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EMERGENCY DEPARTMENT AND PREHOSPITAL POINT OF CARE TESTING–GUIDED TRAUMA RESUSCITATION; A SYSTEMATIC REVIEW OF TIME TO INTERVENTION, RESOURCE UTILIZATION, AND PATIENT OUTCOMES

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Abstract

Background: Point of care testing (POCT) in trauma resuscitation, particularly viscoelastic haemostatic assays and prehospital lactate, can accelerate recognition of coagulopathy and shock and may enable earlier, targeted interventions. We aimed to analyze original articles on emergency department (ED) and prehospital POCT guided trauma resuscitation regarding time to intervention, resource utilization, and patient outcomes. **Methods:** A PRISMA aligned systematic review of full text original studies evaluating POCT guided trauma resuscitation in ED and prehospital settings. Included studies reported at least one of: time to intervention, transfusion use, or clinical outcomes. Risk of bias was assessed using design appropriate tools. **Results:** Ten original studies (2 randomized trials; 8 observational cohorts) were included. In an ED pragmatic randomized trial, TEG guided massive transfusion protocol (MTP) management improved survival and reduced early plasma exposure compared with conventional assays. In the multicenter iTACTIC trial, adding VHA to empiric major hemorrhage protocols did not change the primary composite outcome or 28 day mortality overall, but VHA facilitated earlier targeted interventions. Observational ED and prehospital studies generally showed feasibility and potential improvements in transfusion targeting and decision making, triage, but outcome effects were inconsistent and limited by heterogeneity and confounding. Prehospital lactate predicted resuscitative care and supported decision tools for transfusion escalation. **Conclusion:** ED and prehospital POCT can shorten time to targeted hemostatic interventions and support more selective resource use. However, clinical outcome benefit is inconsistent in settings and protocols. Future trials should focus on protocol fidelity, standardized outcomes (time to hemostatic treatment, avoidable transfusion, and patient centered endpoints), and integrated aprehospital to ED pathways.

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Keywords: Trauma Resuscitation; Point of Care Testing; Thromboelastography; Rotational Thromboelastometry; Viscoelastic Haemostatic Assays; Lactate; Massive Transfusion; Emergency Department; Prehospital Care.

INTRODUCTION

Trauma hemorrhage remains a leading cause of early preventable death, and timely hemostatic resuscitation is central to survival. Contemporary approaches combine hemorrhage control with balanced transfusion and early correction of trauma induced coagulopathy (TIC). Conventional coagulation tests (CCTs) can be slow and provide limited functional insight into clot formation and fibrinolysis, potentially delaying targeted therapy in the initial “golden hour” of trauma care (Wikkelsø et al. 2016; Brill et al. 2021).

Viscoelastic haemostatic assays (VHA), thromboelastography (TEG) and thromboelastometry (ROTEM), provide rapid, whole blood functional assessment of coagulation and can be used at the point of care. These assays enable algorithm driven administration of plasma, platelets, fibrinogen products, and antifibrinolytics (tranexamic acid) based on dynamic clot parameters rather than static plasma based results (Gonzalez et al. 2016; Baksaas Aasen et al. 2020). Although VHA guided strategies are biologically plausible and widely adopted, uncertainty remains regarding consistent improvement in patient centered outcomes when used as an “add on” to modern empiric major hemorrhage protocols (Baksaas Aasen et al. 2020; Barrett et al. 2024).

In the prehospital phase, point of care lactate and other rapid bedside measurements may help identify occult shock, guide early activation of hemorrhage pathways, and inform transfusion decisions before arrival. For normotensive trauma patients, elevated prehospital lactate has been associated with subsequent need for resuscitative care (St John et al. 2018). In helicopter, critical care systems, prehospital lactate has also been evaluated as an adjunct to guide transfusion decisions and predict continued in hospital blood product need (Griggs et al. 2022).

METHODS

Protocol and reporting

This systematic review was conducted and reported in accordance with PRISMA 2020 principles (Page et al. 2021) with a prespecified question, eligibility criteria, and structured screening and extraction workflow.

Eligibility criteria

Population: Adult trauma patients, suspected major hemorrhage and TIC, or high risk trauma requiring activation level care.

Intervention and exposure: POCT used to guide resuscitation decisions (VHA, TEG, ROTEM algorithms; POCT lactate used to guide transfusion, activation, triage).

Comparator: Conventional coagulation tests, standard care, or pre implementation control periods; or alternative decision rules without POCT.

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Outcomes: At least one of time to intervention (time to targeted hemostatic therapy, time to transfusion decision, time to protocol directed intervention), resource utilization (blood products, hemostatic agents, MTP activations, ICU utilization), patient outcomes (mortality, organ dysfunction, LOS, complications). Original research (randomized trials, prospective, retrospective cohorts) with full text available.

Information sources and search strategy

We searched electronic databases for English language full text studies using combinations of:
(trauma OR hemorrhage OR coagulopathy) AND (point of care OR bedside) AND (TEG OR thromboelastography OR ROTEM OR thromboelastometry OR viscoelastic OR lactate) AND (prehospital OR emergency department OR trauma bay). Reference lists of included trials and key reviews were hand searched in PMC to identify additional eligible studies.

Study selection and data extraction

Two stage screening was performed: title, abstract screening; full text eligibility review. Discrepancies were resolved by consensus. A standardized form captured: design, setting, sample size, POCT modality, comparator, protocol features, timing metrics, resource utilization, and clinical outcomes. When studies did not report a specific time metric, we extracted the closest surrogate.

Risk of bias

Randomized trials: Cochrane RoB 2. Observational studies: Newcastle–Ottawa Scale (NOS). Given heterogeneity in interventions and outcomes, meta analysis was not performed; results were synthesized narratively with structured tables.

RESULTS

Ten original studies met inclusion criteria: 2 randomized controlled trials and 8 observational studies evaluating ED and, or prehospital POCT guided trauma resuscitation. Key characteristics and outcomes are summarized in Tables 1–2.

Table 1: Characteristics of included original studies

Study	Setting	Design	POCT modality	Comparator	Outcomes
Gonzalez et al. (2016)	ED (Level I trauma center)	Pragmatic RCT	TEG guided MTP	CCA guided MTP (INR, fibrinogen, platelets)	28 day survival; early blood product use
Baksaas Aasen et al. (2020) iTACTIC	Multicenter trauma centers (ED)	Pragmatic RCT	VHA (TEG, ROTEM) algorithm augmentation	CCT guided augmentation	Alive & free of massive transfusion at 24h; 28 day mortality; timing of interventions

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David et al. (2023)	Trauma resuscitation system	Observational propensity matched	ROTEM guided hemostatic resuscitation	CCT guided	Resource use; outcomes (matched analysis)
Salehi et al. (2023)	Trauma center ED	Retrospective cohort	ROTEM guided transfusion strategy	Standard, CCT practice	Blood product utilization; outcomes
Kozera et al. (2025)	Trauma center ED	Prospective cohort + historical control	ROTEM algorithm (shock room)	Pre ROTEM period	Blood products; factor concentrates; outcomes
Prat et al. (2017)	Combat support hospital	Prospective observational	ROTEM deployment	Pre implementation, standard	Transfusion, management feasibility and outcomes
Mohamed et al. (2017)	Trauma activation cohort	Observational	Early TEG directed therapy	Historical, standard	Time, resource measures; mortality associations
Spasiano et al. (2020, 2022 in PMC)	Prehospital trauma care pathway	Observational	VHA in prehospital workflow	Usual care	Feasibility and downstream management outcomes
St John et al. (2018)	Prehospital ALS to Level I center	Prospective cohort (secondary analysis)	Prehospital lactate	Shock index, vitals	Need for resuscitative care; early operative, transfusion needs
Griggs et al. (2022)	HEMS, prehospital major hemorrhage cohort	Retrospective cohort	Prehospital lactate decision support	Clinical variables	Prediction of continued in hospital transfusion; proposed tool

Table 2: Direction of effects in outcomes

Domain	Summary of findings	Supporting studies
Time to intervention	VHA algorithms can accelerate targeted hemostatic interventions versus conventional testing. In iTACTIC, first study intervention occurred a median 21 minutes earlier in the VHA arm (though primary outcome unchanged).	Baksaas Aasen et al. 2020
Blood product utilization	TEG guided MTP reduced early plasma exposure and improved survival versus conventional assays in a single center RCT. Observational ROTEM implementations commonly reported changes in transfusion practice and hemostatic product targeting.	Gonzalez et al. 2016 ; Salehi et al. 2023 ; Kozera et al. 2025 ; David et al. 2023
Patient outcomes	Evidence is mixed. iTACTIC found no overall difference in primary composite outcome or 28 day mortality. Single center ED RCT showed improved survival with TEG guided MTP. Observational studies are suggestive but confounded.	Baksaas Aasen et al. 2020 ; Gonzalez et al. 2016

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Domain	Summary of findings	Supporting studies
Prehospital decision support	Prehospital lactate predicted need for ED resuscitative care and supported stratified transfusion, activation decision making tools in major hemorrhage systems.	St John et al. 2018 ; Griggs et al. 2022

DISCUSSION

This review found that ED and prehospital POCT, especially VHA and lactate, can improve the speed and specificity of resuscitation decisions, but patient outcome benefits are inconsistent in contexts and protocols.

A consistent operational advantage is faster actionable information compared with conventional laboratory testing. In the iTACTIC trial, VHA guided arms received first targeted interventions earlier than the CCT arm, demonstrating a measurable acceleration of algorithm driven care, even though clinical outcomes were not different overall (Baksaas Aasen et al. 2020). Earlier targeted correction is conceptually important because TIC evolves rapidly and delays can perpetuate shock, hypoperfusion, and ongoing bleeding. Reviews of TIC and resuscitation emphasize that rapid diagnosis and correction of coagulopathy is a key element of damage control resuscitation (Brill et al. 2021; Savioli et al. 2021).

Resource utilization effects appear most reproducible where POCT is linked to explicit transfusion algorithms and clinician adherence is high. The pragmatic randomized ED trial by Gonzalez et al. showed improved survival with a TEG guided MTP and less early exposure to plasma, platelets, supporting the concept that individualized hemostatic therapy can reduce unnecessary component therapy while preserving (or improving) outcomes. In contrast, iTACTIC compared VHA augmented versus CCT augmented care on top of an empiric major hemorrhage protocol with intensive monitoring, which may have narrowed any incremental benefit achievable by VHA in that environment (Baksaas Aasen et al. 2020). This “ceiling effect” interpretation aligns with contemporary debate on whether modern empiric balanced transfusion reduces the marginal benefit of additional testing, or whether benefit depends on local baseline practice and delays with conventional tests (Barrett et al. 2024; Wikkelsø et al. 2016).

Differences in outcomes in trials and cohorts likely reflect: (1) population differences (severity, blunt vs penetrating, TBI burden), (2) variability in VHA platforms and thresholds, (3) protocol adherence, and (4) whether POCT replaced delays versus merely added information. iTACTIC did not demonstrate overall mortality benefit, but did show earlier interventions and suggested possible signal in a prespecified TBI subgroup (Baksaas Aasen et al. 2020). Meanwhile, Gonzalez et al. observed survival benefit in a single center system where conventional test turnaround and empiric strategies may have differed. These findings support the need for future implementation trials that measure “mechanism of benefit” endpoints (time to fibrinogen, platelet correction, avoidable transfusion, proportion receiving appropriate hemostatic therapy within prespecified windows) alongside mortality.

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Prehospital lactate addresses a different failure mode, occult shock and under triage in normotensive trauma. St John et al. demonstrated that elevated prehospital lactate predicted the need for resuscitative care in non hypotensive patients, using clinically meaningful endpoints such as early operative intervention, early transfusion, or ED death. Griggs et al. extended this by proposing lactate based decision support to guide (or de escalate) blood product transfusion pathways and to anticipate continued in hospital transfusion needs. While these studies do not prove outcome benefit, they support lactate as an actionable prehospital stratifier to trigger earlier hemorrhage activation, pre alerting, and timely product availability.

First, the evidence base is heterogeneous, preventing pooled effect estimates. Second, observational studies are prone to confounding by indication (sicker patients more likely to get POCT). Third, outcome definitions vary (massive transfusion, early intervention windows, protocol triggers), limiting comparability. Fourth, restricting to PMC full text improves verifiability but may omit relevant non PMC studies.

Health systems considering POCT guided trauma resuscitation should focus on end to end pathway integration: prehospital identification (lactate), ED immediate VHA testing, and strict algorithm adherence with audit feedback. Future studies should standardize core outcomes: time to first targeted hemostatic intervention, “avoidable component exposure,” balanced vs targeted transfusion efficiency, and long term neurologic outcomes in bleeding + TBI populations.

CONCLUSION

ED and prehospital POCT guided trauma resuscitation, especially VHA based algorithms and prehospital lactate, can shorten time to targeted interventions and support more selective resource utilization. High quality evidence for consistent improvements in mortality or major clinical outcomes is mixed: a single center ED RCT suggests benefit with TEG guided MTP, whereas the multicenter iTACTIC trial showed no overall outcome difference despite earlier interventions. Further pragmatic trials should evaluate integrated prehospital to ED pathways, protocol fidelity, and standardized time and resource centered outcomes.

List of Abbreviations

ALS: Advanced Life Support

CCA: Conventional coagulation assays

CCT: Conventional coagulation tests

ED: Emergency Department

HEMS: Helicopter Emergency Medical Services

INR: International Normalized Ratio

LOS: Length of Stay

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MHP: Major Hemorrhage Protocol

MTP: Massive Transfusion Protocol

POCT: Point of Care Testing

RBC: Red Blood Cells

ROTEM: Rotational Thromboelastometry

TEG: Thromboelastography

TBI: Traumatic Brain Injury

TIC: Trauma Induced Coagulopathy

VHA: Viscoelastic Haemostatic Assay

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