct position. Error compensation was defined