DOI: 10.36566/ijhsrd/Vol8.Iss1/358
https://ijhsrd.com/index.php/ijhsrd
Indonesian Journal Of Health Sciences Research and Development
e- ISSN: 2715-4718

Research Article

UTILIZATION OF ARTIFICIAL INTELLIGENCE IN MEDICAL EMERGENCY SERVICES: A SYSTEMATIC REVIEW OF OPPORTUNITIES FOR PUBLIC HEALTH ENHANCEMENT

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ABSTRACT

Background:
Digital transformation in healthcare, particularly Artificial Intelligence (AI), has created significant opportunities to enhance emergency medical services. However, the clinical effectiveness and public health impact of AI in emergency contexts require comprehensive evidence synthesis.
Methods: This systematic review was conducted following PRISMA 2020 guidelines. Literature searches were performed across six databases (PubMed, Scopus, Web of Science, IEEE Xplore, CINAHL, Google Scholar) for publications from 2015 to 2025. Nine empirical studies met the inclusion criteria after rigorous selection.
Results: AI demonstrated high diagnostic accuracy (85–96%) for acute conditions such as intracranial hemorrhage and sepsis. AI implementation reduced sepsis mortality by 17% in facilities with high digital maturity. However, medical chatbots showed low accuracy (58%) and potential for harmful recommendations. Ethical issues, algorithmic bias, and infrastructure readiness emerged as major challenges.
Conclusion: AI has the potential to improve the accuracy and efficiency of emergency services, but its success depends on infrastructure readiness, ethical governance, and targeted implementation strategies.

Keywords: *Artificial Intelligence, Emergency, Medical Services, Systematic Review, Clinical, Decision, Support, Systems, Patient, Safety*

INTRODUCTION

Digital transformation has shifted the paradigm of global healthcare delivery, particularly through the integration of technologies such as artificial intelligence (AI) and big data [1]. In the context of Society 5.0, digital technology enhances operational efficiency and expands healthcare access, including in remote areas [2]. Emergency medical services, as the frontline of the health system, face complex challenges such as overcrowding, limited resources, and time pressure. AI offers innovative solutions through automation, prediction, and workflow optimization [3]. However, AI adoption in emergency settings still faces technical, regulatory, and clinician acceptance barriers.

AI has shown significant potential in improving diagnostic accuracy and response speed in emergency departments (ED). A study by Yun et al. [4] demonstrated that a deep learning model could detect acute intracranial hemorrhage with 96.7% sensitivity, reducing reliance on manual interpretation. Predictive algorithms for sepsis and clinical deterioration have reduced mortality and increased compliance with standard protocols [5]. AI's ability to analyze real-time data also enables early outbreak detection and more efficient resource management [6]. However, external validation and generalization of AI models remain major concerns.

In triage, AI-based decision support systems can prioritize patients by severity. Research by El Arab and Al Moosa [7] shows that machine learning models achieve AUC above 0.80 for predicting intensive care needs. AI chatbots such as ChatGPT have been tested for triage, but their accuracy and safety require improvement before autonomous use [8]. AI implementation in triage not only accelerates the process but also reduces healthcare worker workload and human error [9]. Nevertheless, risks of automation bias and loss of human touch persist.

AI implementation challenges include ethical issues, algorithmic bias, and digital infrastructure readiness. Adam et al. [10] revealed that biased AI design can lead to discriminatory clinical decisions. Lack of transparency (black box) and digital literacy also hinder AI adoption among clinicians [11]. In low- and middle-income countries, the digital divide and limited resources exacerbate these challenges [12]. Therefore, inclusive governance frameworks and adaptive regulations are essential to ensure responsible AI use.

Based on this background, this systematic review aims to examine the latest evidence on AI utilization in medical emergencies, analyze its impact on clinical and operational outcomes, and identify facilitators and barriers to implementation. This review is expected to provide evidence-based recommendations for policy development, clinical practice, and further research in emergency care and public health.

MATERIAL AND METHODS

Research Design

This systematic review was designed and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines to ensure transparency, reproducibility, and methodological integrity. The systematic approach was chosen to map comprehensive evidence on AI applications in emergency medical services, identify research gaps, and evaluate public health implications.

Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were formulated using the PICOS framework (Population, Intervention, Comparison, Outcomes, Study design).

Inclusion Criteria:

Population: Patients with emergency conditions (trauma, cardiology, neurology, sepsis, obstetrics, pediatrics), emergency healthcare workers, and emergency service systems.

Intervention: Application of AI, Machine Learning, or Deep Learning for diagnosis, prediction, triage, patient flow optimization, resource management, or outbreak surveillance in emergency contexts.

Comparison: Standard practice without AI, or comparison between AI algorithms.

Outcomes: Diagnostic accuracy, response time, mortality, morbidity, operational efficiency, and equity. Secondary outcomes included patient satisfaction, cost-effectiveness, and adoption.

Study Design: Primary empirical studies, systematic reviews, meta-analyses, and mixed-methods studies.

Publication Year: 2015–2025.

Language: English or Indonesian.

Status: Peer-reviewed and available as full-text.

Exclusion Criteria:

Editorials, commentaries, letters, conference abstracts without complete data; Protocol studies without implementation results; Non-clinical AI applications; Non-empirical studies; AI in non-emergency settings; Publications before 2015 or inaccessible full-text.

Literature Search Strategy

A comprehensive search was performed in January 2025 across PubMed, Scopus, Web of Science, IEEE Xplore, CINAHL, and Google Scholar. Boolean operators combined AI-related terms with emergency and public health terms. The search was limited to 2015–2025 and English/Indonesian publications. Citation tracking was also performed.

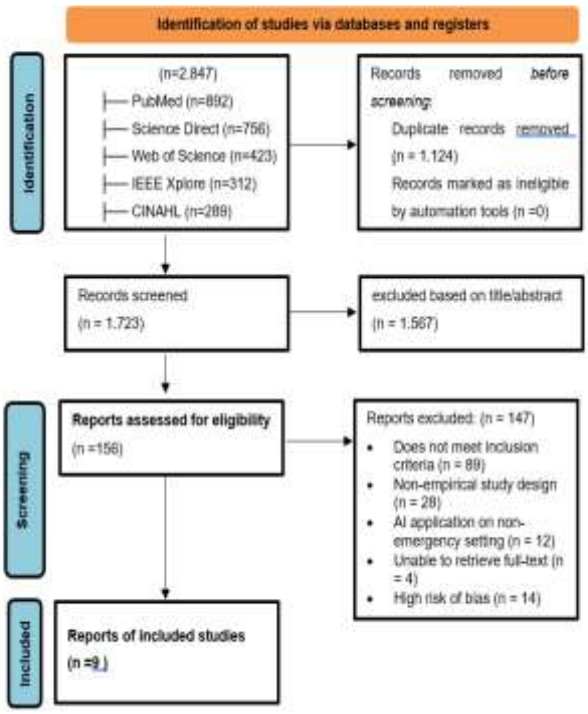
Study Selection and Data Extraction

Duplicates were removed using Rayyan.ai. Screening was conducted in two stages: title/abstract and full-text. Two researchers independently performed selection and data extraction using a standardized form. Narrative synthesis was applied due to heterogeneity.

Quality Assessment

Methodological quality was assessed using QUADAS-2 for diagnostic studies, PROBAST for prediction studies, and QUIPS for observational studies. Two independent researchers performed assessments.

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



RESULTS

Synthesis of Findings

Findings were grouped into five domains. AI demonstrated high diagnostic accuracy (92.61% for critical biomarkers; 96.7% sensitivity for intracranial hemorrhage). Sepsis prediction AI reduced mortality by 17% and increased bundle compliance by 10% in digitally mature facilities. Medical chatbots had low accuracy (58%) with 23% potentially harmful recommendations. Ethical challenges included algorithmic bias, which could be mitigated through descriptive framing. Stakeholder perceptions were mixed: 81% believed AI improved accuracy, but 76% were concerned about losing human interaction.

Note: Detailed characteristics of the included studies, summary of findings by focus/purpose, and synthesis by AI application domain are provided in Table 1, Table 2, and Table 3, respectively, which are placed at the end of this manuscript after the References section.

DISCUSSION

AI utilization in medical emergencies shows significant potential to enhance healthcare efficiency and accuracy. Kachman et al. [3] highlight AI integration across emergency care, from triage to clinical documentation and deterioration prediction, aligning with Jiang et al. [13] regarding rapid data processing for clinical decision support. This review confirms AI's transformative potential in emergency services, emphasizing that effectiveness depends on implementation context rather than algorithmic performance alone.

AI triage models, such as gradient boosting and random forest, consistently achieve AUC >0.80 for predicting intensive care needs [7], supporting prior findings by Tang et al. [9]. Generative AI like ChatGPT shows promise in triage support but requires caution in critical interpretations [14]. In pandemics, AI aids in biomarker identification for prognosis [15], aligning with Syrowatka et al. [6] on early detection and management.

Successful AI integration requires robust infrastructure, interoperability, and continuous monitoring [5, 16]. Ethical considerations, transparency, and explainable AI are crucial for trust and adoption [17, 18]. While AI can improve outcomes in sepsis, resuscitation, and emergency surgery [19, 20], implementation barriers include model interpretability, legal concerns, and clinician autonomy [11, 18].

In low-resource settings, targeted deployment, privacy-preserving federated learning, and digital literacy are essential. Overall, AI is an enabler, not a panacea, requiring synergy between technology, infrastructure, governance, and multi-sectoral collaboration.

CONCLUSION

AI improves diagnostic accuracy (85–96%) and operational efficiency in emergency services. Its impact on sepsis mortality (17% reduction) is significant only in digitally mature settings. Practical recommendations include AI for outbreak surveillance and neurological emergencies, while medical chatbots should be regulated as Class III devices until accuracy exceeds 90%. For LMICs like Indonesia, targeted deployment, federated learning, and ethical governance are critical. AI success depends on valid algorithms, ready infrastructure, equitable digital literacy, and inclusive multi-sector collaboration.

ACKNOWLEDGMENT

The author would like to thank the Hermina Institute of Health for supporting this research.

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