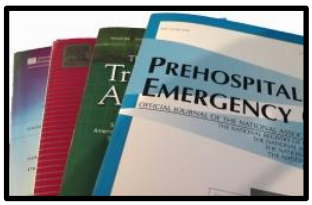
International Prehospital Medicine Institute



IPHMI Literature Review

Keeping You Up To Date with Current EMS Literature and Studies

Vol. 4.3

1. **Characteristics of patients who had a stroke not initially identified during emergency prehospital assessment: a systematic review.** Jones SP, Bray JE, Gibson J, et al. *Emerg Med J* 2021;38:387-393. Full text available at: https://emj.bmj.com/content/38/5/387.abstract
2. **Prehospital end-tidal carbon dioxide predicts hemorrhagic shock upon emergency department arrival.** Bulger N, Harrington B, Krieger J, et al. *J Trauma Acute Care Surg.* 2021;91:457-464.
3. **PreHospital Factors Associated With Cervical Injury in Pediatric Blunt Trauma Patients.** Browne LR, Ahmad FA, Schwartz H, et al. *Acad Emerg Med* 2021;28:553-561.

1. **Characteristics of patients who had a stroke not initially identified during emergency prehospital assessment: a systematic review.** Jones SP, Bray JE, Gibson J, et al. *Emerg Med J* 2021;38:387-393. Full text available at: https://emj.bmj.com/content/38/5/387.abstract

Stroke is the fifth leading cause of death in the United States. The chain of survival for stroke describes five unique links that together increase stroke survival and decrease patient disability. Emergency Medical Services (EMS) can have a direct effect on the first three of those links and can certainly contribute to the remaining two links.

Early recognition of stroke, timely and appropriate response, along with early notification and transport to a stroke center are the three links in the chain where EMS can have an immediate and positive impact on the stroke patient's outcome and disposition. A chain is only as strong as its weakest link. Recognizing a stroke early and accurately is often the greatest challenge and thus the weakest link. EMS is often thought of only as being the responding pre-hospital providers but the profound effect accurate Emergency Medical Dispatch (EMD) has on the stroke chain of survival must also be considered. Any early detection stroke scale or test should be included in EMD to help identify and alert field responders of the patient's potential to be suffering from a stroke.

Currently, there are multiple stroke scales that have either been adapted for EMS use or specifically developed for EMS providers to accurately identify stroke patients. Most of these scales, or tests, rely heavily on the provider's ability to recognize changes in the patients face (asymmetry and droop), arm (drift) and speech

The authors of this paper completed a systematic review of published stroke articles to determine the prehospital presentation of stroke patients that led to inaccurate assessment. They searched using the identifiers "stroke, EMS, paramedics, identification and assessment". They further narrowed their article search to adult patients, age greater than or equal to 18, and any type of stroke. The search yielded 847 articles of which 21 studies met inclusion criteria.

Those studies reported data on 6,934 stroke patients, of which 1,774 EMS patients (26%) were falsely assessed as negative for stroke. The studies reviewed used multiple pre-hospital stroke scales and tests. The most commonly missed symptoms, depending on the study, were nausea and vomiting

(8% to 38%), visual disturbances or impairment such as blurring, diplopia or loss (13% to 29%), dizziness (23% to 27%), changes in mental status (8% to 25%) and speech problems (13% to 28%). Patients that were correctly identified as stroke patients had a significantly reduced door to CT scan times (34.6 minutes VS. 84. 7 minutes).

The authors acknowledge limitations in their study. The EMS clinicians may have only performed the stroke evaluation tools for patients whom they already suspected as having an acute stroke. Many of the studies used retrospective data contributing to risk of selection bias. Not all of the studies differentiated stroke between intracranial hemorrhage and ischemic in origin.

While not conclusive, this paper should raise the pre-hospital provider's and emergency medical dispatcher's suspicion of stroke for any patient that complains of nausea / vomiting, visual disturbances, mental status changes, vertigo and speech problems. The last being the most concerning since it is already included in most stroke scales. Just as a perceived non-diagnostic ECG should not be used to rule out a cardiac event, a negative prehospital stroke screen should not be used to rule out the possibility of stroke in patients with vague neurological symptoms such as speech difficulties, visual disturbances and dizziness.

2. Prehospital end-tidal carbon dioxide predicts hemorrhagic shock upon emergency department arrival. Bulger N, Harrington B, Krieger J, et al. *J Trauma Acute Care Surg.* 2021;91:457-464

The early detection and aggressive management of hypovolemic shock is a cornerstone of modern shock management. Clinical lab tests such as lactic acid level and base deficit are available to assist in early detection of pending hypovolemic shock in the emergency department (ED). However, in the prehospital setting, paramedics must rely on physical exam, vital signs (pulse, BP, RR) and clinical suspicion. The authors of this retrospective cohort study investigated the use of prehospital end tidal carbon dioxide ($ETCO_2$) as a tool for early detection of hypovolemic shock.

The authors analyzed data obtained from a single urban EMS system from January 1, 2016 to December 31, 2019. Trauma patients who had an advanced airway placed in the field and were ventilated were enrolled. Patients were excluded if they were under 1 years of age, did not receive an endotracheal (ET) tube, did not have full waveform $ETCO_2$ data available or were unable to match in the trauma registry. A total of 510 were included in this group. Hemorrhagic shock was defined as the patient receiving at least one unit of any blood product in the ED with either a BP of less than 90 mmHg or a shock index of greater than 0.9 on arrival at the ED.

There were 510 patients eligible for entry into the study. After exclusions, a total of 307 patients were enrolled in the final cohort. Of the patients in the study cohort, 82% were male, 42% were in hemorrhagic shock by definition of the study and 34% of the injuries were due to penetrating trauma.

Study participants were three (3) times more likely to be in hemorrhagic shock if they presented to the ED with at $ETCO_2$ of less than 25 mm hg. Of the 87 patients that had a median ETCo2 of 25 mm Hg, 69% were in hemorrhagic shock on arrival to the ED. Of the 56 patients that had an $ETCO_2$ less than 20 mm Hg, 82% were in hemorrhagic shock.

The authors note the major limitation of the study is that it represents a single urban EMS system with short transport times; therefore it is difficult to generalize it to other settings. There were some cases that could not match prehospital and trauma registry entries. Lastly, only intubated patients were enrolled in the study. Some of the intubated patients were chemically paralyzed thus the $ETCO_2$ values could have been affected by being ventilated.

The use of $ETCO_2$ waveform monitoring is the standard for monitoring intubated patients in the prehospital setting. While initially used for the detection of proper ET tube placement, the use of waveform interpretation for other aspects of care has evolved in recent years including for the evaluation of bronchospasm, air trapping, and decreased cardiac output. This study suggests that ETCo2

could also become a prehospital tool for the early detection of hemorrhagic shock. However there are a few key questions that should be further investigated. Would a patient with longer transport times demonstrate a falling ETCo2 if developing hemorrhagic shock during transport? Is there a specific threshold value that should be considered as an indicator of shock? Should $ETCO_2$ values be incorporated into prehospital triage and destination decisions? Additional studies are needed to answer these sorts of question.

3. **PreHospital Factors Associated With Cervical Injury in Pediatric Blunt Trauma Patients.** Browne LR, Ahmad FA, Schwartz H, et al. *Acad Emerg Med* 2021;28:553-561.

Although rare, cervical spine injury (CSI) remains a concern in children who sustain blunt trauma. The application of spinal motion restriction has, in the past, been applied to virtually all victims of blunt injury, both adult and pediatric. More recently, there has been a greater effort on the use of selective spinal immobilization based on prediction rules for spinal injury.

In this study, the authors sought to determine the ability of EMS providers to identify risk factors associated with cervical spine injuries in children after blunt trauma. A secondary objective was to assess the performance of the Pediatric Emergency Care Applied Research Network (PECARN) CSI risk factors based solely on EMS provider observation. The PECARN CSI model identifies eight CSI risk factors in children based on emergency department observations. These risk factors are high-risk motor vehicle collision, diving mechanism, predisposing condition, neck pain, decreased neck mobility, altered mental status, neurological deficits, and substantial torso injury.

This was a four center study of children ages 0-17 years old that were transported by EMS after blunt trauma. They looked at all children that received spinal motion restriction or trauma team activation in the ED. Rresearch assistants (RA) approached EMS providers while in the ED to record their observations for previously determined CSI risk factors, including the PECARN risk factors. Cervical spine injuries were then identified by reviewing ED records, imaging, consultations and telephone follow-up.

Of 2,096 children that met inclusion criteria, 1,372 children were enrolled in the study. The remainder either arrived during RA off hours or refused to participate. Cervical spine injuries were found in 25 (1.8%). Seven of the priori determined risk factors showed significant association with CSI: axial load, altered mental status, signs of basilar skull fracture, substantial torso injury, substantial thoracic injury, respiratory distress and decreased oxygen saturation. Use of the PECARN prediction model by EMS personnel correctly identified 24 of the 25 patients with CSI and 519 of the 1,347 patient who did not.

A limitation of the study was that there was a large component of the patient population that was not included and could have affected the results. In addition, factors that were found to be significant in the ED, including diving mechanism, clotheslining mechanism, loss of consciousness, neck pain, inability to move neck, intubated patient, and focal neurologic deficits were not identified on EMS analysis because of extremely small numbers of cases.

EMS providers in this study were able to identify risk factors associated with cervical spine injuries in children who experienced blunt trauma. The PECARN risk assessment model had a similar result when used by EMS personnel as it did with ED personnel. Given the differences however in ED evaluation criteria versus EMS evaluation, further study is needed to develop specific pediatric injury risk assessment tools for EMS providers to limit the inappropriate use of prehospital SMR in children.