

2820MED Trauma and Environmental Conditions in Paramedic Practice

Title: Critically Appraised Topic in Trauma

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PICO Question

In the rural setting of prehospital adult trauma patients, is point-of-care testing for serum lactate levels a useful addition to the standard cares of advanced care paramedics as a reliable marker of mortality?

Search Rationale

Although well-established in the in-hospital setting, prognostic reliability of serum lactate as a prehospital predictor for resuscitative care and mortality is not well-examined. Challenges faced in the rural setting of traumatic injuries often pertain to resource restrictions, thereby accurate triage assessment and trauma level activation is critical for paramedic practice to ensure appropriate patient care. Consideration for ACP use of the i-STAT analyser, or similar device, to inform transport and trauma response activation may prove a beneficial addition to standard cares in the management of adult trauma patients.

Search Strategy

A literature search was conducted using databases, *Medline OVID* and *Embase*. A manual search was also conducted using *Google Scholar* and *COCHRANE* to identify any literature missed in the initial search. As detailed in *Table 1* below, a dearth of research in the initial search broadened inclusion criteria to the emergency department setting, should the methods and outcomes be transferrable to the prehospital context. The PRISMA flowchart of the search results is listed in Appendix A.

Databases	Search terms	Inclusion criteria	Results
<i>Medline OVID</i>	MeSH headings: (pre-hospital OR out-of-hospital OR EMS OR emergency medical technician OR paramedic OR ambulance) AND (trauma* OR “traumatic injur*”) AND (lactate OR “serum lactate” OR “blood lactate” OR iSTAT or EPOC OR PSL OR ISL) AND (mortality OR fatality)	January 2015-September 2020, English language, human subjects, prehospital, or emergency department setting	25
<i>Embase</i>			54

Results

Author, Year	Study type and CEBM evidence rank ¹	Sample Cohort	Outcomes	Results	Strengths (+) and Limitations (-)
Javali et al. (2017)	Prospective observational Level 3b	100 adult trauma patients admitted with exclusion of extraneous factors, such as severe HI with IC bleeding.	Sensitivity and specificity of serum lactate in the ED.	Correlation of ISL with highest sensitivity for 24-hour mortality, blood transfusion requirement and ICUA, as compared with BD, SBP <90, HR >100, and SI >1. ISL may be useful in detection of OH.	(-) ED study. (-) Small sample study. (+) Numerous treatment endpoints evaluated.

¹ Refer to Appendix A, *Table 2*, for Oxford CEBM: Levels of Evidence

Brown et al. (2016)	Retrospective cohort Level 2b	6,347 patients transported from level I trauma centres by air medical services, collected by numerous prehospital medical databases and linked with trauma registry.	Prognostic accuracy of PSL to determine trauma team activation in comparison with current trauma activation guidelines.	Use of ACS+ISL algorithm reduced over-triage by 7.2%, though cited a 0.7% increase in under-triage. Demonstrable gains in overall accuracy of trauma team activation, PPV, and NPV compared with current ACS algorithm.	(+) Large sample cohort in prehospital context. (+) Direct comparison of standard methods with inclusion or absence of ISL. (-) Possible selection bias present as not all patients had lactate levels measured. (-) Possible confoundment of lactate elevation by hypoperfusion following injury.
Raux et al. (2017)	Retrospective prospective cohort analysis Level 2b	1075 trauma patients, following medical prehospital care needs, were transported by medical mobile ICUs to the study centres.	Prognostic reliability of ISL compared with BD for initial severity assessment of trauma patients and guide for early resuscitation.	ISL superior mortality and haemorrhage predictor in the normotensive patient. ISL more proficient predictor than BD in triage scores and Trauma-Related ISS.	(-) Given study design, correlation is established, but cannot infer causality (+) Large sample study (+) Multi-centre study (+) Measurement of multiple relevant clinical endpoints
St. John et al. (2018)	Retrospective prospective and cross-sectional analysis Level 4	314 trauma patients over a 14-month period transported by ALS units	Reliability of PSL as a predictor of RC in PH normotensive trauma patients.	Although not more predictive than SI for need of RC, sensitivity of POC assay indicated only increases in PSL above levels of 2.5 mmol/L were associated with concordant risk for RC.	(+) PH study (-) Small cohort study (+) ALS paramedics (-) Cohort restrictive to non-hypotensive trauma patients (+) Use of RC as primary treatment outcome, however, definition of the composite outcome for RC were subjective (-)
Zwisler et al. (2019)	Prospective randomised study Level 2b	222 patients included, either allocated to the ABG group or treated with standard cares (non-ABG group).	Prognostic reliability of ABG (with capacity for measuring serum lactate) as a prehospital screening tool.	Greater specificity of ABG analysis found with targeting specific PH therapeutic interventions, incl. upgrading level of urgency. Overall, non-ABG analysis perceived with decreased diagnostic accuracy.	(+) PH study (-) Non-blinded, single-centre study, however, it was prospectively conducted with a pre-defined hypothesis (+) (-) Possible issue to internal validity due to recall bias

Galvagno et al. (2020)	Prospective observational study Level N/A	261 trauma patients were enrolled following transport by an aeromedical emergency service to a Primary Adult Resource trauma centre. Data collection was completed en-route by flight paramedics with the i-STAT analyser.	Predictive reliability of PSL for detecting early haemorrhagic shock and need for LSIs in adult patients with traumatic injuries.	Increases in PH lactate and glucose were highly associated with requisite LSIs within the first hour of trauma centre admission. Statistical significance of greater sensitivity and specificity for LSI in the presence of PSL level > 4mmol/L compared with SI. Extreme outliers in the no-LSI group presenting with elevated lactate was prospectively attributed by alcohol intoxication.	(+) PH study (+) Use of paramedic-intervention (+) One of the largest PH POC testing cohorts reported to-date (-) Small sample size (-) Single-centre study
Freitas and Franzon (2015)	Retrospective observational study Level 2b	117 patients admitted to ICU for multiple trauma over a 15-month period. Predominant injury mechanism involved cranial trauma, followed by abdominal trauma.	Prognostic correlation between admission serum lactate and mortality in adult patients treated for polytrauma.	No statistical relationship established between admission lactate or lactate clearance and patient mortality less than and following 48 hours of admission. Comparison between admission lactate and vital signs denoted only minimal correlation with SBP.	(-) Limited sample size. (-) ISL taken within three hours of hospital admission. (+) Internal validity due to exclusion criteria implemented.

Table 1. Included Studies

Abbreviations: CEBM, Centre for Evidenced-Based Medicine; HI, head injury; IC, intracranial; OH, occult hypoperfusion; ISL, initial serum lactate; VS, vital signs; ABG, arterial blood gas; PH, prehospital; ED, emergency department; incl., including; POC, point-of-care; PSL, prehospital serum lactate; RC, resuscitative care; LSI, lifesaving interventions; ALS, advanced life support; ACS; American College of Surgeons activation criteria; PPV, positive predictive value; negative predicted value; SI, shock index; ISS, injury severity score; HR, heart rate (beats per minute); SBP, systolic blood pressure (mmHg); ICU, intensive care unit; ICUA, intensive care unit admission.

Comments

In adult patients with traumatic injury, preliminary diagnostic recognition is imperative for enhancing patient outcomes in the rural prehospital setting. With a predictive accuracy for triage score, 24-hour mortality, requirement for blood transfusion, intensive care unit admission, and requirement for resuscitative care, extending prehospital serum lactate in current practice to ACPs in rural practice can prospectively expedite trauma activation protocols. By further sourcing a reduction in rates of over-triage, this tool of risk stratification may concomitantly improve patient outcomes and reduce impact on pre- and in-hospital resources. Although inconsistent in the setting of polytrauma and alcohol intoxication, congruence with the prognostic accuracy of point-of-care serum lactate with mortality, compared to markers of base deficit, shock index, tachycardia, and hypotension, further supports the revision of prehospital serum lactate to appropriately trained ACPs in the rural locality. With haemorrhage attributable to the most frequent deadly preventable injuries and a sensitivity superior to systolic blood pressure (Galvagno et al., 2020), prehospital serum lactate in the ACP scope may be also useful in the early detection of occult hypoperfusion.

Consider

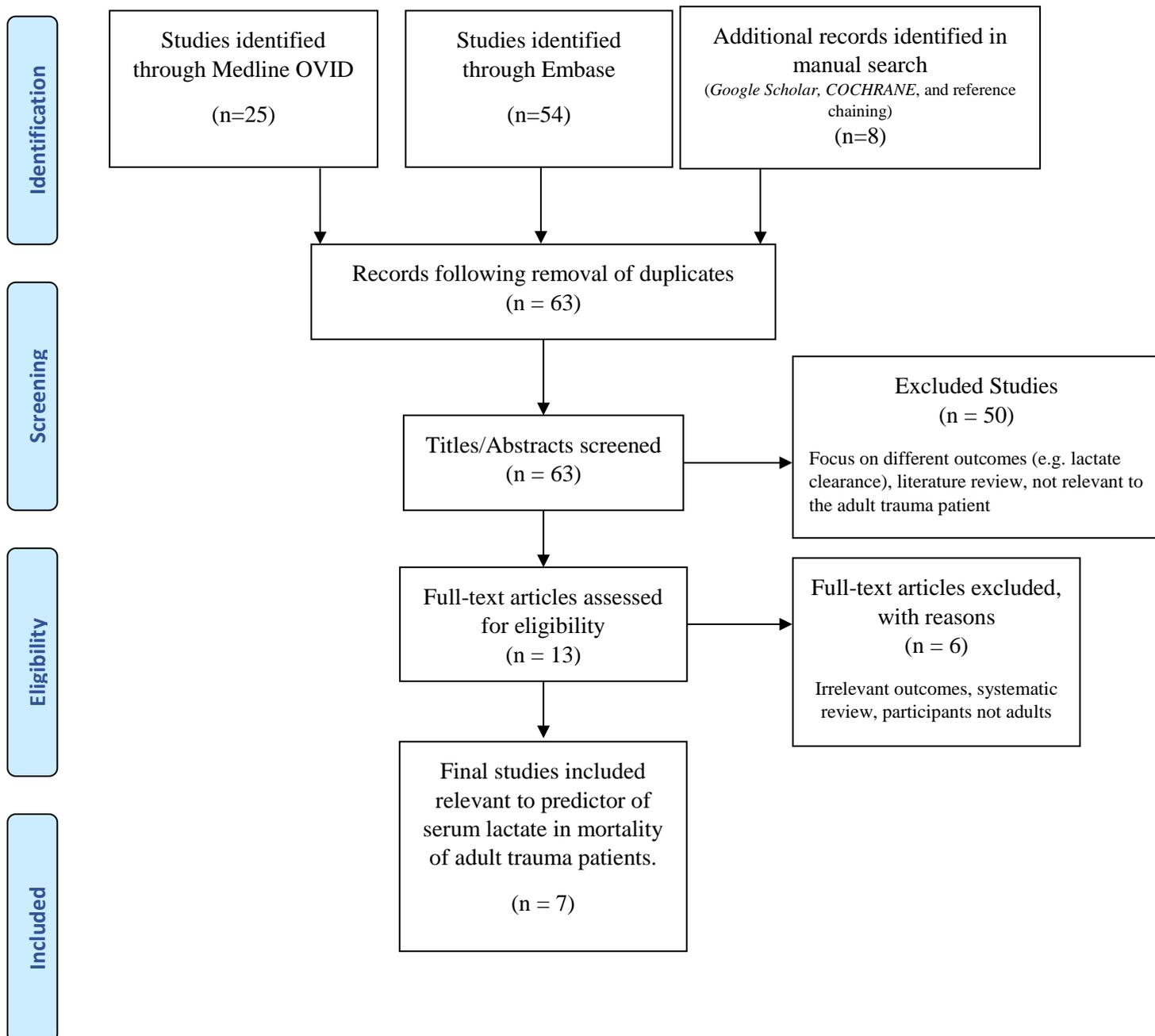
Despite the identified clinical benefit in accurate trauma system activation and expediting patient transport to definitive care, discrepancy was identified in the context of polytrauma or alcohol intoxication. A dearth of high-quality research in this setting further limits the development of existing prehospital clinical practice guidelines with consideration to the ACP scope in rural practice. Future research is thus required to investigate the prognostic accuracy of serum lactate with these variables in the prehospital trauma setting.

Clinical bottom line

The current body of evidence regarding serum lactate as a prehospital prognostic adjunct at the ACP level is incomplete, particularly in the rural setting. However, among factors of early shock recognition and a higher sensitivity for mortality, pre-hospital serum lactate presents an opportunity for incorporation into emergency medical practice at the ACP level to as a prognostic tool to improve outcomes of the adult patient with traumatic injuries.

Appendix A

PRISMA Flowchart of Results



Level	Therapy / Prevention. Aetiology / Harm	Prognosis	Diagnosis	Differential diagnosis / symptom prevalence study	Economic and decision analyses
1a	SR (with homogeneity*) of RCTs	SR (with homogeneity*) of inception cohort studies; CDR* validated in different populations	SR (with homogeneity*) of Level 1 diagnostic studies; CDR* with 1b studies from different clinical centres	SR (with homogeneity*) of prospective cohort studies	SR (with homogeneity*) of Level 1 economic studies
1b	Individual RCT (with narrow Confidence Interval ⁱ)	Individual inception cohort study with > 80% follow-up; CDR* validated in a single population	Validating** cohort study with good ^{***} reference standards; or CDR* tested within one clinical centre	Prospective cohort study with good follow-up****	Analysis based on clinically sensible costs or alternatives; systematic review(s) of the evidence; and including multi-way sensitivity analyses
1c	All or none [§]	All or none case-series	Absolute SpPins and SnNouts	All or none case-series	Absolute better-value or worse-value analyses
2a	SR (with homogeneity*) of cohort studies	SR (with homogeneity*) of either retrospective cohort studies or untreated control groups in RCTs	SR (with homogeneity*) of Level >2 diagnostic studies	SR (with homogeneity*) of 2b and better studies	SR (with homogeneity*) of Level >2 economic studies
2b	Individual cohort study (including low quality RCT; e.g., <80% follow-up)	Retrospective cohort study or follow-up of untreated control patients in an RCT; Derivation of CDR* or validated on split-sample ^{§§§} only	Exploratory** cohort study with good ^{***} reference standards; CDR* after derivation, or validated only on split-sample ^{§§§} or databases	Retrospective cohort study, or poor follow-up	Analysis based on clinically sensible costs or alternatives; limited review(s) of the evidence, or single studies; and including multi-way sensitivity analyses
2c	"Outcomes" Research; Ecological studies	"Outcomes" Research		Ecological studies	Audit or outcomes research
3a	SR (with homogeneity*) of case-control studies		SR (with homogeneity*) of 3b and better studies	SR (with homogeneity*) of 3b and better studies	SR (with homogeneity*) of 3b and better studies
3b	Individual Case-Control Study		Non-consecutive study; or without consistently applied reference standards	Non-consecutive cohort study, or very limited population	Analysis based on limited alternatives or costs, poor quality estimates of data, but including sensitivity analyses incorporating clinically sensible variations.
4	Case-series (and poor quality cohort and case-control studies ^{§§})	Case-series (and poor quality prognostic cohort studies ^{***})	Case-control study, poor or non-independent reference standard	Case-series or superseded reference standards	Analysis with no sensitivity analysis
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"	Expert opinion without explicit critical appraisal, or based on economic theory or "first principles"

Table 2. Levels of Evidence for Included studies. Oxford CEBM (2009).

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