What Physiologic Parameters Are Indicative of Severe Injury in Trauma?

TAKE-HOME MESSAGE

Pulse rate, systolic blood pressure, shock index, respiratory rate, and lactate demonstrate poor sensitivity but high specificity for predicting severe injury among trauma patients. No parameter in isolation is able to adequately predict the risk of severe injury.

METHODS

DATA SOURCES

Authors searched Ovid MEDLINE, CINAHL, EMBASE, and the Cochrane databases from 1996 through August 2017 for relevant studies. Investigators evaluated reference lists of included studies for additional publications.

STUDY SELECTION

Authors performed a systematic review of studies collecting physiologic parameters (circulatory, respiratory, and level of consciousness) among trauma patients to identify those with severe injuries as measured by resource use (blood transfusion, critical care admission, lifesaving intervention), anatomic injury severity measures (eg, Injury Severity Score), mortality, or a combination of any of these parameters developed by stakeholders including the Agency for Healthcare Research and Quality and the National Highway Transportation Safety Administration. Authors did not restrict the type of trials included. Two or more authors independently evaluated studies meeting criteria for inclusion, with

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Jestin N. Carlson, MD, MS, and Alan Jones, MD, serve as editors of the SRS series.

Results

Results of included studies.

	Out-of-Hospital		ED		
Predictor of Severe Injury	**Sensitivity, Specificity, %**	**No. of Studies**	**Sensitivity, Specificity, %**	**No. of Studies**	**+LR**
SBP <90 mm Hg	19, 95	17	18, 97	9	4.32
SBP <100 mm Hg	35, 88	6	35, 89	4	3.30
HR >110 beats/min	28, 85	4	29, 93	5	1.37
SI >1	37, 85	5	40, 93	11	3.13
Lactate >2 mmol/L	74, 62	3	74, 52	9	1.94
Lactate >4 mmol/L	23, 93	1	50, 86	9	2.34
RR <10 or >29 breaths/min	13, 96	6	27, 95	4	5.61

+*LR*, Positive likelihood ratio; *SBP*, systolic blood pressure; *HR*, pulse rate; *SI*, shock index; *RR*, respiratory rate.

Authors selected 138 articles reporting results of 134 studies from an initially identified 4,188 studies. Ninety-six studies were retrospective, and the remainder were prospective studies.

Included studies used different predictors for serious injury, with many using more than one. Individual parameters included systolic blood pressure, shock index, pulse rate, lactate level,

disagreements resolved by consensus.

DATA EXTRACTION AND SYNTHESIS

A single investigator extracted data from studies concerning the diagnostic accuracy of physiologic parameters for severe injuries, and a second team member checked this for completeness. The authors used random-effects modeling to calculate the pooled sensitivity, specificity, area under the receiver operating characteristic curves (AUROCs), and likelihood ratios across studies.[1,2] Authors assessed heterogeneity with I^2 and χ^2 tests and evaluated bias with the Quality in Prognosis Studies tool.

respiratory rate, and qualitative summaries of pulse rate variability or complexity, base deficit, and oxygen saturation. One hundred ten studies (79.7%) reported resource use, whereas 95 (68.8%) reported mortality and 19 (13.8%) reported injury severity or type. Physiologic parameters demonstrated poor sensitivity, but several possessed high specificity (Table). The combination of Glasgow Coma Scale (GCS) score, age, and arterial pressure (also known as GAP) demonstrated the best performance (AUROC 0.96). Moderate risk of bias was present in 103 studies, with 10 at low risk and 25 at high risk of bias. Bias issues included study participation (sampling and recruitment), attrition (lost to follow-up), and lack of adequate control for confounders. Strength of evidence assessments was mostly low because of inconsistency of results across studies.

Commentary

Unintentional injury is a leading cause of death in the United States, with greater than 40 million emergency department (ED) visits in 2014.[3,4] Traumatic injuries are also the most common reason for use of emergency medical services (EMS).[5] Trauma management depends on early intervention and triage, which can be difficult in the ED and even more so in the out-of-hospital environment. Most systems seek to avoid undertriage, which increases mortality.[6] Minimizing overtriage is also important to reduce overuse of limited resources and improve outcomes.[7-9] Parameters used to guide triage decisions must be accurate, easy to use, and applicable across a broad range of scenarios. Many systems use circulatory markers, respiratory status, and levels of consciousness as potential markers to estimate injury severity.[10,11]

This systematic review and meta-analysis sought to summarize the existing data in regard to accuracy of these myriad parameters for predicting injury severity. No single parameter demonstrated sufficient sensitivity alone to exclude serious injury, although specificities were generally high for most parameters examined, including systolic blood pressure less than 90 mm Hg, pulse rate greater than 110 beats/min, shock index greater than 1, and respiratory rate less than 10 or greater than 29 breaths/min. Shock index, lactate level, and respiratory rate demonstrated fair AUROC values (0.61 to 0.77), although the authors of the included studies did not identify optimal cutoffs for these parameters. A receiver operating characteristic (ROC) curve plots the various sensitivity and specificity values for a diagnostic test, which yields a continuous quantitative result. Each point on the ROC curve represents an alternative quantitative cutoff that marks the threshold for a positive finding or abnormal result. The AUROC then offers an overall measure of the test's diagnostic accuracy across all cutoff values: 1 represents a perfect test, whereas 0.5 represents a test with no added value beyond chance (eg, flipping a coin). Combining parameters may further increase predictive capabilities. In particular, assessment of GCS, age, and arterial pressure combined demonstrated the highest AUROC value.

Limitations of this meta-analysis include the small number of direct comparisons of separate parameters and low strength of evidence in the included studies. The meta-analysis included a wide range of parameters from ED and out-of-hospital settings, which can create heterogeneity. Most studies included trauma patients transported by EMS, with data obtained most commonly in a retrospective fashion from trauma registries; such data can be of inconsistent quality. Many studies also lacked much salient information in regard to the collection of physiologic parameters, to include timing of collection and experience level of individuals assessing these parameters. This meta-analysis identified a dearth of data from pediatric and elderly populations, thus limiting analyses specific to these important subgroups. Finally, there was significant heterogeneity with respect to the definition of severe injuries, thereby limiting the evaluation of this outcome.

This meta-analysis suggests that physiologic predictors of injury have generally high specificity but low sensitivity across settings. Thus, health care providers should not use these measures to exclude severe injuries. Future studies should examine the accuracy of physiologic parameters for diagnosing severe injuries in other subgroups (eg, elderly, pediatric patients) and investigate alternative parameter combinations to optimize diagnostic accuracy. Novel technologies using point-of-care testing may also be useful but require further study.

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