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From Code to Clinic: Bridging the Implementation Gap in AI-Based Clinical Decision Support

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Abstract

Abstract

AI-based clinical decision support systems (AI-CDSS) can improve diagnosis, risk prediction, and workflow, but many high-performing models remain confined to retrospective studies. This structured narrative review synthesizes 2015–2025 literature to explain why implementation fails and how sustainable deployment can be achieved. We identify socio-technical barriers across data infrastructure, validation, workflow, governance, regulation, economics, and equity. Failure is rarely due to accuracy alone; it often reflects dataset shift, weak prospective evidence, alert fatigue, unclear accountability, and misaligned incentives. We propose a lifecycle roadmap: local readiness and silent-mode calibration, graded workflow deployment, and sustained algorithmic stewardship.

Research method

Structured Narrative Synthesis

- Design: structured narrative synthesis, not a formal systematic review or meta-analysis.
- Period: English-language literature, January 2015–September 2025.
- Sources: PubMed/MEDLINE, Scopus, Web of Science, ACM Digital Library, and selected digital-health journals.
- Evidence: deployment studies, reviews, implementation frameworks, reporting guidelines, and regulatory/policy documents.
- Domains: infrastructure, validation, human factors, governance, policy/economics, and equity.

conclusion

Core Findings

- The gap is a socio-technical translation problem, not simply a model-performance problem.
- Retrospective AUC does not guarantee clinical utility, safety, or adoption.
- AI-CDSS require local validation, workflow ownership, human-centered design, governance, and monitoring.
- AI-CDSS should be managed as adaptive clinical services with lifecycle oversight.
- Equity auditing and stakeholder alignment are needed to avoid uneven benefits across sites and patient groups.

The purpose of the research

Objectives

- Explain why high-performing AI-CDSS often fail to reach routine care.
- Classify barriers across technical, human, organizational, regulatory, economic, and equity domains.
- Compare AI-CDSS with traditional rule-based CDSS to highlight drift, opacity, and calibration risks.
- Translate evidence into a lifecycle-oriented roadmap for sustainable implementation.
- Shift evaluation from model-centric accuracy to system-level clinical impact.

Practical or simulation results

Three-Phase Implementation Roadmap

Key Implementation Mechanisms

- Fragmented EHR data → dataset shift and silent decay.
- Retrospective-only validation → uncertain clinical benefit.
- Poor workflow fit → alert fatigue and override behavior.
- Unclear ownership → weak monitoring of safety, drift, equity, and updates.
- Liability/reimbursement gaps → weak institutional incentives.
- Uneven subgroup or site performance → inequitable benefit.

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