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Systematic Review

Sepsis in Saudi Arabian acute care settings, a systematic review of epidemiology, prognostic markers, antimicrobial management, and prediction models

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Abstract

Background: Sepsis is a primary driver of in-hospital mortality. Guideline driven bundles have not eliminated outcome variability in settings, and significant implementation challenges persist.This review synthesizes Saudi and regional studies regarding sepsis epidemiology, prognostication, antimicrobial timing, stewardship, and the performance of prediction models in emergency and ICU settings. **Methods:** We conducted a PRISMA aligned systematic review, searching electronic databases for adult studies in acute care hospitals. Eligible designs (observational cohorts, qualityimprovement reports) were required to report mortality, ICU admission, organ support, length of stay, or model performance (discrimination, calibration). Two reviewers screened, extracted data, and assessed bias. Significant heterogeneity necessitated a narrative synthesis. **Results:** Ten studies met inclusion criteria. High ICU mortality from septic shock was a consistent finding. Both comorbidity and dynamic laboratory markers (platelet trajectories) had strong prognostic value. Evidence comparing antimicrobial timing (less than 1 hour versus 1-3 hours) in the ED was heterogeneous post adjustment. We also identified significant operational barriers to culture guided de-escalation. Prediction models showed reasonable discrimination but variable calibration, requiring local validation before use. **Conclusions:** Key gaps identified include strengthening stewardship, HAI prevention, and the cautious, validated-only use of predictive models. Priorities for future work include standardized definitions and prospective multicenter evaluations.

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Introduction

Sepsis is a life-threatening organ dysfunction from a deregulated host response, it is a primary driver of in-hospital morbidity and mortality, even with modern antimicrobial and critical care. Global guidelines advocate for early recognition, source control, timely antibiotics, and protocolized resuscitation. Such structured programs are linked to improved care processes and reduced mortality. Implementation is hindered by case-mix heterogeneity, resource variability, and the known inaccuracies of traditional screening tools. This gap necessitates context specific evidence [1].

The field of predictive informatics has advanced. A recent systematic review and meta-analysis of diagnostic accuracy found that machine learning (ML) models achieved high AUROC values for sepsis prediction across ICU, ward, and ED settings. Heterogeneity in definitions and reporting standards severely limited data pooling and clinical generalizability [2]. While guidelines acknowledge that ML supported screening outperform classical tools in specific cohorts, they also urge caution, as model sensitivity and specificity vary significantly by setting and dataset [1].

Hospital acquired infections (HAIs) represent a significant sepsis risk. A meta-analysis from Iran estimated an 11.1% HAI prevalence, primarily respiratory and urinary, identifying these as preventable upstream drivers [3]. The clinical impact is severe: a prospective cohort in Jordanian ICUs reported 30-day mortality exceeding 50% for adults with sepsis, with SOFA scores and solid tumors as key predictors [4]. Saudi specific data mirrors this. A report from Buraidah Central Hospital (Qassim) found 16% of ICU admissions met sepsis criteria; 75% presented in septic shock (mostly pulmonary), and hospital mortality was 40.3%, correlating with APACHE II/SOFA scores and invasive ventilation [5].

This systematic review was undertaken to synthesize the available Saudi and regional literature on sepsis epidemiology, prognostication, antimicrobial management, and prediction-model performance. Our objective was to consolidate evidence from both ED and ICU settings to identify modifiable factors in early-phase care, contextualize the adoption of predictive analytics, and inform a pragmatic, locally adapted pathway to reduce mortality from sepsis [1-5].

Methodology

We conducted this systematic review following the PRISMA 2020 guidance. To ensure comprehensive retrieval, we searched electronic databases and also hand screened the reference lists of all included studies. Our search strategy combined controlled vocabulary (MeSH) with free-text terms for sepsis, septic shock, acute care settings (ED, ICU), and the relevant geographic contexts. We used a prespecified PICOS framework to define eligibility:

Population: Adults in acute-care hospital settings (ED, ICU, wards) with suspected or confirmed sepsis or septic shock.

Intervention

Any relevant exposure, including usual sepsis care, specific prognostic markers, antimicrobial timing, or the application of a risk-prediction model.

Comparator

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Standard care, alternative timings/thresholds, or other relevant risk strata, when applicable.

Outcomes

Key clinical outcomes (mortality, ICU admission, organ support, length of stay) or model performance metrics (validated discrimination, calibration).

Study Designs

We included observational cohorts, casecontrol, cross-sectional, and quality improvement, descriptive studies. We excluded editorials, case reports, and pediatric-only studies.

Study Selection and Data Extraction

Our study selection was a two-stage process. Two reviewers screened all titles and abstracts against the eligibility criteria. They reviewed the full text of any relevant record. Any disagreements at either stage were resolved by consensus. We logged the specific reasons for all full text exclusions.

A PRISMA flow diagram details this screening and inclusion process. For data extraction, we developed and piloted a dedicated form. This form captured citation details, study design, setting, sample size, patient characteristics, the sepsis definition used, and all relevant PICOS data. As with screening, two reviewers extracted all data independently and then cross checked their entries for accuracy. We attempted to contact corresponding authors for missing or unclear data when feasible.

Risk of Bias and Data Synthesis

We assessed the risk of bias in non-randomized studies using the Newcastle-Ottawa Scale (NOS), tailored for cohort or case control designs. For descriptive studies, we used an adapted methodological checklist that focused on sampling, measurement, and confounding. Two reviewers rated each study, and these judgments informed our final interpretation.

We prespecified our synthesis plan. We anticipated significant clinical and methodological heterogeneity (varied settings, definitions, and outcomes), so our primary plan was a structured narrative synthesis. We grouped results by theme (epidemiology, biomarkers, antimicrobial timing, prediction models, etc.

We only planned to conduct a random effects meta-analysis (using the Hartung-Knapp adjustment) if we found two or more studies that were sufficiently homogeneous. we presented all effect sizes and their 95% confidence intervals descriptively. We planned to appraise the certainty of evidence for our main outcomes using the GRADE framework.

Result

In the ten Saudi studies including ED and ICU settings, designs were mainly retrospective cohorts with two single center descriptive, quality-improvement analyses. Sample sizes ranged from 62 ICU patients to 7,906 ED, ICU sepsis encounters, including a cirrhosis subgroup of 497 patients [6].

In ICU cohorts, mortality prediction and epidemiology were prominent. A prospective ICU study validated six mortality models in severe sepsis, septic shock; overall discrimination was adequate, with the best AUC for customized MPM II24 (0.826), while several models showed poor calibration [7]. A descriptive ICU series from Qassim reported that 16% of ICU admissions were sepsis, 75.8% presented

in septic shock, pulmonary infections predominated, [10]. A tertiary center cohort identified and hospital mortality reached 40.3% [5].

Citation	Study design	Sample size	Population characteristics	Method	Study aim
Algethamy et al. 2025 (13)	Retrospective cohort at a large tertiarycare center.	235 adult inpatients with complicated skin, soft tissue infections.	Adults hospitalized for complicated SSTIs at King Abdulaziz University Hospital, Jeddah, Saudi Arabia.	Electronic record abstraction of demographics, comorbidities, labs; logistic regression for predictors of sepsis, ICU admission, and mortality.	Identify predictors of sepsis, ICU admission, and death in hospitalized complicated SSTI patients.
Salahuddin et al. 2016 (11)	Prospective cohort in a tertiary ICU.	395 adults with sepsis or septic shock.	Critically ill adults at King Faisal Specialist Hospital & Research Centre, Riyadh.	Categorized antibiotic changes: de-escalation, no change, escalation, mixed; multivariable regression to identify predictors and outcomes.	Identify variables associated with failure to de-escalate antibiotics in sepsis.
Bou Chebl et al. 2021 (6)	Single-center retrospective cohort.	7,906 ICU sepsis admissions; 497 with cirrhosis.	Adult ICU patients with sepsis per Sepsis-3; subgroups by cirrhosis status; 2002-2017.	Retrospective database analysis comparing mortality and lengths of stay by cirrhosis status; multivariable modeling.	Examine outcomes and mortality predictors in septic ICU patients with versus without cirrhosis.
Gasim et al. 2016 (5)	Descriptive study of ICU sepsis epidemiology.	62 sepsis of 387 ICU admissions	Adults in Buraidah Central Hospital ICU, Qassim, Saudi Arabia; high	Recorded APACHE II, SOFA, infection sites, organisms, outcomes; statistical comparisons	Describe incidence, characteristics, organisms, and

Two Riyadh cohorts evaluated trajectory, biomarker risk. In septic shock, platelet-count trajectories identified phenotypes with markedly different risks; a pattern and persistently low counts predicted higher 28-day mortality [8]. Hyperuricemia at sepsis recognition was linked to shock progression and ICU mortality on crude analyses, but uric acid lost association with mortality after adjustment [9].

Antimicrobial optimization featured in three studies. In ED sepsis, administering the first antibiotic within less than 1 hour versus 1 to 3 hours showed no significant mortality difference after adjustment determinants of de-escalation failure after cultures, emphasizing stewardship barriers [11]. A contemporary Eastern Province series highlighted that adherence to standardized protocols and timely broad-spectrum coverage were associated with improved outcomes in a 234-patient sepsis cohort [12].

Population specific risk was evident in cirrhosis: among 7906 sepsis admissions, cirrhotic patients (n=497) had markedly higher in hospital mortality (adjusted OR 2.5) and greater vasopressor, mechanical ventilation needs [6]. A Jeddah tertiary

Table 1: Study Characteristics

hospital analysis of complicated skin, soft-tissue infections systematically captured sepsis, ICU admission, vasopressor use, length of stay, and mortality as outcomes to identify predictors of unfavorable courses [13]. An academic hospital review of rapid response activations on medical wards mapped deterioration triggers and downstream outcomes, situating sepsis among common escalation causes [12].

Saudi data show high ICU mortality for septic shock, heterogeneity in ED timing to antibiotics effects, and strong prognostic signals from dynamic platelets and comorbidity states (cirrhosis), while model calibration and stewardship practicality remain recurring challenges [5,6,8,14].

		(16%) over six months.	proportion presenting with septic shock.	between survivors and non-survivors.	outcomes of ICU sepsis locally.
Al Saleh et al. 2021 (8)	Retrospective observational study.	205 septic shock patients.	Adults with septic shock at a Riyadh tertiary hospital, 2018-2020.	Grouped platelet count trajectories; correlations with APACHE-II; multivariable logistic regression for mortality risk.	Evaluate platelet count patterns and timing as mortality predictors beyond APACHE-II.
Alshehri et al. 2024 (9)	Retrospective multicenter cohort.	599 adult sepsis patients.	Adult ICU sepsis at National Guard Health Affairs hospitals, Riyadh, 2021-2023.	Compared outcomes in uric acid categories; collected SOFA, treatments; multivariable regression assessing independent associations.	Assess whether hyperuricemia independently predicts worse outcomes in sepsis patients.
Arabi et al. 2001 (14)	Prospective study of consecutive ICU admissions.	969 eligible of 1,084 ICU admissions.	Adults in a Riyadh tertiary ICU; exclusions: readmissions, brain-dead, incomplete data.	Collected variables for APACHE II, SAPS II, MPM II0, II24; assessed calibration, discrimination, standardized mortality ratios.	Validate performance of four mortality prediction systems in a Saudi ICU.
Althunayyan et al. 2021 (10)	Retrospective secondary analysis of ED sepsis cohort.	292 included from 495 screened.	Adults with sepsis at King Saud Medical City Emergency Department, Riyadh (July 2018-June 2019).	Compared less than 1-hour versus 1 to 3-hour antibiotic initiation from triage; primary outcome in-hospital mortality.	Assess mortality benefit of immediate versus early antibiotics in ED sepsis.
Arabi et al. 2003 (7)	Prospective cohort in severe sepsis, septic shock.	250 patients.	Adults admitted to a tertiary ICU, Riyadh, meeting severe sepsis, septic shock criteria.	Applied six mortality prediction models; evaluated calibration and discrimination in septic population.	Assess validity of mortality prediction systems in severe sepsis, shock ICU patients.
Jalal et al. 2025 (12)	Retrospective multicenter study using systematic sampling.	234 hospitalized sepsis patients.	Adults admitted with sepsis to tertiary hospitals in eastern Saudi Arabia, 2024.	EHR extraction of demographics, vitals, SOFA, labs, treatments; outcomes analyzed in management strategies.	Evaluate sepsis management strategies and their impact on clinical outcomes regionally.

Table 2: Main Findings and Outcomes (Sepsis Studies)

Citation	Main findings	Outcome
Algethamy et al. 2025 (13)	Low mean arterial pressure, vasopressor use, and low GCS predicted sepsis and ICU admission; kidney disease predicted in-hospital death.	Sepsis 27.7%; ICU admission 30.6%; mortality 20.4% in 235 hospitalized complicated skin, soft tissue infections.

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Al Saleh et al. 2021 (8)	Greater platelet decline and low nadir independently predicted mortality; WBC patterns not associated; platelet trajectories enhanced risk stratification beyond APACHE II.	Mortality 47.8% in 205 septic shock patients; OR 1.028 per platelet decline; OR 6.901 for nadir-at-admission pattern.
Althunayyan et al. 2021 (10)	No significant mortality difference between antibiotics within 1 hour versus 1-3 hours in ED; timing category did not alter outcomes.	Overall in-hospital mortality 31.8%; immediate group 33.3%, early group 31.6% (p=0.823).
Arabi et al. 2003 (7)	General ICU models had poor calibration for sepsis; customizing SAPS II and MPM II24 improved calibration; customized MPM II24 showed best discrimination.	AUC 0.826 for customized MPM II24; standardized mortality ratios ~1; hospital mortality significant in cohort.
Gasim et al. 2016 (5)	Septic shock common (75.8%); pulmonary infections predominant; higher APACHE II, SOFA, and ventilation need associated with death.	ICU sepsis incidence 16%; mortality 40.3%; median APACHE II 26.5; SOFA 11; mean hospital stay 11.95 days.

Discussion

Our pooled Saudi findings include, high ICU mortality in septic shock, heterogeneous effects of emergency department (ED) antibiotic timing, and strong prognostic signals from SOFA and select biomarkers, which are similar regional data showing substantial early risk and persistent case fatality [4]. A Jordanian multicenter cohort reported 30 day mortality of 52.7% and highlighted SOFA score and underlying solid tumors as independent predictors, underscoring the need for early recognition and aggressive support [4]. These signals align with our ICU focused results and show prioritizing rapid physiological assessment and escalation pathways.

Our synthesis found no adjusted mortality difference between antibiotics given less than 1 hour versus 1 to 3 hours in a large Riyadh ED cohort, while Saudi data linked timely broad spectrum coverage and protocol adherence with better survival [10,12]. This heterogeneity echoes broader evidence that, although guidelines advocate initiation within 1 hour given the association between delay and death, operational realities and case-mix can blur effect estimates at the bedside [2]. Our findings support immediate antibiotics when sepsis is suspected, coupled with rapid culture guided de escalation to limit downstream harms.

Healthcare associated infection (HAI) pressure amplifies local sepsis burden and shapes empiric choices. A Middle East meta analysis estimated HAI prevalence around 11.1% with heterogeneity in regions and infection types, respiratory and urinary sources prominent; Gram-negatives common. These data reinforce parallel priorities: early effective empiric therapy and disciplined stewardship, infection control bundles to curb resistance and mortality [3].

A meta analysis of machine learning models reported AUROCs frequently 0.87 in ED and hospital settings, yet stressed wide heterogeneity, inconsistent sepsis definitions, and few deployments. Our review suggests piloting locally trained, validated models only alongside clinician oversight, with transparent reporting and impact evaluation before scaleup [2].

Implementation implications follow directly from our evidence base. Prioritize rapid recognition and resuscitation bundles; adopt protocolized early antimicrobials with structured reassessment; strengthen HAI prevention and stewardship; and explore early-warning, response systems to reduce delays from triage to ICU transfer [2].

Conclusion

In Saudi ED and ICU settings, sepsis care is time critical, with high mortality in septic shock and clear prognostic signals from comorbid state and laboratory trajectories. Heterogeneous effects of strict antibiotic timing indicate the importance of rapid initiation when suspicion is high, followed by culture guided de-escalation. Prediction tools

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should be locally trained and validated, ICU pathways, bundle adherence, and robust complementing, not replacing, clinical judgment. stewardship, infection control programs. Health system priorities include reliable triage to

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