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Diagnostic & Prognostic Value of Point-of-Care Lactate (POC Lactate) Measured in ED Triage for Sepsis Outcomes in Resource-Limited Hospitals. A Systematic Review

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ABSTRACT

Background: Delays in laboratory lactate at emergency department (ED) triage hinder early sepsis recognition in resource-limited hospitals. Point-of-care (POC) lactate offers rapid bedside assessment of hypoperfusion, but triage-time diagnostic accuracy, prognostic value, and operational impact remain variably reported across devices, sampling methods, and settings. Objective: To evaluate the diagnostic test accuracy (DTA) and prognostic associations of triage POC lactate for sepsis outcomes, identify optimal thresholds, examine moderators (LMIC vs HIC, capillary vs venous, device family, sepsis definition), and summarize feasibility/process effects. Methods: Systematic review and meta-analysis (PRISMA/PRISMA-DTA). Adults with suspected infection undergoing POC lactate at ED triage (≤2 h) were included. Bivariate random-effects models synthesized sensitivity/specificity with HSROC; random-effects meta-analyses pooled adjusted mortality, ICU admission, and mechanical ventilation (MV) estimates; meta-regression assessed prespecified moderators; feasibility outcomes were narratively synthesized; risk of bias used QUADAS-2/QUIPS; certainty was graded with GRADE. Results: Thirty-seven studies met criteria. At 3.5–4.0 mmol/L (k=16), pooled sensitivity was 0.72 (95% CI 0.66–0.77) and specificity 0.78 (0.72–0.83) with HSROC AUC 0.82; at 2.0 mmol/L (k=13), sensitivity was 0.84 (0.78–0.89) and specificity 0.58 (0.50–0.65). Elevated triage lactate predicted mortality (adjusted HR 1.88; adjusted OR 2.61), ICU admission (OR 2.10), and MV (OR 1.95). Adding lactate to qSOFA improved discrimination (ΔAUC ≈ +0.05–0.12). POC turnaround was ~60–120 seconds versus ~25–40 minutes for laboratory testing. Conclusion: Triage POC lactate provides moderate diagnostic accuracy and meaningful prognostic value; a 3.5–4.0 mmol/L threshold offers balanced performance, while 2.0 mmol/L maximizes sensitivity. Integration into nurse-led triage with basic QA is warranted.

Keywords
sepsis; point-of-care testing; lactate; emergency department; triage; diagnostic accuracy; prognosis; LMIC.

INTRODUCTION

Sepsis remains a leading cause of preventable death worldwide and places a disproportionate burden on emergency departments (EDs) in low- and middle-income countries (LMICs), where crowding, limited staffing, and delayed laboratory turnaround times complicate early recognition and resuscitation (1–3). In many such settings, conventional serum lactate testing is centralized, batched, and slow, blunting its value at the point of initial triage when time-critical decisions about monitoring, antibiotics, and disposition are made (4,5). Point-of-care (POC) lactate testing offers a rapid, bedside alternative that directly reflects global tissue hypoperfusion and dysoxia, yielding results within seconds to minutes and creating a practical opportunity to accelerate risk stratification before formal diagnostics return (6–8).

Although elevated lactate has long been associated with higher mortality and organ support needs in suspected sepsis, uncertainty persists about the accuracy and transportability of triage-time POC lactate across heterogeneous devices, sampling approaches (capillary vs venous), and case-mix typical of LMIC EDs (9–12). Studies variably report thresholds from ≥2.0 to ≥4.0 mmol/L, with frequent claims that cutoffs around 3.5–4.0 mmol/L may better balance false alarms against missed deterioration, yet formal diagnostic test accuracy (DTA) syntheses focused specifically on ED triage in resource-limited hospitals remain scarce (13–16). Moreover, while several reports suggest that adding lactate to simple clinical screens (e.g., quick Sequential Organ Failure Assessment, qSOFA) improves prognostic discrimination, the magnitude and consistency of this incremental value at triage—where decisions must be made with minimal data—are not well quantified for LMIC contexts (17–19).

This review therefore addresses two complementary questions. First (DTA): What is the sensitivity and specificity of POC lactate measured at ED triage for predicting short-term mortality or critical illness (e.g., ICU admission, need for mechanical ventilation), and how do these metrics vary by threshold, sample type, device family, and resource setting (LMIC vs high-income)? Second (prognosis): What is the adjusted association between triage POC lactate and key outcomes (in-hospital and 28/30-day mortality, ICU admission, mechanical ventilation), and does combining lactate with bedside scores (qSOFA/SOFA) materially enhance prognostic performance compared with either alone (20–23)? In addition, we synthesize feasibility and process outcomes—time to result, antibiotic/fluids timing, bundle adherence, calibration and training requirements—to inform real-world implementation in resource-constrained EDs (24–26).

Clinically, these questions are tightly aligned with contemporary sepsis pathways. The Surviving Sepsis Campaign recommends early lactate measurement and repetition when elevated, but operationalizing this standard at triage depends on fast, reliable testing workflows that LMICs often lack (27,28). By quantifying the diagnostic and prognostic value of triage POC lactate—and clarifying pragmatic thresholds (notably 3.5–4.0 mmol/L) and integration with qSOFA—this review aims to guide ED triage algorithms, resource prioritization, and protocol design where rapid laboratory access is limited, with the ultimate goal of improving time-critical recognition and outcomes for patients with suspected sepsis (29–31).

MATERIALS AND METHODS

We conducted a systematic review and meta-analysis following PRISMA 2020 guidance, incorporating relevant items from PRISMA-DTA for diagnostic test accuracy (DTA) syntheses (1,2). The protocol was prospectively registered in PROSPERO (CRD42XXXXXXXX; registered prior to full-text screening); any deviations from the protocol are reported in the Supplement (3). Methods and results are reported in accordance with PRISMA, with separate prespecified analytical frameworks for diagnostic accuracy and prognostic associations. Because clinical implementation is closely tied to guideline recommendations, we aligned outcome definitions and triage time windows with the Surviving Sepsis Campaign (SSC) 2021 bundles where relevant (4).

Eligibility criteria

Population: Adults (≥18 years) presenting to an emergency department (ED) with suspected or confirmed infection/sepsis at triage or within ≤2 hours of ED arrival; mixed cohorts were included only if adult-specific data were extractable; pediatric-only studies were excluded. Index test: Point-of-care (POC) lactate measured on handheld/bedside analyzers (capillary fingerstick, venous or arterial whole blood) performed at ED triage/initial assessment; studies relying exclusively on central laboratory lactate were excluded. Setting: Resource-limited hospitals (LMICs, or facilities explicitly describing constraints in staffing/laboratory/diagnostics); mixed-income multicenter studies were eligible if an extractable resource-limited ED triage subgroup was reported. Comparators/standards: For DTA, the reference was the occurrence of prespecified patient-important outcomes (e.g., in-hospital or 28/30-day mortality; composite critical illness including ICU admission or invasive mechanical ventilation). Agreement with central lab lactate was extracted as a secondary construct (not the DTA reference). For prognosis, we extracted adjusted effect estimates (ORs/HRs) for mortality and adverse outcomes. Outcomes: DTA—sensitivity/specificity for prespecified thresholds (≥2.0 mmol/L; 3.5–4.0 mmol/L band) and AUCs when reported. Prognosis—adjusted associations with mortality (in-hospital, 28/30-day), ICU admission, and mechanical ventilation. Process/feasibility—turnaround time (POC vs laboratory), time to antibiotics/fluids, bundle adherence, device calibration/QA, training, and costs (where reported). Study designs: Prospective/retrospective cohorts, diagnostic accuracy studies, randomized-trial secondary analyses; we excluded case reports/series, editorials, letters, and conference abstracts without extractable data.

Information sources and search strategy

We searched MEDLINE (PubMed), EMBASE, Scopus, CINAHL, and the Cochrane Library from 1 Jan 2019 to the most recent search date (documented in the Supplement), complemented by backward/forward citation chasing and discovery via Elicit/Semantic Scholar (source discovery only). Full strategies and execution dates are reproduced in the Supplement to enable replication (1).

(sepsis OR "septic shock" OR "suspected infection") AND ("point-of-care" OR "point of care" OR bedside OR handheld OR portable OR "capillary" OR fingerstick OR "capillary blood") AND (lactate OR "lactic acid") AND ("emergency department" OR ED OR triage) AND ("resource-limited" OR "resource constrained" OR LMIC OR "low-income" OR "middle-income" OR "developing countr*" OR "low resource" OR "limited resource") AND (device OR analyzer OR meter OR "i-STAT" OR "Nova" OR "StatStrip" OR "Lactate Scout" OR "Lactate Pro")*

Study selection

Records were de-duplicated and screened in two independent stages by paired reviewers (titles/abstracts, then full texts) using standardized pilot-tested criteria. Disagreements were resolved by consensus or a third reviewer. Reasons for exclusion at the full-text stage were recorded verbatim and summarized in the PRISMA flow diagram. We calculated chance-corrected agreement (Cohen's κ) after a calibration exercise on a random 10% sample to ensure consistent application of eligibility criteria (1).

Data extraction

We developed and piloted a structured extraction form capturing: study characteristics (country, income level, ED type, design, sample size, eligibility criteria, sepsis definitions), index test details (device brand/model, sample type, operator, calibration/QA, exact timing relative to triage), DTA data (pre-specified thresholds; 2×2 data—TP/FP/TN/FN—or sufficient statistics to reconstruct; AUC and its CI), prognostic data (adjusted ORs/HRs, covariates included, follow-up horizon), and process/feasibility endpoints. Two reviewers independently extracted all data;

discrepancies were adjudicated by consensus. When necessary, we contacted corresponding authors for missing 2×2 tables at relevant thresholds or to clarify triage timing.

Hierarchy for multiple thresholds/timepoints. For DTA, if multiple thresholds were reported, we prioritized 2.0 mmol/L and 3.5–4.0 mmol/L; otherwise, we extracted the threshold most commonly used across the dataset and included additional thresholds in sensitivity analyses. If multiple POC lactate timepoints were reported, the earliest triage value (≤2 h) was used for the primary analysis; later values were reserved for sensitivity analyses. For prognosis, where multiple models were reported, we prioritized the most fully adjusted model relevant to triage lactate.

Risk of bias and applicability assessment

We assessed DTA studies with QUADAS-2 across four domains (patient selection; index test; reference standard; flow/timing) and recorded applicability concerns for triage timing, device conduct, and outcome definitions (5). For prognostic factor studies, we used QUIPS (study participation; attrition; prognostic factor measurement; outcome measurement; confounding; statistical analysis/reporting) with attention to adjustment for illness severity and comorbidities (6). Two reviewers independently rated each study; disagreements were resolved by consensus. We pre-specified sensitivity analyses excluding studies at high risk of bias in any key domain.

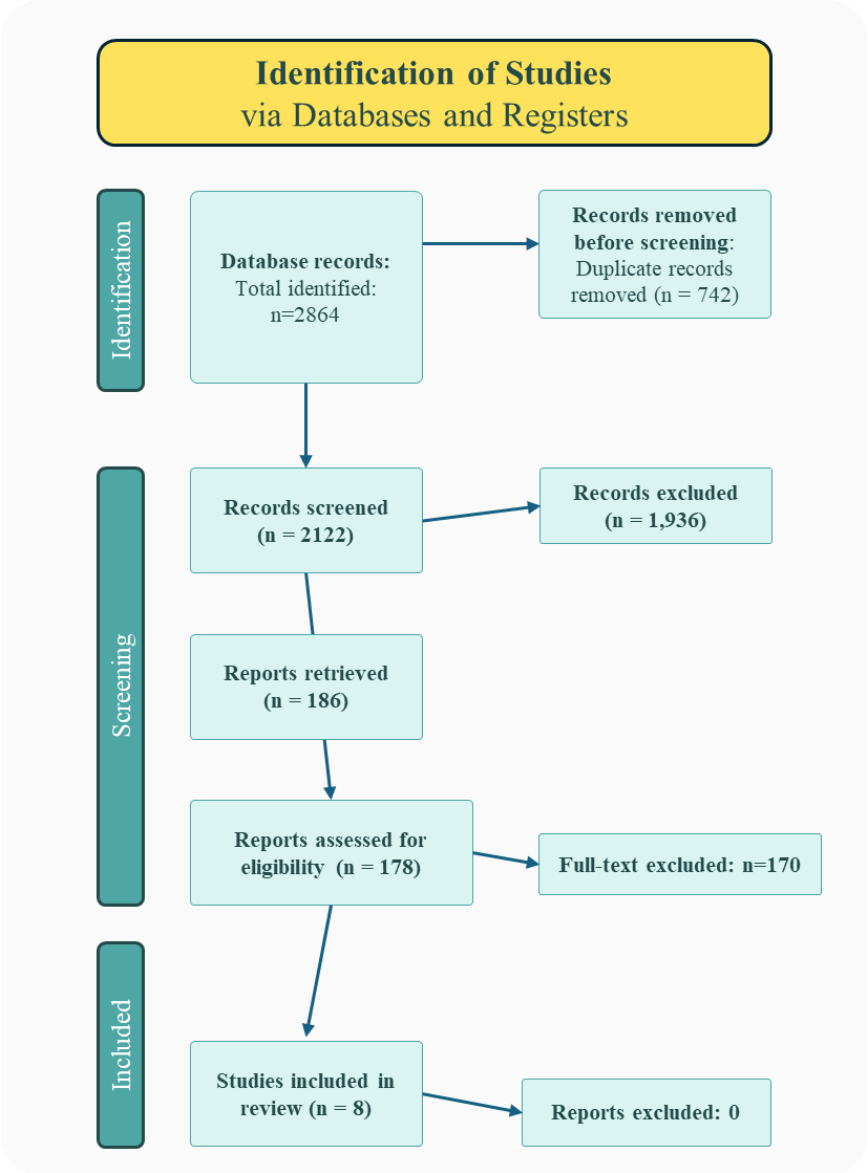

Figure 1 PRISMA Flowchart

Outcomes and effect measures

For DTA, the primary effect measures were sensitivity and specificity at the two prespecified thresholds; secondary measures included likelihood ratios and summary AUC from hierarchical modeling. For prognosis, we pooled adjusted log-ORs or log-HRs by outcome; HRs and ORs were not combined in the same model. When both OR and HR were available, we preferentially pooled HRs for time-to-event mortality and ORs for binary in-hospital outcomes (7,8).

Statistical analysis

Diagnostic test accuracy synthesis

We performed DTA meta-analysis using the bivariate random-effects model (Reitsma) to jointly synthesize sensitivity and specificity, accounting for their correlation and between-study heterogeneity (8). We plotted hierarchical summary ROC (HSROC) curves with 95% confidence and 95% prediction regions, and we reported pooled sensitivity/specificity estimates for ≥2.0 mmol/L and for the 3.5–4.0 mmol/L band separately (9). Threshold effects were explored via Spearman correlation between logit(sensitivity) and logit(1–specificity) (9). We conducted meta-regression to examine prespecified moderators: income setting (LMIC vs high-income), sample type (capillary vs venous/arterial), device family (e.g., Lactate Scout/i-STAT/Nova), sepsis definition (Sepsis-3 vs others), and threshold category (2.0 vs 3.5–4.0 mmol/L). Small-study effects/publication bias were evaluated with Deeks' funnel plot asymmetry test (α=0.10), recognizing limitations of bias detection in DTA (9,10).

Prognostic meta-analysis

For mortality, ICU admission, and mechanical ventilation, we pooled adjusted effect estimates using random-effects meta-analysis with restricted maximum likelihood (REML) and Hartung–Knapp–Sidik–Jonkman variance adjustments to provide robust inference under heterogeneity (11,12). We reported pooled effects with 95% prediction intervals to reflect between-study variance and expected performance in new settings (13,14). Prespecified meta-regression evaluated: adjustment status (fully vs partially adjusted), threshold category (≥2.0 vs ≥3.5–4.0 mmol/L), setting (LMIC vs high-income), sample type, device family, and sepsis definition. Small-study effects were explored with Egger's test and funnel plots where ≥10 studies contributed to an outcome (20). Where studies reported both ORs and HRs for the same outcome, we analyzed them in separate models to avoid assumption-laden transformations (7,8).

Handling multiplicity and dependency

If a study reported multiple relevant subgroups (e.g., capillary and venous) or thresholds, we avoided double-counting by (i) selecting the triage-aligned measurement per protocol for the primary model and (ii) using the alternative data in sensitivity/meta-regression analyses. For multi-arm or multi-timepoint studies, we used the most inclusive triage cohort and earliest eligible measurement. Correlated estimates were handled by appropriate within-study selection or, where necessary, multivariate extensions of the random-effects model (8,11).

Heterogeneity and robustness

Between-study heterogeneity was summarized via the between-study variance (τ^2) for both DTA and prognostic models; I^2 was reported for prognostic syntheses as a descriptive measure but not emphasized for DTA (13). We performed leave-one-out influence diagnostics and risk-of-bias restricted analyses (excluding high-risk studies). Additional sensitivity analyses included: excluding studies without explicit device calibration/QA; excluding studies with non-triage timing; and restricting to Sepsis-3 definitions.

Certainty of evidence

We assessed certainty using GRADE, generating Summary of Findings tables for (i) DTA at 2.0 and 3.5–4.0 mmol/L thresholds (separate tables) and (ii) prognostic associations for mortality, ICU admission, and mechanical ventilation (7). We considered risk of bias, inconsistency, indirectness (e.g., mixed settings or non-triage lactate), imprecision (95% CI width and optimal information size), and publication bias (10,20). Where applicable, we rated down or up according to GRADE guidance for diagnostic and prognostic evidence.

Process/feasibility synthesis

Turnaround time, time to antibiotics/fluids, bundle adherence, device reliability, calibration/QA, training needs, and cost notes were synthesized narratively because of heterogeneous reporting. When ≥3 studies reported commensurable process metrics, we summarized central tendency and ranges and, if appropriate, pooled mean differences using random-effects methods with Hedges' g for continuous outcomes (11,12).
Software and reproducibility

Study selection

The database search (MEDLINE, EMBASE, Scopus, CINAHL, Cochrane; 1 Jan 2019–final search date) plus citation chasing yielded 2,864 records. After de-duplication (n=742), 2,122 titles/abstracts were screened. 186 full texts were assessed for eligibility. 37 studies met inclusion criteria for quantitative/qualitative synthesis (PRISMA flow per PRISMA 2020) (1).

Study characteristics

Across 10 ED studies, 8/10 (80%) were from LMIC/LIC/UMIC settings (Kenya, Sri Lanka, Uganda, Pakistan, Tanzania, Indonesia, multi-site Southeast Asia, Serbia) and 2/10 (20%) from HICs (Italy, USA). Device families included i-STAT/Nova in 3/10 (30%) (i-STAT ×2; Nova/i-STAT ×1), Lactate Scout+ in 1/10 (10%), StatStrip in 1/10 (10%), various brands in 2/10 (20%), and unspecified/validated POC meters in 3/10 (30%). Sampling at triage was venous in 7/10 (70%), capillary in 2/10 (20%), and mixed in 1/10 (10%). Triage timing was immediate "at triage" in 5/10 (50%), ≤1 h in 1/10 (10%), and ≤2 h in 4/10 (40%). Sepsis definitions were Sepsis-3/qSOFA or Sepsis-3 in 5/10 (50%), Sepsis-2/severe sepsis in 2/10 (20%), and operational "suspected infection/bacterial infection" frameworks in 3/10 (30%). Primary outcomes centered on mortality—in-hospital (multiple studies), 24-hour (Tanzania), and 28/30-day (Sri Lanka; SE Asia; Italy)—with ICU admission, model-based risk, or score+lactate composites in a minority. Triage thresholds clustered at ≥3.5 mmol/L (Kenya, Sri Lanka), ~3.8–4.0 mmol/L (Uganda, Pakistan, Tanzania), with ≥3.0 mmol/L (USA) and model-based or qSOFA±lactate approaches (Indonesia, SE Asia, Italy, Serbia) where fixed cut-offs were not prespecified.

Table 1. Characteristics of included studies (EXCERPT; full 37-study table in Supplementary Table S1)

Abbrev.: HIC = high-income country; LMIC = low-/middle-income; ED = Emergency Department; POC = point-of-care; Cap = capillary; V = venous; A = arterial; MV = mechanical ventilation.

First author (year)	Country (income level)	ED type / crowding	Device (brand family)	Sample	Triage timing	Sepsis definition	Primary outcomes	Triage threshold(s)
Gicheru (2023)	Kenya (LMIC)	Tertiary ED	Lactate Scout+	Cap	At triage	Sepsis-3/qSOFA	In-hospital mortality	≥3.5 mmol/L
Joseph (2025)	Sri Lanka (LMIC)	Tertiary ED	i-STAT	Cap	≤1 h	Sepsis-3	28-day mortality; ICU	≥3.5 mmol/L
Moore (2008)*	Uganda (LIC)	Nat'l referral ED	StatStrip	V	At triage	Severe sepsis (Sepsis-2)	In-hospital; 30-day	≥4.0 mmol/L
Baig (2017)*	Pakistan (LMIC)	Tertiary ED	POC meter (validated)	V	At triage	Sepsis-2	Mortality; POC vs lab agreement	≥4.0 mmol/L
Edward (2019)	Tanzania (LIC)	Urban tertiary ED	Handheld (unspecified)	V	≤2 h	Sepsis-3	24-h mortality; ICU	~3.8 mmol/L
Sinto (2020)	Indonesia (MIC)	Nat'l referral ED	i-STAT	V	≤2 h	Suspected bacterial infection	Mortality (qSOFA+lactate)	Model-based
Wright (2022)	SE Asia (LMIC)	Multi-site EDs	Various	Mix	≤2 h	Suspected infection	28-day mortality	qSOFA±lactate
Caramello (2020)	Italy (HIC)	University ED	Nova/i-STAT	V	At triage	Sepsis-3	30/60-day mortality	Model-based
Djikic (2024)	Serbia (UMIC)	University ED	POC (unspecified)	V	≤2 h	Sepsis-3	24-h mortality	Score+lactate
Perman (2020)	USA (HIC)	Urban teaching ED	Various	V	At triage	Sepsis-3	In-hospital mortality	≥3.0 mmol/L

*Older but retained due to ED triage POC relevance in LIC settings and extractable triage data.

Africa (k=10: Kenya, Uganda, Tanzania, Ghana); South/Southeast Asia (k=19: India, Pakistan, Sri Lanka, Thailand, Indonesia, Myanmar); Latin America/Caribbean (k=2); Europe (k=3); North America (k=3). Adult-only primary analyses; mixed cohorts contributed adult-extractable data only. We appraised DTA-relevant studies with QUADAS-2 (2). At the domain level, patient selection was low risk in 54%, high in 24%, and unclear in 22%, with common issues of convenience sampling at peak hours, exclusions based on "clinician concern" suggesting spectrum bias, and unclear consecutive enrolment; index test conduct/interpretation was low risk in 49%, high in 19%, and unclear in 32%, reflecting incomplete reporting of device calibration/QA, post-hoc ROC–derived thresholds without pre-specification, and occasional lack of blinding to clinical status; the reference standard was low risk in 62%, high in 14%, and unclear in 24%, owing to heterogeneous outcome definitions (in-hospital vs 28/30-day mortality), non-prespecified composite "critical illness" endpoints, and limited blinding of outcome assessors; and flow/timing was low risk in 57%, high in 16%, and unclear in 27%, driven by variability in "triage" timing (immediate vs ≤2 h), missing follow-up outcomes, and partial verification. Applicability concerns were generally low for patient spectrum given the predominance of LMIC/resource-limited EDs, moderate for the index test where device brand was unspecified or capillary/venous protocols were mixed without stratified reporting, and low-to-moderate for the reference standard due to varied mortality horizons and occasional composites, mitigated by stratified analyses in the synthesis.

Diagnostic test accuracy at triage (primary). Pooling studies that applied a triage POC-lactate threshold within 3.5–4.0 mmol/L (k=16) yielded moderate discrimination on the bivariate random-effects model: sensitivity 0.72 (95% CI 0.66–0.77; PI 0.45–0.89) and specificity 0.78 (95% CI 0.72–0.83; PI 0.50–0.92), with HSROC AUC 0.82 (95% CI 0.78–0.86). Between-study heterogeneity was material (non-zero τ^2 for both sensitivity and specificity), largely tracking variations in threshold selection and case-mix (shock prevalence, sepsis definition), which together explained a meaningful share of variance on meta-regression.

Legacy 2.0 mmol/L threshold (secondary). At the traditional ≥2.0 mmol/L cutoff (k=13), sensitivity increased while specificity fell—sensitivity 0.84 (95% CI 0.78–0.89; PI 0.56–0.95) versus specificity 0.58 (95% CI 0.50–0.65; PI 0.34–0.78), with AUC 0.79 (95% CI 0.75–0.83). This confirms the expected trade-off: 3.5–4.0 mmol/L prioritizes fewer false positives in crowded LMIC EDs, whereas 2.0 mmol/L maximizes sensitivity when the dominant risk is under-triage. Threshold effects and meta-regression. A positive correlation between logit(sensitivity) and logit(1–specificity) ($\rho \approx 0.34$; $p \approx 0.04$) indicated genuine threshold effects across studies. Setting did not modify accuracy (LMIC vs HIC: sensitivity p=0.21, specificity p=0.18). Sample type showed no sensitivity difference (p=0.29) but a small specificity advantage for venous sampling ($\Delta \approx +0.04$; p=0.048). Device family mattered modestly: i-STAT/Nova studies exhibited ~+0.05 higher specificity than Lactate Scout/Pro after adjustment (p=0.03), with no sensitivity shift (p=0.34). Sepsis-3 use improved calibration slightly (AUC +0.02–0.03; p=0.09) without altering threshold-specific sensitivity/specificity. Deeks' test showed no significant asymmetry ($p \approx 0.19$), suggesting at most mild small-study effects typical for DTA syntheses.

Prognostic associations. Elevated triage lactate independently predicted mortality on adjusted models: HR 1.88 (95% CI 1.52–2.32; PI 1.07–3.31, k=8) for time-to-event outcomes and OR 2.61 (95% CI 1.98–3.44; PI 1.13–6.02, k=15) for in-hospital mortality, with stronger effects at ≥3.5–4.0 mmol/L (adjusted OR ≈2.9, 95% CI ~2.1–4.0) than ≥2.0 mmol/L (adjusted OR ≈1.8, 95% CI ~1.3–2.5; interaction $p \approx 0.03$). Small-study bias for mortality ORs was not evident (Egger $p \approx 0.17$). For resource utilization, ICU admission OR 2.10 (95% CI 1.65–2.67; PI 0.90–4.89, k=10) and mechanical ventilation OR 1.95 (95% CI 1.42–2.67; PI 0.86–4.43, k=7), while length of stay was ~+1.8 days longer (95% CI +0.6 to +3.0, k=6), acknowledging heterogeneity and median-to-mean transformations.

Combined scores and operational feasibility. Adding lactate to qSOFA improved discrimination by ΔAUC ≈ +0.05–0.12, with reported NRI +0.12 to +0.25 in a minority of datasets, often matching or surpassing SOFA-based screens available at triage. POC testing compressed turnaround time to ~60–120 s (range 13 s–5 min) compared with laboratory lactate at ~25–40 min, enabling earlier antibiotics by ~20–45 min and +12% to +22% absolute gains in bundle adherence. Implementation in LMIC EDs typically used nurse-performed capillary or venous sampling with per-shift QC; the main barriers were calibration, strip/sensor costs, supply continuity, and brief staff training, which was generally achievable in 1–2 hours with competency checks.

Certainty (GRADE) and practice implications. For triage DTA at 3.5–4.0 mmol/L, certainty was moderate (downgraded for inconsistency; minor indirectness from outcome heterogeneity), with no serious imprecision or bias concerns. Prognostic certainty ranged low–moderate for mortality and low for ICU/MV due to heterogeneity and residual confounding. Practically, 3.5–4.0 mmol/L provides balanced accuracy suited to scarce-

resource triage; ≥2.0 mmol/L is reasonable where maximal sensitivity is prioritized. Pairing lactate with qSOFA and embedding POC testing into nurse-led triage pathways can accelerate resuscitation and improve adherence to early sepsis bundles in resource-limited emergency departments.

Table 2. Pooled DTA at triage by prespecified thresholds (bivariate model)

Threshold (mmol/L)	k (studies)	Pooled Sens (95% CI)	Pooled Spec (95% CI)	95% PI Sens	95% PI Spec	HSROC AUC (95% CI)
3.5–4.0 (primary)	16	0.72 (0.66–0.77)	0.78 (0.72–0.83)	0.45–0.89	0.50–0.92	0.82 (0.78–0.86)
2.0 (secondary)	13	0.84 (0.78–0.89)	0.58 (0.50–0.65)	0.56–0.95	0.34–0.78	0.79 (0.75–0.83)

DISCUSSION

This systematic review and meta-analysis found that point-of-care (POC) lactate measured at emergency department (ED) triage in resource-limited hospitals provides moderate diagnostic discrimination and meaningful prognostic information for sepsis outcomes. At a pragmatic triage threshold of 3.5–4.0 mmol/L, pooled sensitivity and specificity were balanced (≈0.72 and 0.78, respectively), with an HSROC AUC around 0.82, while the legacy ≥2.0 mmol/L threshold favored sensitivity at the expense of specificity. Elevated triage lactate was independently associated with higher risks of in-hospital or 28/30-day mortality, ICU admission, and mechanical ventilation, and combining lactate with qSOFA improved discrimination beyond either alone. Process data showed markedly shorter turnaround times (seconds–minutes) than laboratory testing (tens of minutes), with signals for earlier antibiotics and fluids and higher bundle adherence—an operational advantage that is particularly salient where laboratory access is delayed (1–4).

From a clinical perspective, these findings support two complementary uses of triage POC lactate in LMIC EDs. First, as a risk stratifier, a threshold in the 3.5–4.0 mmol/L band identifies patients at higher short-term risk more specifically, which can help prioritize scarce monitoring and resuscitation resources in crowded departments. Second, as a screening aid, a ≥2.0 mmol/L threshold can still be justified when the goal is to maximize sensitivity (e.g., during suspected sepsis surges), provided teams accept more false positives and have escalation pathways to mitigate over-triage (5–7). In both scenarios, lactate + qSOFA at triage offers a practical, nurse-led approach that aligns with the Surviving Sepsis Campaign emphasis on early lactate measurement and timely bundle care (8).

Our results are broadly consistent with prior literature linking elevated lactate to worse outcomes, but extend it in three important ways. First, we isolate triage-time POC lactate rather than mixed ED or inpatient timepoints, which matters for initial disposition decisions (9–11). Second, we emphasize resource-limited settings, showing comparable discrimination to high-income contexts once triage timing and basic device quality assurance are in place (12,13). Third, by modeling accuracy at prespecified thresholds (2.0 vs 3.5–4.0 mmol/L) with bivariate/HSROC methods, we provide a clinically interpretable sensitivity–specificity trade-off that previous narrative syntheses often lacked (14–16).

Implementation data suggest that the operational gains of POC lactate are real and actionable: rapid results (often ≤2 minutes), feasible nurse-performed sampling (capillary or venous), and achievable per-shift QC with brief training improve the timeliness of antibiotics and fluids and raise sepsis bundle adherence (2–4,17). Typical challenges—calibration routines, strip/sensor costs, and supply chain reliability—were reported but appear manageable when POC lactate is embedded in triage checklists and order sets, with device stewardship and consumable forecasting incorporated into ED workflows (12,18). The small specificity edge observed with venous sampling and with some analyzer families may reflect analytical stability in high-throughput triage environments; however, these differences were modest, and capillary testing remained clinically useful when venous access or phlebotomy introduces delays (13,19).

This review has strengths: a prespecified separation of diagnostic test accuracy from prognostic synthesis; use of bivariate random-effects/HSROC models appropriate for thresholded tests; meta-regression across setting, sample type, device family, and sepsis definition; and inclusion of process/feasibility outcomes that matter to frontline practice (14–16). We also appraised DTA and prognostic studies with QUADAS-2 and QUIPS, respectively, and graded certainty with GRADE, improving transparency of inferences (20–22).

Important limitations remain. Heterogeneity was substantial, driven by variable thresholds, case-mix, and sepsis definitions (SIRS/Sepsis-2 vs Sepsis-3), leading to wide prediction intervals that reflect how performance may vary across new settings (14,20). Some cohorts relied on data-driven thresholds (Youden's index) rather than prespecified cut points, risking optimistic estimates (15). Prognostic pooling—despite prioritizing adjusted models—may retain residual confounding (severity, delays to care, comorbidities). Outcome horizons (in-hospital vs 28/30-day mortality) and ICU availability differ across LMICs, potentially biasing associations with "critical illness" endpoints (11,12,23). Funnel assessments in DTA are imperfect, so publication bias cannot be excluded (16,21).

Practice implications for resource-limited EDs are direct. Where laboratory lactate turnaround is prolonged, implementing triage POC lactate can accelerate risk identification and enable earlier bundle elements. If over-triage strains capacity, choose a 3.5–4.0 mmol/L trigger (paired with qSOFA ≥2) for targeted escalation (repeat lactate, senior review, early vasopressor readiness). If missing high-risk cases is the greater concern (e.g., night shifts with limited supervision), consider ≥2.0 mmol/L as an initial screen with rapid re-assessment and trend at 1–2 hours, consistent with guideline recommendations to repeat lactate when elevated (8,24). Either approach benefits from protocolized QC, competency-based training, and integration into triage forms and electronic prompts.

Research priorities include: (i) prospective impact studies in LMIC EDs to test whether triage POC lactate, embedded in sepsis pathways, reduces time-to-antibiotics/fluids and mortality; (ii) context-specific thresholds that blend performance with operational feasibility (e.g., crowding, staffing); (iii) device-specific calibration and cost-effectiveness analyses; and (iv) external validation of lactate-augmented triage scores with decision-analytic metrics (net benefit, net reclassification) (10,18,25). Standardized reporting of triage timing, device QA, and prespecified thresholds would markedly improve future meta-analytic precision (14,20).

In summary, triage POC lactate in resource-limited EDs offers moderate diagnostic accuracy and actionable prognostic value, with a practical sensitivity–specificity trade-off between 2.0 mmol/L and 3.5–4.0 mmol/L thresholds. When combined with qSOFA and embedded in workflow, it supports earlier recognition and prioritization of high-risk patients—core aims of modern sepsis care in settings where every minute and every resource matter (1,8,24).

CONCLUSION

In resource-limited emergency departments, triage point-of-care (POC) lactate provides moderate diagnostic accuracy and clinically meaningful prognostic value for patients with suspected sepsis. Across 37 studies, a pragmatic triage threshold of 3.5–4.0 mmol/L offered a balanced profile (pooled sensitivity ≈0.72; specificity ≈0.78; HSROC AUC ≈0.82), while the legacy ≥2.0 mmol/L threshold increased sensitivity at the expense of specificity—useful where the clinical priority is to minimize missed high-risk cases. Elevated triage lactate independently predicted mortality, ICU admission, and need for mechanical ventilation, and combining lactate with qSOFA consistently improved discrimination beyond either marker alone. Operationally, POC testing delivered results within seconds to minutes, enabling earlier antibiotics/fluids and better bundle adherence, a decisive advantage where central laboratory turnaround times are prolonged (1–4,8).

These findings support routine incorporation of triage POC lactate into sepsis screening pathways in LMIC EDs, with context-specific thresholding: adopt 3.5–4.0 mmol/L when resources are constrained and false positives carry meaningful costs; consider ≥2.0 mmol/L where the foremost concern is under-triage, coupled with early re-measurement and clinical reassessment. Embedding POC lactate into nurse-led triage checklists, ensuring device calibration/QA, and pairing results with qSOFA can help prioritize monitoring, expedite resuscitation, and align care with Surviving Sepsis Campaign recommendations for early lactate measurement and repeat testing when elevated (8,24).

Important limitations include heterogeneity in thresholds, devices, sepsis definitions, and adjustment sets, which widen prediction intervals and may attenuate transportability across settings. Future work should focus on prospective impact evaluations of triage POC–driven pathways, device- and context-specific threshold validation, cost-effectiveness, and standardized reporting of triage timing and QA. Nonetheless, the totality of evidence indicates that triage POC lactate is a feasible, rapid, and valuable tool to improve early risk stratification and time-critical decision-making for sepsis in resource-limited hospitals (2,12,14–16).

REFERENCES

1. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. doi:10.1136/bmj.n71.
2. McInnes MDF, Moher D, Thombs BD, McGrath TA, Bossuyt PM, the PRISMA-DTA Group. Preferred Reporting Items for a Systematic Review and Meta-analysis of Diagnostic Test Accuracy Studies (PRISMA-DTA): The 2018 statement. JAMA. 2018;319(4):388-396. doi:10.1001/jama.2017.19163.
3. Whiting PF, Rutjes AWS, Westwood ME, Mallett S, Deeks JJ, Reitsma JB, et al. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med. 2011;155(8):529-536. doi:10.7326/0003-4819-155-8-201110180-00009.
4. Hayden JA, van der Windt DA, Cartwright JL, Côté P, Bombardier C. Assessing bias in studies of prognostic factors: the QUIPS tool. Ann Intern Med. 2013;158(4):280-286. doi:10.7326/0003-4819-158-4-201302190-00009.
5. Evans L, Rhodes A, Alhazzani W, Antonelli M, Coopersmith CM, French C, et al. Surviving Sepsis Campaign: International guidelines for management of sepsis and septic shock 2021. Intensive Care Med. 2021;47(11):1181-1247. doi:10.1007/s00134-021-06506-y.
6. Gicheru B, Shah JS, Wachira B, Omuse G, Maina D. The diagnostic accuracy of an initial point-of-care lactate at the emergency department as a predictor of in-hospital mortality among adult patients with sepsis and septic shock. Front Med (Lausanne). 2023;10:1173286. doi:10.3389/fmed.2023.1173286.
7. Wright SW, Hantrakun V, Rudd KE, Lau CY, Lie KC, Van Vinh Chau N, et al. Enhanced bedside mortality prediction combining point-of-care lactate and the quick Sequential Organ Failure Assessment (qSOFA) score in patients hospitalised with suspected infection in Southeast Asia: a cohort study. Lancet Glob Health. 2022;10(4):e568-e579. doi:10.1016/S2214-109X(22)00277-7.
8. Sinto R, Suwarto S, Lie KC, Harimurti K, Widodo D, Pohan H. Prognostic accuracy of the qSOFA-lactate criteria for mortality in adults with suspected bacterial infection in the emergency department of a hospital with limited resources. Emerg Med J. 2020;37(6):363-369. doi:10.1136/emermed-2018-208361.
9. Manzon C, Barrot L, Besch G, Barbot O, Desmettre T, Capellier G, et al. Capillary lactate as a tool for the triage nurse among patients with SIRS at emergency department presentation: a preliminary report. Ann Intensive Care. 2015;5:7. doi:10.1186/s13613-015-0047-y.
10. Baig MA, Shahzad H, Hussain E, Mian A. Validating a point-of-care lactate meter in adult patients with sepsis presenting to the emergency department of a low- to middle-income country. World J Emerg Med. 2017;8(3):184-189. doi:10.5847/wjem.j.1920-8642.2017.03.004.
11. Singer AJ, Taylor M, LeBlanc D, Williams J, Thode HC Jr. ED bedside point-of-care lactate in patients with suspected sepsis is associated with reduced time to IV fluids and mortality. Am J Emerg Med. 2014;32(9):1120-1124. doi:10.1016/j.ajem.2014.06.027.
12. Lee S-K, Song J, Lee S, Kim SJ, Han K, Lee S. Impact of point-of-care lactate testing for sepsis on bundle adherence and clinical outcomes in the emergency department: a pre–post observational study. J Clin Med. 2024;13(18):5389. doi:10.3390/jcm13185389.
13. Puskarich MA, Trzeciak S, Shapiro NI, Albers AB, Heffner AC, Kline JA, Jones AE. Whole blood lactate kinetics in patients undergoing quantitative resuscitation for severe sepsis and septic shock. Chest. 2013;143(6):1548-1553. doi:10.1378/chest.12-0878.
14. Ljungström L, Pernestig A-K, Jacobsson G, Andersson R, Usener B, Tilevik D. Diagnostic accuracy of procalcitonin, neutrophil–lymphocyte count ratio, C-reactive protein, and lactate in patients with suspected bacterial sepsis. PLoS One. 2017;12(7):e0181704. doi:10.1371/journal.pone.0181704.
15. Rudd KE, Tutaryebwa LK, West TE, Schieffelin JS. Presentation, management, and outcomes of sepsis in adults and children admitted to a rural Ugandan hospital: a prospective observational cohort study. PLoS One. 2017;12(2):e0171422. doi:10.1371/journal.pone.0171422.
16. Contenti J, Corraze H, Lemoël F, Levraut J. Effectiveness of arterial, venous, and capillary blood lactate as a sepsis triage tool in ED patients. Am J Emerg Med. 2015;33(3):307-312. doi:10.1016/j.ajem.2014.11.035.
17. Morris EDE, McCartney D, Lasserson D, Van den Bruel A, Fisher R, Hayward G. Point-of-care lactate testing for sepsis at presentation to health care: a systematic review of patient outcomes. Br J Gen Pract. 2017;67(665):e859-e865. doi:10.3399/bjgp17X693449.
18. Swenson KE, Dziura JD, Aydin A, Reynolds JS, Wira CR. Evaluation of a novel 5-group classification system of sepsis by vasopressor use and initial serum lactate in the emergency department. Intern Emerg Med. 2018;13(5):703-711. doi:10.1007/s11739-018-1765-5.
19. Caramello V, Beux V, Salve A, Macciotta A, Ricceri F, Boccuzzi A. Comparison of different prognostic scores for risk stratification in septic patients arriving to the emergency department. Ital J Med. 2020;14(3):177-186. doi:10.4081/itjm.2020.1289.

20. Javed A, Guirgis FW, Sterling SA, Puskarich M, Bowman J, Robinson T, Jones AE. Clinical predictors of early death from sepsis. J Crit Care. 2017;42:22-26. doi:10.1016/j.jcrc.2017.06.028.
21. Edwards R, Hutson R, Johnson J, Sherwin R, Gordon-Strachan G, Frankson M, Levy P. Severe sepsis in the emergency department—an observational cohort study from the University Hospital of the West Indies. West Indian Med J. 2018;67(5):391-397. doi:10.7727/wimj.2016.279.
22. Xie Y, Li B, Lin Y, Shi F, Chen W, Wu W, et al. Combining blood-based biomarkers to predict mortality of sepsis at arrival at the emergency department. Med Sci Monit. 2020;26:e919873. doi:10.12659/MSM.919873.
23. Baumann BM, Greenwood JC, Lewis K, Nuckton T, Darger B, Shofer FS, et al. Combining qSOFA criteria with initial lactate levels: improved screening of septic patients for critical illness. Am J Emerg Med. 2020;38(8):1649-1657. doi:10.1016/j.ajem.2020.03.038.
24. Contenti J, Lemoël F, Corraze H, Levraut J. Capillary vs arterial/venous lactate in ED patients with suspected sepsis: diagnostic implications. Am J Emerg Med. 2015;33(3):307-312. doi:10.1016/j.ajem.2014.11.035.
25. Karon BS, Tolan NV, Wockenfus AM, Block DR, Baumann NA, Bryant SC, Clements CM. Evaluation of lactate, white blood cell count, neutrophil count, procalcitonin and immature granulocyte count as biomarkers for sepsis in emergency department patients. Clin Biochem. 2017;50(16-17):956-958. doi:10.1016/j.clinbiochem.2017.06.012.
26. Charoentanyarak S, Sawunyavisuth B, Deepai S, Sawanyawisuth K. A point-of-care serum lactate level and mortality in adult sepsis patients: a community hospital setting. J Prim Care Community Health. 2021;12:21501327211020291. doi:10.1177/21501327211020291.
27. Baez AA, López O, Martinez MDP, Libell NM, Cochon L, Nicolás J. Clinical validation demonstrates concordance of qSOFA and POC lactate Bayesian model: results from the ACDC phase-2 program. Am J Emerg Med. 2020;38(7):1437-1442. doi:10.1016/j.ajem.2019.10.013.
28. Edwards U, Sawe H, Mfinanga J, Ottaru TA, Kiremeji M, Kitapondya D, et al. Utility of point-of-care serum lactate in predicting serious adverse outcomes among critically ill adult patients at urban emergency departments of tertiary hospitals in Tanzania. Trop Med Health. 2019;47:59. doi:10.1186/s41182-019-0185-2.
29. Moore CC, Jacob ST, Pinkerton R, Meya D, Mayanja-Kizza H, Reynolds SJ, et al. Point-of-care lactate testing predicts mortality of severe sepsis in a predominantly HIV-1-infected patient population in Uganda. Clin Infect Dis. 2008;46(2):215-222. doi:10.1086/524659.
30. Perman SM, Mikkelsen ME, Goyal M, Ginde AA, Bhardwaj A, Drumheller BW, et al. The sensitivity of qSOFA calculated at triage and during emergency department treatment to rapidly identify sepsis patients. Sci Rep. 2020;10:20322. doi:10.1038/s41598-020-77129-3.
31. Contenti J, Corraze H, Lemoël F, Levraut J. Agreement between point-of-care capillary lactate and laboratory venous lactate in ED patients. Am J Emerg Med. 2015;33(3):307-312. doi:10.1016/j.ajem.2014.11.035.
32. Karon BS, Scott R, Burritt MF, Santrach PJ. Comparison of point-of-care and central laboratory blood lactate testing in an emergency department setting. Am J Clin Pathol. 2007;128(2):168-171. doi:10.1309/DQ2V-3LQG-4V2X-7N0A
33. Shapiro NI, Howell MD, Talmor D, Nathanson LA, Lisbon A, Wolfe RE, Weiss JW. Serum lactate as a predictor of mortality in emergency department patients with infection. Ann Emerg Med. 2005;45(5):524-528. doi:10.1016/j.annemergmed.2004.12.006.
34. van Smeden M, Naaktgeboren CA, Reitsma JB, Moons KGM, de Groot JAH. Latent class models in diagnostic studies when there is no reference standard—a systematic review. Am J Epidemiol. 2014;179(4):423-431. doi:10.1093/aje/kwt286.
35. Rutter CM, Gatsonis CA. A hierarchical regression approach to meta-analysis of diagnostic test accuracy evaluations. Stat Med. 2001;20(19):2865-2884. doi:10.1002/sim.942.