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IMPACT OF HEALTH INFORMATION AND MEDICAL DEVICE TECHNOLOGIES ON PATIENT MEDICATION SAFETY AND CLINICAL DECISION-MAKING IN EMERGENCY MEDICINE: A SYSTEMATIC REVIEW PROTOCOL AND PRELIMINARY EVIDENCE MAP

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ABSTRACT

Medication errors and preventable adverse drug events remain a leading, largely avoidable source of patient harm, and the emergency department (ED) is among the highest-risk settings owing to time pressure, interruptions, undifferentiated patients, and crowding. Health information technologies (HIT) and medical-device technologies—computerised provider order entry (CPOE), clinical decision support systems (CDSS), barcode-assisted medication administration (BCMA) with electronic medication administration records, automated dosing and dispensing devices, smart infusion systems, and interoperable electronic health records (EHR)—are widely promoted to reduce error and to support clinical decision-making. Evidence specific to emergency medicine remains fragmented across technology types and outcomes, and evaluations from Saudi Arabia and the wider Gulf region are sparse. To specify, in advance, a rigorous protocol for a systematic review of the effect of HIT and medical-device technologies on medication safety and clinical decision-making in the ED, and to present a preliminary evidence map that characterises the current landscape and its gaps. Methods. The review will be reported in line with PRISMA 2020 and this protocol follows PRISMA-P; prospective registration on PROSPERO is intended. Eligibility is framed with a PICO structure: ED patients and clinicians (Population); any HIT or medical-device technology in the medication-use process (Intervention); usual care, manual processes, or an alternative technology (Comparator); and medication-safety outcomes (error and

adverse-drug-event rates) plus clinical decision-making outcomes (alert acceptance and override, prescribing appropriateness, and time-to-administration). PubMed/MEDLINE, Embase, CINAHL, Scopus, Cochrane CENTRAL, and IEEE Xplore will be searched alongside regional and grey-literature sources. Screening will be dual and independent in Rayyan or Covidence; risk of bias will be appraised with design-appropriate tools (RoB 2, ROBINS-I, JBI, AMSTAR-2, and EPOC criteria for interrupted time series), and certainty with GRADE. Findings will be synthesised narratively and displayed as an evidence map, with meta-analysis where clinical and statistical homogeneity allow. Preliminary evidence map. A scoping search identified a purposive corpus of fourteen technology-bearing studies (twelve international, two Saudi/GCC-MENA). Evidence concentrated in CPOE/CDSS (n=6) and BCMA/eMAR (n=4); ordering and administration safety were the best-covered outcomes, whereas clinical decision-making outcomes—particularly alert acceptance, override, and alert fatigue—were comparatively under-represented. Regional evaluations were limited to an automated intravenous dosing tool in a Riyadh paediatric ED and a medication-reconciliation intervention, revealing a marked Saudi–global evidence gap that the full review is designed to address. Conclusion. This protocol and preliminary map establish the scope, methods, and knowledge gaps for a systematic review that will inform technology-enabled medication-safety strategy in emergency medicine, with particular relevance to Saudi Arabia's digital-health transformation. Registration. PROSPERO registration is intended prior to formal screening (identifier to be assigned).

KEYWORDS: Amedication Safety; Clinical Decision Support; Computerised Provider Order Entry; Barcode Medication Administration; Emergency Department; Health Information Technology; Patient Safety; Saudi Arabia; Systematic Review Protocol; Evidence Map.

1. INTRODUCTION

1.1. Medication Safety and the Emergency Department as a High-Risk Setting

Unsafe medication practices and medication errors are one of the largest avoidable contributors to patient harm worldwide, and the World Health Organization has made medication safety a global priority. Within the hospital, the emergency department (ED) concentrates many of the conditions that make error more likely: high patient throughput, frequent interruptions, verbal orders, weight-based and time-critical dosing, incomplete medication histories, and recurrent crowding. Studies of ED prescribing consistently document meaningful error burdens. In a tertiary Saudi teaching hospital, prescribing errors were identified in 13.5% of ED discharge prescriptions, with wrong dose, wrong frequency, and wrong strength the most common types, and with a substantial share of human causes attributed to improper selection from a computerised operator list (Anzan et al., 2021). A retrospective cohort in a Riyadh academic hospital found that, among recorded ED safety events, medication-related events were the single most frequent category, and that crowding was significantly associated with more medication and care-coordination events (Alassaf et al., 2025).

Regional synthesis reinforces the concern. A systematic review of medication safety across the Gulf Cooperation Council (GCC) countries assembled 54 studies and reported wide variation in error rates—prescribing errors reaching as high as 91% of sampled prescriptions in one primary-care study, adverse drug events of the order of 8.5 to 16.9 per 100 admissions with up to 30% judged preventable, and pharmacist-intervention acceptance ranging from roughly one-half to nearly all recommendations—while emphasising that inconsistent methods preclude a single pooled estimate (Alsaidan et al., 2018). ED-specific vulnerability is also illustrated by high error counts among boarded psychiatric patients (Bakhsh et al., 2014) and by the scale of ED prescribing itself in Saudi tertiary care (Alanazi et al., 2019). Together these findings frame the ED as a setting where systematic, technology-enabled safeguards are especially valuable.

1.2. Health Information and Medical-Device Technologies as Safety Interventions

A family of health information technologies (HIT) and medical-device technologies has been developed to intercept error along the medication-use pathway—ordering, transcription, dispensing, administration, and monitoring. Computerised provider order entry (CPOE) removes illegible handwriting and structures the order; clinical decision support systems (CDSS) add dose checking, drug–drug interaction and allergy alerts, and guideline prompts; barcode-assisted medication administration (BCMA) with an electronic medication administration record (eMAR) verifies the right patient and drug at the bedside; automated dispensing cabinets, smart infusion pumps, and automated dose-calculation tools reduce preparation and delivery error; and interoperable electronic health records (EHR) carry medication information safely across transitions. A Cochrane review of interventions to reduce medication errors in hospitalised adults synthesised 65 studies and found that electronic prescribing, barcoding, and medication reconciliation were among the interventions most studied, with reconciliation probably reducing adverse drug events (Ciapponi et al., 2021). These technologies are the intervention family this review will evaluate; their definitions are summarised in Table 1.

Table 1: Taxonomy Of Health-Information and Medical-Device Technologies in the ED Medication-Use Process. Categories Define the Intervention Axis of the Review and of the Evidence Map (Figure 2).

Technology category	Description and typical safety function	Stage(s) of medication use
CPOE with CDSS	Structured electronic ordering combined with automated dose, interaction, allergy, duplicate-therapy and guideline checking, and order-set prompts.	Prescribing / ordering
Barcode-assisted administration (BCMA / eMAR)	Bedside barcode verification of patient, drug, dose, route and time, documented in an electronic administration record.	Administration / documentation
Automated dosing & dispensing devices	Automated dispensing cabinets, automated IV dose-calculation tools, and compounding aids that standardise preparation and reduce calculation error.	Dispensing / preparation
Smart infusion systems	Infusion pumps with drug libraries and dose-error-reduction software (soft/hard limits).	Administration
Interoperable EHR & medication reconciliation	Shared, interoperable medication records and reconciliation tools supporting safe transitions into and out of the ED.	Transitions / reconciliation

Alerting & decision-analytics layers	Alert-management, override analytics, and semi-automated pharmacist-mediated review that shape clinician decision-making.	Cross-cutting decision support

1.3. The Clinical Decision-Making Dimension

Beyond counting errors, these technologies reshape how clinicians decide. CDSS alerts can improve appropriateness but also generate high volumes of low-value warnings; override rates are frequently high, and alert fatigue can erode the safety benefit. An ED analysis of a CDSS knowledgebase change involving more than 800,000 orders showed measurable shifts in alert and override patterns, underscoring how sensitive decision behaviour is to system configuration (Jung et al., 2023). A semi-automated, pharmacist-mediated CDSS achieved a high overall alert-acceptance rate and strong physician satisfaction while containing alert burden, illustrating a design route around fatigue (Dahmke et al., 2023). This review therefore treats clinical decision-making outcomes—alert acceptance and override, prescribing appropriateness, and timeliness—as co-equal with error counts, rather than as secondary.

1.4. The Saudi and Regional Digital-Health Context

Saudi Arabia is undergoing a large-scale digital-health transformation under Vision 2030 and the Health Sector Transformation Program, with rapid EHR adoption, national health platforms, mandatory accreditation through the Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI), and medical-device regulation by the Saudi Food and Drug Authority (SFDA). This creates both an opportunity and an evaluation gap: technologies are being deployed at scale, yet locally generated evidence on their effect on ED medication safety is limited. A notable exception is an automated intravenous dose-calculation tool implemented in the paediatric ED of King Fahad Medical City in Riyadh, which reduced the interval from order to administration for stat medications and increased the proportion delivered within the 30-minute target window (AlGoraini et al., 2020). Internationally, the direction of evidence is more established—CPOE/CDSS and BCMA reduce prescribing and administration errors respectively, and interoperable EHRs appear to improve medication safety in high-income systems (Li et al., 2022)—but whether these effects transfer to the Saudi ED, and under what implementation conditions, has not been synthesised.

1.5. Rationale And Knowledge Gap

Existing reviews tend to examine a single technology (for example CPOE/CDSS) or a single outcome (for example adverse drug events), and few concentrate on the ED or benchmark the Saudi picture against the global one. Before committing to a full synthesis, it is therefore useful both to fix the methods in a transparent protocol and to map what evidence already exists, so that the review question, technology taxonomy, and outcome set are calibrated to real gaps. This article provides that protocol together with a preliminary evidence map derived from a scoping search.

1.6. Objectives And Review Questions

Primary objective. To determine the effect of HIT and medical-device technologies on medication-safety outcomes (medication error and adverse-drug-event rates) in the ED.

Secondary objectives. (i) To evaluate their effect on clinical decision-making outcomes (alert acceptance/override, prescribing appropriateness, and time-to-administration); (ii) to compare effects across technology categories and by setting, with explicit attention to Saudi/GCC-MENA versus international evidence; and (iii) to appraise implementation factors—alert fatigue, workflow fit, and workarounds—that modify effectiveness.

Review question (PICO). In ED patients and clinicians (P), do HIT and medical-device technologies (I), compared with usual care, manual processes, or alternative technologies (C), reduce medication errors and adverse drug events and improve clinical decision-making (O)?

2. METHODS

2.1. Protocol Design and Reporting

This protocol is prepared in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P); the completed review will be reported using PRISMA 2020. Prospective registration on PROSPERO is intended before formal screening begins. Any amendments will be logged with date and rationale. Where included studies are themselves systematic reviews, their methodological quality will be appraised with AMSTAR-2 and their primary studies de-duplicated against directly included primary studies to prevent double counting.

2.2. Eligibility Criteria

Eligibility follows the PICO framework and additional design, setting, timeframe, and language criteria set out in Table 2. The population is patients receiving care in the ED and the clinicians who prescribe, dispense, and administer their medications; paediatric, adult, and older-adult populations are all eligible. The intervention is any technology in the taxonomy of Table 1. Comparators include usual care, manual or paper-based processes, a pre-implementation baseline, or an alternative technology configuration. Outcomes are grouped into medication-safety outcomes and clinical decision-making outcomes.

Table 2: Eligibility Criteria (PICO, Design, Setting, Timeframe, Language).

Element	Include	Exclude
Population	ED patients (all ages) and ED clinicians in the medication-use process.	Non-ED inpatient/outpatient care with no ED-attributable data.
Intervention	Any HIT or medical-device technology per Table 1 (CPOE/CDSS, BCMA/eMAR, automated dosing/dispensing, smart pumps, interoperable EHR/reconciliation, alerting layers).	Purely manual interventions (e.g., stand-alone double-checking) with no technology component.
Comparator	Usual care, manual/paper process, pre-implementation baseline, or alternative technology.	None specifiable.
Outcomes	Medication error rate, adverse/potential adverse drug events; and decision-making outcomes: alert acceptance/override, prescribing appropriateness, time-to-administration.	Studies reporting only usability or satisfaction with no safety/decision outcome.
Study design	RCT, cluster-RCT, quasi-experimental, interrupted time series, controlled/uncontrolled before–after, cohort, cross-sectional; and systematic reviews (for AMSTAR-2 handling).	Editorials, opinion, single case reports, conference abstracts without extractable data.
Setting	Hospital ED (adult, paediatric, mixed); hospital-wide studies with ED-specific data.	Community pharmacy or primary care without ED data.
Timeframe	January 2003 to the final search date (rationale: consolidation of CPOE/CDSS deployment from the early 2000s).	Pre-2003.
Language	English; regional-language records screened where feasible with translation.	Records not retrievable or translatable.

2.3. Information Sources

The search will cover PubMed/MEDLINE, Embase, CINAHL, Scopus, and the Cochrane Central Register of Controlled Trials for the clinical literature, and IEEE Xplore for device- and informatics-engineering studies. Regional coverage will include the Saudi Digital Library and hand-searching of Saudi Ministry of Health, CBAHI, and SFDA outputs; grey literature will be sought via Google Scholar and relevant conference proceedings, and trial registries (ClinicalTrials.gov and the WHO ICTRP) will be screened for completed studies. Reference lists of included studies and relevant reviews will be back-searched, and forward citation searching performed.

2.4. Search Strategy

A three-concept strategy will combine (i) the ED setting, (ii) the technology family, and (iii) medication safety and decision-making, using controlled vocabulary (MeSH/Emtree) and free-text synonyms with truncation and proximity operators, adapted to each database. Concept blocks include, for the setting, terms such as emergency department, emergency service, and emergency medicine; for the technology, computerised provider/physician order entry, clinical decision support, barcode medication administration, electronic medication administration record, automated dispensing, smart pump, dose-error-reduction software, and health information technology; and for the outcome, medication error, prescribing error, adverse drug event, medication safety, alert override, and clinical decision-making. An illustrative PubMed string is provided in the supplementary search appendix and was piloted during the scoping stage that produced the preliminary map (Section 3).

2.5. Study Selection

Records will be de-duplicated in a reference manager (Zotero or Mendeley) and screened in Rayyan or Covidence. Two reviewers will independently screen titles and abstracts against the eligibility criteria, then assess full texts, with disagreements resolved by discussion or a third adjudicator; inter-rater agreement will be quantified with Cohen's kappa. The full selection process, with reasons for full-text exclusion, will be displayed in a PRISMA 2020 flow diagram. Because this protocol is single-authored, the second reviewer for the full review will be a named collaborator recruited before screening.

2.6. Data Extraction

Data will be extracted into a piloted standard form capturing the fields in Table 3. Extraction will be performed by one reviewer and independently

verified by a second; discrepancies will be reconciled against the source. Corresponding authors will be contacted for missing data where feasible.

Table 3: Planned Data-Extraction Fields.

Domain	Fields extracted
Identification	Author, year, country, setting tag (Saudi / GCC-MENA / International), journal, DOI/PMID.
Design & population	Study design, ED type (adult/paediatric/mixed), sample or observation count, patient/clinician characteristics.
Intervention	Technology category (Table 1), vendor/configuration where reported, comparator, implementation context.
Outcomes	Medication-safety outcomes (error/ADE rates, severity); decision-making outcomes (alert acceptance/override, appropriateness, time-to-administration).
Effect estimates	Direction and size of effect, absolute/relative change, OR/RR/HR with 95% CI or p-value as reported.
Appraisal & context	Risk-of-bias judgement, funding, conflicts, implementation facilitators/barriers, workarounds, alert fatigue.

2.7. Risk-Of-Bias and Quality Appraisal

Design-appropriate tools will be applied (Table 4). Randomised trials will be assessed with the Cochrane RoB 2 tool; non-randomised studies of interventions with ROBINS-I; cross-sectional and quasi-experimental studies with the relevant Joanna Briggs Institute (JBI) checklists; interrupted time series against the Cochrane EPOC criteria; and any included systematic reviews with AMSTAR-2. Two reviewers will appraise independently.

Table 4: Risk-Of-Bias and Quality-Appraisal Tools by Study Design.

Study design	Appraisal instrument
Randomised / cluster-randomised trials	Cochrane RoB 2
Non-randomised studies of interventions (cohort, controlled before–after)	ROBINS-I
Cross-sectional and quasi-experimental studies	JBI critical-appraisal checklists
Interrupted time series	Cochrane EPOC criteria
Systematic reviews (for synthesis and de-duplication)	AMSTAR-2
Overall certainty of evidence per outcome	GRADE

2.8. Data Synthesis and Evidence Mapping

Results will be synthesised narratively and structured as an evidence map along three dimensions—technology category, outcome domain, and setting (Saudi/GCC-MENA versus international)—so that concentrations and gaps are visible at a glance. Where two or more studies report a sufficiently homogeneous intervention–comparator–outcome combination, a random-effects meta-analysis will be considered, with heterogeneity quantified by I^2 and τ^2 and explored through pre-specified subgroups (technology category, ED population, and setting) and sensitivity analyses (risk-of-bias–restricted). Small-study effects will be examined with funnel plots and Egger's test when at least ten studies are pooled. The overall certainty of evidence for each key outcome will be rated with GRADE. If quantitative pooling is not appropriate, synthesis-without-meta-analysis (SWiM) guidance will be followed.

2.9. Ethical Considerations

The review uses published, aggregate secondary data and therefore does not require research-ethics approval or individual consent. No patient-identifiable information will be handled.

3. PRELIMINARY EVIDENCE MAP

3.1. Preliminary Search Yield

To calibrate the review and demonstrate feasibility, a scoping search of PubMed/MEDLINE was run across the core concept blocks in August 2026. Indicative volumes were substantial and uneven: clinical decision support with medication errors in the ED returned 79 records; computerised provider order entry with medication safety and emergency care returned 127; barcode medication administration in the ED returned 57; and the broad combination of health information technology with medication safety and reviews returned over 1,450 records. From the top-ranked, on-topic results a purposive corpus of fourteen technology-bearing studies was characterised for this preliminary map; the indicative selection flow is shown in Figure 1. These counts are illustrative of the literature's volume and are not the final review yield, which will

follow the full PRISMA 2020 process across all databases.

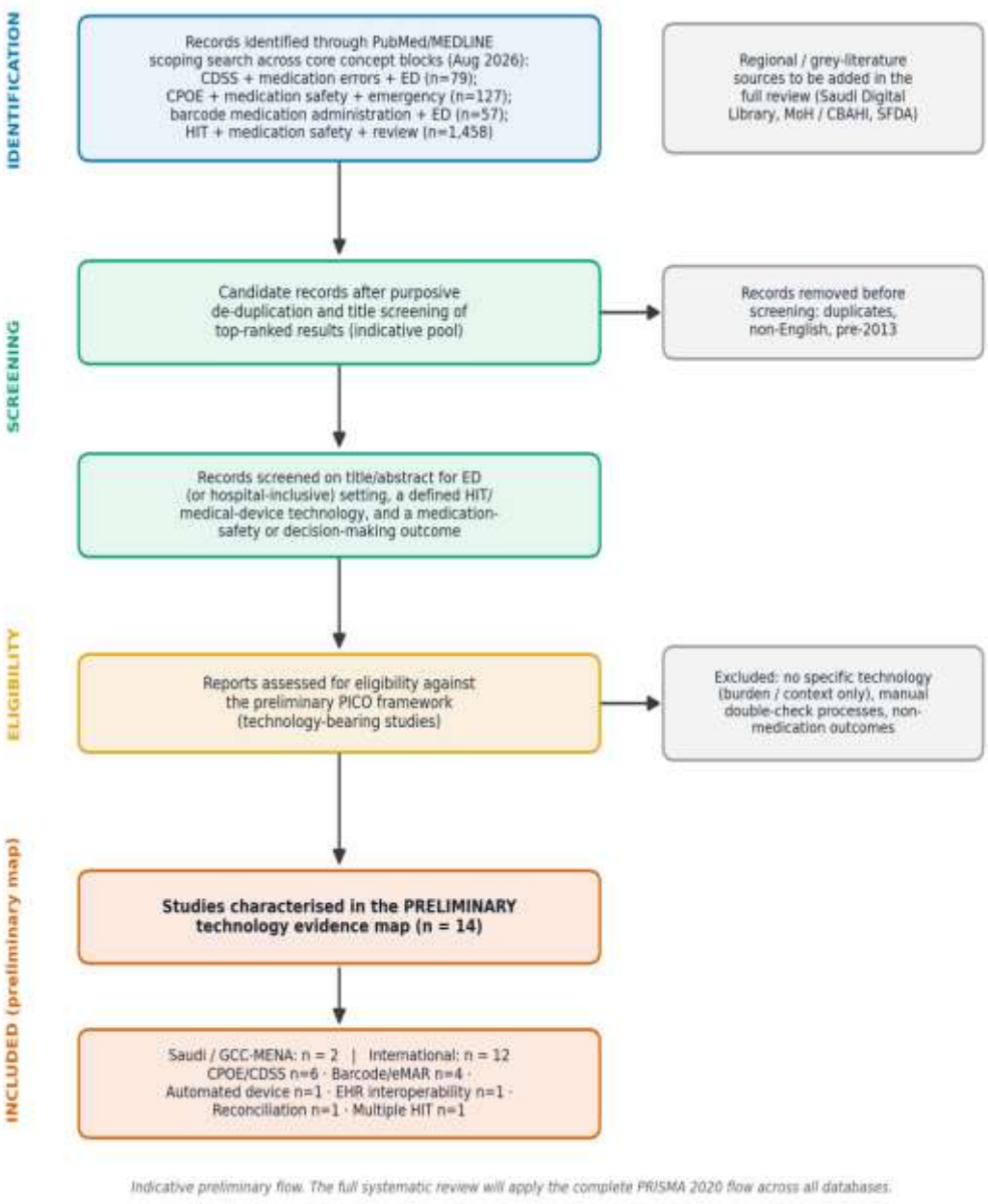

Figure 1: Indicative Preliminary Scoping-Search Flow. Records Identified in a Pubmed/MEDLINE Scoping Search Across Core Concept Blocks Were Purposively Screened to a Preliminary Corpus Of 14 Technology-Bearing Studies (12 International, 2 Saudi/GCC-MENA). The Full Review Will Apply the Complete PRISMA 2020 Flow Across All Databases. ED, Emergency Department; HIT, Health Information Technology; CDSS, Clinical Decision Support System; CPOE, Computerised Provider Order Entry.

3.2. Characteristics Of the Preliminary Corpus

The characterised studies span the full technology taxonomy and both evidence bases, and are summarised in Table 5. They range from multi-study systematic reviews of CPOE/CDSS and of ED geriatric medication programmes to single-site before–after evaluations of BCMA and an automated intravenous dosing tool from a Riyadh paediatric ED. Directions of effect were consistently favourable for error reduction, while decision-making outcomes were reported less often and less uniformly.

Table 5: Preliminary Evidence-Extraction Table for the Technology-Bearing Corpus. Setting Tag: SA/GCC = Saudi Or GCC-MENA; INT = International. Findings Are Paraphrased; See References for Full Data.

Study (year), country	Tag	Design	Technology	Key ED-relevant finding	Source
Georgiou et al. (2013), Australia	INT	Systematic review (22 studies)	CPOE / CDSS	CPOE with CDSS decreased prescribing errors and potential ADEs and cut excessive dosing (~31% for renal drugs); computer time rose without loss of patient-care time.	10.1016/j.annemergmed.2013.01.028
Hajesmaeel Gohari et al. (2020), Iran	INT	Systematic review (11 studies)	CPOE / CDSS	CPOE/CDSS reduced errors and ADEs in about half of studies and increased guideline-concordant prescribing in the remainder.	10.1177/8755122520958160
Jung et al. (2023), South Korea	INT	Observational (>829k orders)	CPOE / CDSS (alerting)	A CDSS knowledgebase change shifted ED alert rates (12.6%→14.1%) and override rates (60.8%→67.4%), highlighting configuration sensitivity.	10.1038/s41598-023-40188-4
Dahmke et al. (2023), Switzerland	INT	Retrospective + survey	CDSS (pharmacist-mediated)	Semi-automated, pharmacist-filtered alerts achieved 72.4% acceptance and 94.5% physician satisfaction while limiting alert burden.	10.57187/smw.2023.40082
Skains et al. (2025), USA	INT	Systematic review / meta-analysis	CPOE / CDSS	Across ED geriatric programmes, computerised CDSS was associated with ~40% lower potentially-inappropriate-medication ordering (OR 0.60).	10.1001/jamanetworkopen.2025.0814
Alsabri et al. (2024), multinational	INT	Systematic review (6 studies)	CPOE / CDSS (HIT)	Paediatric-ED medication-error prevalence 10–15% (dosing errors 39–49%); HIT solutions promising but effectiveness varied.	10.1097/PEC.0000000000003108
Seibert et al. (2014), USA	INT	Quasi-experimental	Barcode / eMAR	BCMA-eMAR raised administration accuracy (e.g., 92%→96% excluding wrong-time) across units including the ED.	10.2146/ajhp130332
Owens et al. (2020), USA	INT	Before–after	Barcode / eMAR	BCMA in a community ED cut administration errors from 2.96% to 0.76% (74% relative reduction) and improved nurse satisfaction.	10.1016/j.jen.2020.07.004
Gauthier-Wetzel (2022), USA	INT	Before–after	Barcode / eMAR	ED BCMA reduced error rate by 10.8% and mean medications-in-error per chart by 21%; ED uptake of BCMA was low.	10.1097/CIN.0000000000000846
Lunt (2024), USA	INT	Quality improvement	Barcode / eMAR (mobile)	Handheld scanning devices raised ED BCMA compliance by 20% over six months.	10.3233/SHTI240213

AlGoraini et al. (2020), Saudi Arabia (KFMC)	SA/GCC	Prospective observational	Automated dosing device	An automated IV dose-calculation tool in a Riyadh paediatric ED shortened order-to-administration time and improved 30-minute stat delivery.	10.1016/j.heliyon.2020.e04140

Li et al. (2022), UK / high-income	INT	Systematic review (12 studies)	EHR interoperability	Interoperable EHRs positively influenced medication safety and reduced safety events and costs; workflow effects were mixed.	10.2196/38144
Ciapponi et al. (2021), international (Cochrane)	INT	Systematic review (65 studies)	Multiple HIT	Among hospital interventions (incl. e-prescribing and barcoding), medication reconciliation probably reduced ADEs (OR 0.38).	10.1002/14651858.CD009985.pub2
Al Garsan et al. (2021), Saudi-affiliated	SA/GCC	Pre/post cross-sectional	Reconciliation / transitions	An education-based reconciliation intervention raised ED reconciliation completion from 64.7% to 81.3%.	10.1111/ijcp.14782

3.3. Distribution Across Technology Categories and Outcomes

Arranging the corpus by technology category against outcome domain produces the evidence map in Figure 2. Two clusters dominate: CPOE/CDSS studies, which populate prescribing/ordering safety, adverse-drug-event, and decision-making/alerting cells; and BCMA/eMAR studies, which concentrate almost entirely in administration safety. Automated dosing devices, interoperable EHRs, reconciliation, and mixed-HIT reviews each contribute a single cell. The map makes the decision-making gap explicit: only the CPOE/CDSS column reaches the alerting/decision-making row, and no cell in that row derives from a Saudi/regional study.

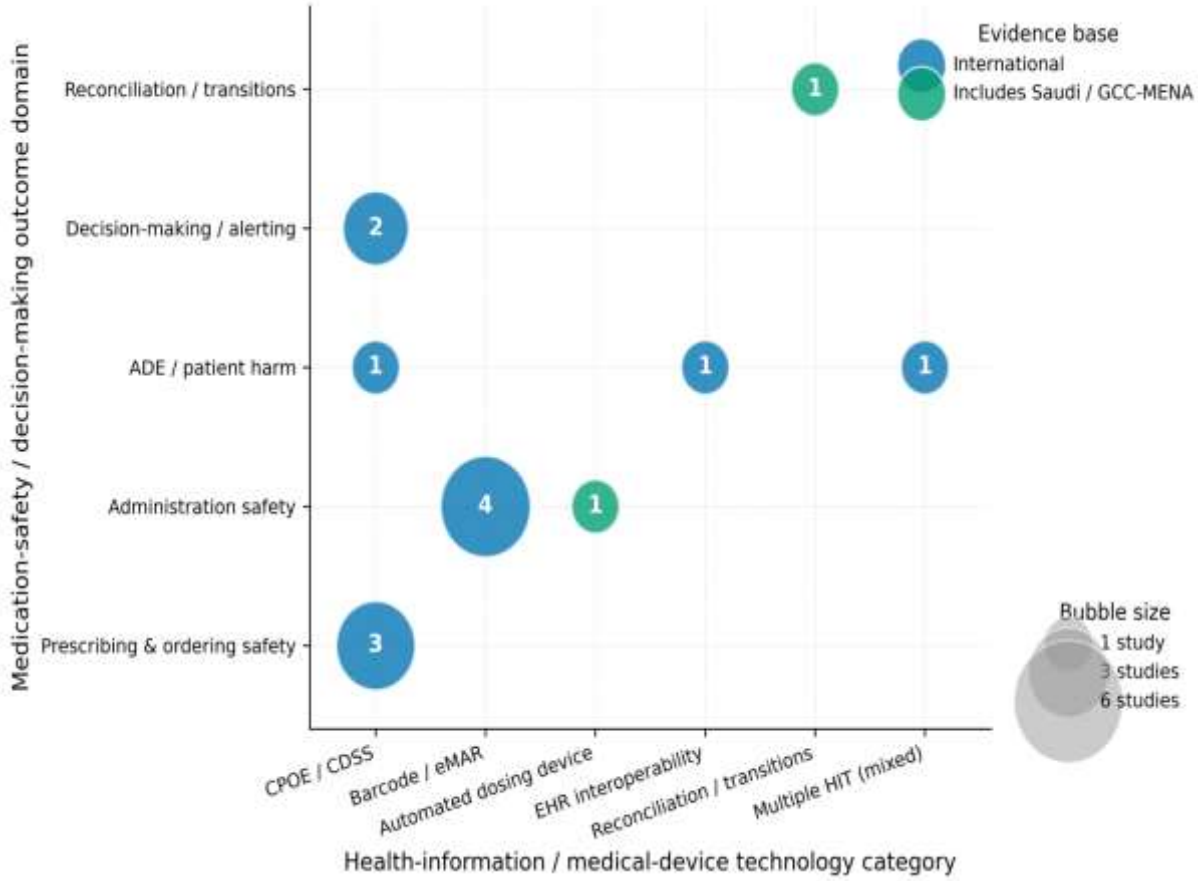

Figure 2: Preliminary Evidence Map: Technology Category by Outcome Domain. Bubble Size Is Proportional to The Number of Studies; Teal Bubbles Include Saudi/GCC-MENA Evidence and Navy Bubbles Are

International Only. Empty Cells Indicate Outcome–Technology Combinations with No Study in the Preliminary Corpus. ADE, Adverse Drug Event; CDSS, Clinical Decision Support System; CPOE, Computerised Provider Order Entry; Emar, Electronic Medication Administration Record; EHR, Electronic Health Record.

3.4. Geographic Distribution and the Saudi–Global Gap

Stratifying the corpus by setting (Figure 3) shows that twelve of the fourteen technology-bearing studies were international and only two were Saudi/GCC-MENA—an automated dosing device and a reconciliation intervention—with no regional evaluation of CPOE/CDSS or BCMA in the ED among the characterised studies. This is the central motivation for the full review: the interventions being deployed most widely under Saudi Arabia's digital-health transformation are precisely those for which locally generated ED evidence is thinnest, so international effect estimates cannot yet be assumed to transfer without local confirmation.

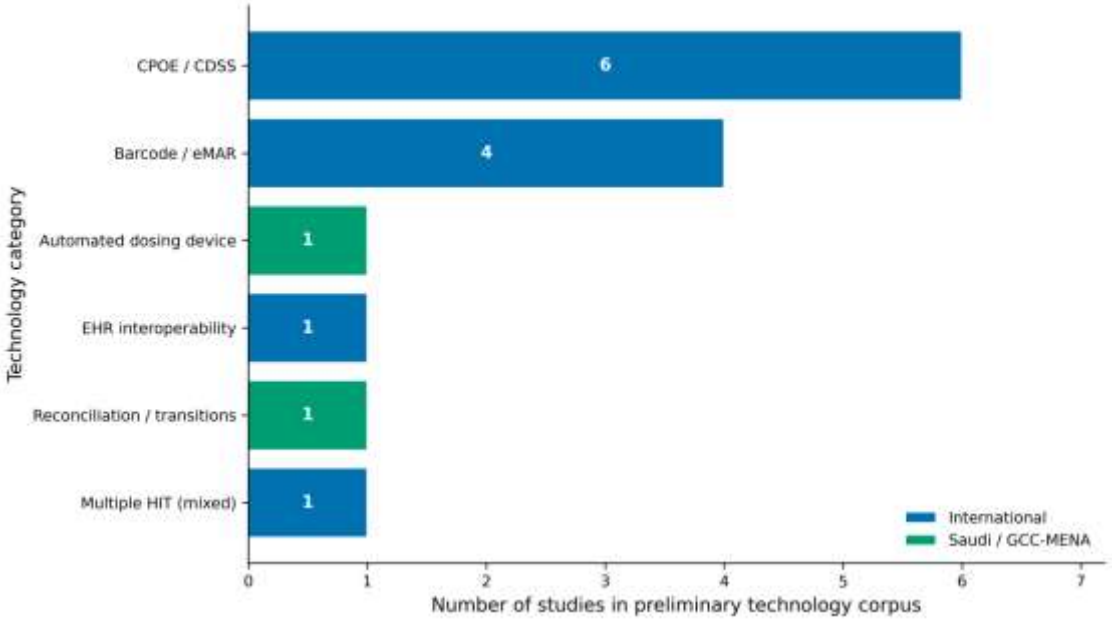

Figure 3: Preliminary Evidence by Technology Category and Setting. Counts Of Technology-Bearing Studies by Category, Split by Setting (International Versus Saudi/GCC-MENA). Regional Evidence Is Confined to Automated Dosing and Reconciliation, With No Saudi/GCC ED Evaluation Of CPOE/CDSS Or Barcode Administration in This Preliminary Corpus.

3.5. Temporal Distribution

The preliminary corpus spans 2013 to 2025 (Figure 4), with output increasing in recent years and the only meta-analytic ED-specific synthesis appearing in 2025. The temporal spread indicates an active and maturing field, which supports both the timeliness of a full systematic review and the value of a protocol that fixes methods before the literature grows further.

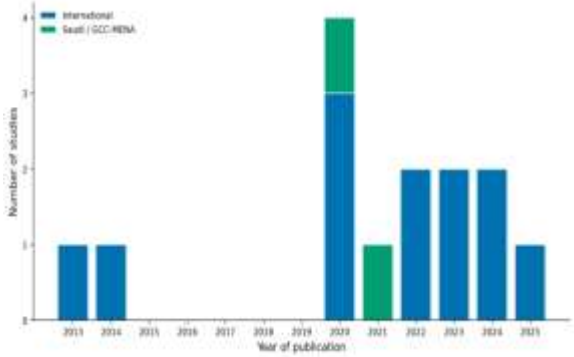

Figure 4: Temporal Distribution of the Preliminary Corpus (2013–2025). Number Of Characterised

Technology-Bearing Studies by Publication Year, Split by Setting. The Recent Concentration of Studies, Including the First ED-Specific Meta-Analysis In 2025, Reflects A Maturing Evidence Base.

3.6. Preliminary Synthesis of Directions of Effect

Read together, the preliminary evidence points in a consistent direction while leaving important questions open. CPOE combined with CDSS is associated with fewer prescribing errors and potential adverse drug events and with more guideline-concordant dosing (Georgiou et al., 2013; Hajesmaeel Gohari et al., 2020), and, in the ED geriatric context, with materially lower ordering of potentially inappropriate medications (Skains et al., 2025). Barcode administration reduces administration errors substantially where it is used, though ED uptake and scanning compliance are recurring implementation challenges (Owens et al., 2020; Gauthier-Wetzel, 2022; Lunt, 2024). Automated dose calculation improves the timeliness of high-risk stat medications in a paediatric ED (AlGoraini et al., 2020), and interoperable records and reconciliation reduce transition-related harm (Li et al., 2022; Ciapponi et al., 2021). The clearest unresolved theme is decision-making quality: high override rates and alert fatigue can blunt CDSS benefit, and pharmacist-mediated, context-aware alerting is one promising mitigation (Jung et al., 2023; Dahmke et al., 2023). The full review will test whether these directions hold under formal risk-of-bias appraisal and, where possible, quantify them.

4. DISCUSSION

4.1. Principal Findings

This protocol specifies, in advance, a transparent method for synthesising the effect of health-information and medical-device technologies on ED medication safety and clinical decision-making, and the accompanying preliminary map characterises the current landscape. The map's principal messages are that evidence concentrates in two mature technology families—CPOE/CDSS and BCMA/eMAR—that error-count outcomes are far better covered than decision-making outcomes, and that Saudi and regional ED evaluations are scarce.

4.2. The Saudi Picture Against the Global Picture

Internationally, the balance of evidence favours these technologies for reducing prescribing and administration error and for supporting safer transitions, with the important caveat that poorly configured decision support can generate alert fatigue and high override rates. The Saudi and GCC evidence is concordant in what little exists—an automated dosing tool improving stat-medication timeliness in a Riyadh paediatric ED, and a reconciliation intervention improving completion—but it is thin and does not yet cover CPOE/CDSS or BCMA in the ED. Given the burden documented regionally, where medication-related events are a leading ED safety-event category and prescribing errors are common (Anzan et al., 2021; Alassaf et al., 2025; Alsaidan et al., 2018), and given the pace of national digital-health deployment, the transferability of international effect estimates to the Saudi ED is an open and policy-relevant question. The full review is structured to answer it by tagging every study by setting and comparing effects across the two evidence bases.

4.3. Implications For the Review and for Practice

For research, the map justifies a technology-stratified synthesis with explicit decision-making outcomes and a setting comparison, rather than a single-technology or single-outcome review. For Saudi practice and policy, it signals where local evaluation would add most value—ED-specific CPOE/CDSS and BCMA studies, and pragmatic evaluations of alert-management strategies—so that accreditation (CBAHI) and quality-improvement programmes can be guided by locally validated evidence rather than by extrapolation alone. It also suggests that implementation quality, not merely technology presence, should be a first-class object of measurement.

4.4. Strengths And Limitations

The main strengths are prospective methodological specification aligned with PRISMA-P, a clearly bounded technology taxonomy, dual outcome focus, and deliberate benchmarking of Saudi/regional against international evidence. Several limitations attach to the preliminary component. The evidence map is based on a purposive scoping search of a single database and a characterised corpus of fourteen studies; it is intended to be indicative of the landscape rather than exhaustive, and the counts should not be read as final prevalence estimates. Restriction to English-language, indexed literature at the scoping stage may under-represent regional and grey-literature evidence, which the full multi-database search—including the Saudi Digital Library

and MoH/CBAHI/SFDA sources—is designed to recover. Finally, no effect sizes are pooled here; quantitative synthesis awaits the full review and formal risk-of-bias appraisal.

5. CONCLUSION

Medication safety in the emergency department is a high-stakes, technology-sensitive problem, and health-information and medical-device technologies are central to current safety strategy. This protocol fixes a rigorous, PRISMA-aligned method for evaluating their effect on both error and decision-making, and the preliminary evidence map shows a field concentrated in CPOE/CDSS and barcode administration, comparatively silent on decision-making outcomes, and markedly under-populated by Saudi and regional ED evidence. By making these gaps explicit before synthesis, the planned review is positioned to generate findings that are directly useful to emergency medicine and to Saudi Arabia's digital-health transformation.

Protocol Registration. Prospective registration on PROSPERO is intended before formal screening; the identifier will be added on assignment.

Ethics Approval and Consent. Not required; the study uses published aggregate secondary data with no patient-identifiable information.

Funding. No external funding was received for this protocol.

Conflicts of Interest. The author declares no competing interests.

Data Availability. All data supporting the preliminary map are contained within the article and its references; the extraction dataset is available from the author on reasonable request.

AI Transparency. Bibliographic retrieval was assisted by database tools (PubMed) and general-purpose software was used to format figures and the document; all evidence was verified by the author against the primary sources, and no content was reproduced verbatim from source articles.

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