ISSN: 2577 - 8005

Research Article

Medical & Clinical Research

Artificial Intelligence in Accident and Emergency Practice: Applications, Challenges, and Future Directions

Aya Mohammed[1], Haleh Al Abadi[1], Ahmed Hassan[2], Mazen Shasha[3] and Mohammed Al Abadie[4*]

[1]*The Midlands Medical Academy, United Kingdom*

[2]*Department of Vascular Surgery, Coventry Hospital, United Kingdom*

[3]*Rotorua Hospital Emergency Department, New Zealand*

[4]*University of Wolverhampton, North Cumbria Integrated Care NHS Foundation Trust, United Kingdom*

[*]**Corresponding Author**
Mohammed Al Abadie, University of Wolverhampton, North Cumbria Integrated Care NHS Foundation Trust, United Kingdom.

Submitted: 09 Sep 2025; **Accepted**: 17 Sep 2025; **Published**: 30 Sep 2025

Citation: Mohammed, A., Al Abadi, H., Hassan, A., Shasha, M., & Al Abadie, M. (2025). Artificial Intelligence in Accident and Emergency Practice: Applications, Challenges, and Future Directions. *Med Clin Res, 10*(9), 01-04.

Abstract
Artificial Intelligence (AI) is rapidly transforming healthcare, and its integration into Accident and Emergency (A&E) practice offers significant potential for improving diagnostic accuracy, workflow efficiency, and patient outcomes. This paper critically explores current applications of AI in emergency medicine, discusses its limitations, and envisions its role in shaping the future of urgent care. We provide case-based insights and propose ethical frameworks and integration strategies for AI adoption in A&E.

Keywords: Artificial intelligence, Diagnostic imaging, Sepsis, Pulmonary embolism

1. Introduction
The chaotic, high-stakes environment of A&E demands swift clinical decisions, often based on limited data. AI, through machine learning (ML), computer vision, and natural language processing (NLP), can assist clinicians by rapidly analyzing large volumes of patient data. As the global burden on emergency departments rises, AI presents a promising frontier for real-time decision support, triage optimization, and diagnostic augmentation [1].

2. AI Applications in A&E Practice
2.1 Diagnostic Imaging
AI-powered radiological tools can identify life-threatening abnormalities such as intracranial hemorrhages, pneumothorax, and spinal fractures. These tools assist in accelerating detection, especially during peak hours or in understaffed environments [2].

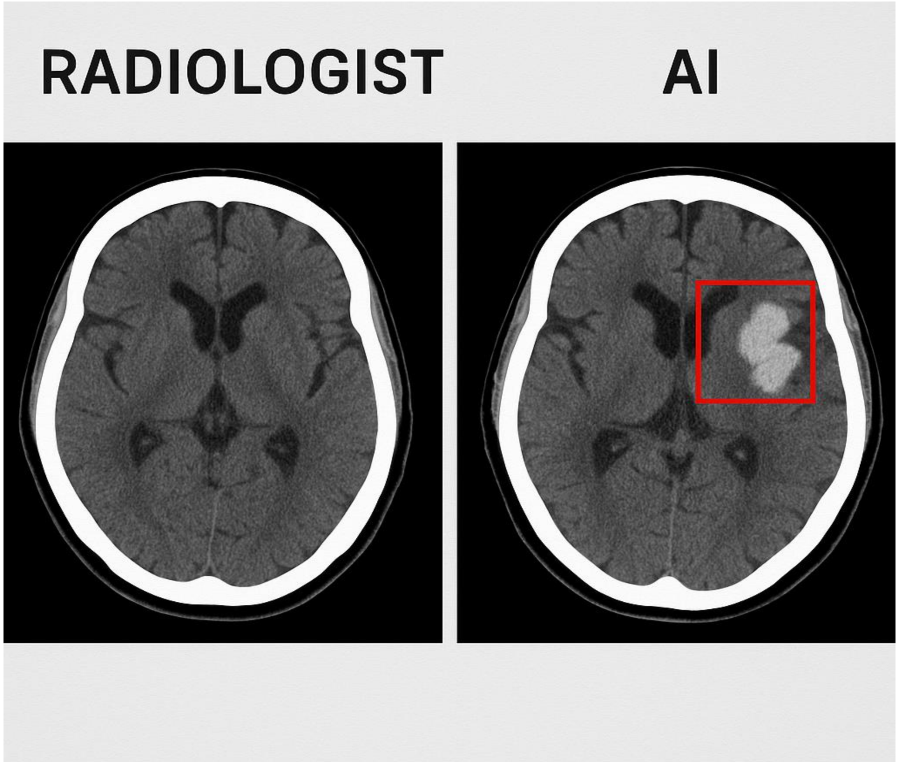

Figure 1: Comparison of standard radiologist interpretation (left) and AI-augmented CT scan (right), with AI highlighting a suspected abnormality.

2.2 Triage and Risk Stratification

AI algorithms like Deep-Triage use vital signs, chief complaints, and EHR data to assign urgency scores. These models can outperform traditional Early Warning Scores. For instance, some have shown >90% accuracy in predicting sepsis within 6 hours of ED presentation [3].

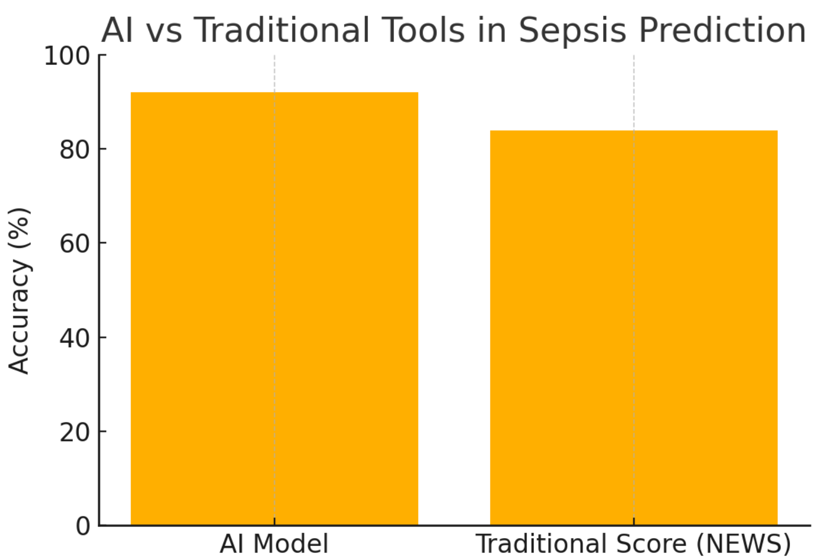

Figure 2: AI *vs* Traditional Tools in Sepsis Prediction

As shown in Figure 2, AI-based models surpass traditional scoring systems in accuracy for sepsis prediction, demonstrating real potential in urgent triage contexts.

Another documented use of AI is in stroke pathways. Brainomix e-Stroke system, deployed in the UK in 2020, uses AI algorithms to support clinicians in the interpretation of brain scans to aid stroke detection and subsequent treatment. It processes over 97% of scans in an average time of 4 minutes, alerting to a potential large-vessel occlusion [4]. Its implementation has also been found to cut Door-in-Door-out time down from 140 minutes to 79 minutes for patients receiving treatment with mechanical thrombectomy [5].

2.3 Clinical Decision Support

AI can offer drug-drug interaction alerts, suggest diagnostic pathways, and assist in disposition planning (e.g., ICU vs. ward). Integration with electronic health records (EHRs) ensures real-time, context-aware recommendations [6].

AI tools have also been shown to improve the accuracy of pulmonary embolism (PE) detection on CT pulmonary angiography (CTPA) with increased sensitivity and specificity compared to traditional radiologist reports. A retrospective analysis comparing missed positive PE findings found that out of 717 patients with PE, AI systems missed only 23 compared to 60 cases missed by the attending radiologists, highlighting the potential of AI-assisted reporting to enhance diagnostic accuracy in emergency medicine [7].

		Reference		
		+	-	
Radiology report	+	657	9	666
	-	60	2590	2650
		717	2599	3316

		Reference		
		+	-	
AI algorithm	+	694	2	696
	-	23	2597	2620
		717	2599	3316

Figure 3: AI versus radiologist reports in the detection of PE

As shown in Figure 3, comparison of radiologist reports and AI algorithms for pulmonary embolism (PE) detection on CT pulmonary angiography (CTPA) demonstrated superior performance of the AI system. Of 717 confirmed PE cases, radiologists missed 60, whereas the AI system missed only 23, underscoring the potential of AI-assisted interpretation to enhance sensitivity and overall diagnostic accuracy in clinical practice [8].

2.4 Operational Optimisation

AI enhances emergency department flow management by predicting patient surges, assisting in bed allocation, and optimizing staff deployment. These improvements contribute to reduced waiting times and increased throughput [9].

Application Area	AI Tool/Technique	Benefit	Example Use Case
Diagnostic Imaging	Deep CNNs	Faster, accurate diagnosis	Detecting brain hemorrhage
Triage & Risk Scoring	ML Models (e.g., XGBoost)	Early identification of sepsis	Predicting ICU need
Clinical Decision Support	NLP + Rules Engines	Drug alerts, diagnostic suggestions	Chest pain pathway alerts
Workflow Optimization	Predictive Analytics	Reduced crowding, better flow	Staff scheduling

Table 1: Summary of AI Applications in A&E

Table 1 summarizes the core domains where AI contributes to A&E practice, highlighting the specific technologies employed, their primary benefits, and real-world clinical applications. Diagnostic imaging benefits from convolutional neural networks (CNNs) that enhance detection speed and accuracy. Machine learning models improve risk stratification by identifying high-risk patients earlier than traditional methods. Clinical decision support systems use natural language processing (NLP) to provide timely alerts and pathway suggestions. Lastly, predictive analytics optimize resource allocation and patient flow, directly addressing operational bottlenecks. This table provides a practical overview of how AI enhances both clinical and administrative aspects of emergency care.

3. Limitations and Challenges

Data bias and fairness are major concerns. AI trained on selective datasets may underrepresent minority populations, skewing triage outcomes [9]. Interpretability remains a hurdle, as black-box models make it difficult to understand how conclusions are reached, reducing clinician trust [10].

Integration barriers include system incompatibilities, staff resistance, and unclear regulatory pathways [11]. Legal and ethical issues, such as liability, consent, and data security, further complicate AI adoption in A&E [12].

4. Case Studies

At an urban trauma center, an AI-ECG tool predicted 30-day major cardiac events with 95% sensitivity, outperforming traditional scoring systems [13]. In a UK pediatric A&E, an NLP-based chatbot reduced waiting times by 18% by pre-assessing symptoms without compromising safety [14].

5. Ethical and Regulatory Frameworks

A robust AI integration policy in A&E should include human-in-the-loop safeguards, transparent algorithm reporting, post-deployment auditing, and equity monitoring protocols [15].

6. The Future of AI in Emergency Medicine

Anticipated innovations include ambient AI for passive monitoring, digital twins for disease modeling, and multi-modal AI combining imaging, labs, and clinical notes [16].

7. Conclusion

AI holds trans-formative potential in A&E—offering speed, scale, and sophistication. With responsible implementation, it can augment emergency care while preserving human judgment [18].

References

1. Topol, E. (2019). *Deep medicine: how artificial intelligence can make healthcare human again.* Hachette UK.
2. Arbabshirani, M.R., et al. (2018). Advanced machine learning in radiology: A call for quality control and transparency. Radiology.
3. Taylor, R. A., Pare, J. R., Venkatesh, A. K., Mowafi, H., Melnick, E. R., Fleischman, W., & Hall, M. K. (2016). Prediction of in-hospital mortality in emergency department patients with sepsis: a local big data–driven, machine learning approach. *Academic emergency medicine, 23*(3), 269-278.
4. Health Innovation Oxford & Thames Valley (2024) AI in Health and Care Award: Final Report—e-Stroke by Brainomix. Health Innovation Oxford
5. Department of Health and Social Care, Barclay, S. (2022). Artificial intelligence revolutionising NHS stroke care
6. Langius-Wiffen, E., de Jong, P. A., Hoesein, F. A. M., Dekker, L., van den Hoven, A. F., Nijholt, I. M., ... & Veldhuis, W. B. (2023). Retrospective batch analysis to evaluate the diagnostic accuracy of a clinically deployed AI algorithm for the detection of acute pulmonary embolism on CTPA. *Insights into Imaging, 14*(1), 102.
7. Tahayori B, et al. (2021). Predicting emergency department crowding using machine learning. BMC Med Inform Decis Mak.
8. Obermeyer, Z., Powers, B., Vogeli, C., & Mullainathan, S. (2019). Dissecting racial bias in an algorithm used to manage the health of populations. *Science, 366*(6464), 447-453.
9. Rudin, C. (2019). Stop explaining black box machine learning models for high stakes decisions and use interpretable models instead. *Nature machine intelligence, 1*(5), 206-215.
10. Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal, 6*(2), 94-98.
11. Price WN II, Cohen IG. (2019). Privacy in the age of medical big data. Nat Me Price, W. N., & Cohen, I. G. (2019). Privacy in the age of medical big data. *Nature medicine, 25*(1), 37-43.
12. Attia, Z. I., Noseworthy, P. A., Lopez-Jimenez, F., Asirvatham, S. J., Deshmukh, A. J., Gersh, B. J., ... & Friedman, P. A. (2019). An artificial intelligence-enabled ECG algorithm for the identification of patients with atrial fibrillation during sinus rhythm: a retrospective analysis of outcome prediction. *The Lancet, 394*(10201), 861-867.
13. Liu X, et al. (2020). Chatbot application in healthcare: review and future directions. Healthcare.
14. London, A. J. (2019). Artificial intelligence and black-box medical decisions: accuracy versus explainability. *Hastings Center Report, 49*(1), 15-21.
15. Esteva, A., Robicquet, A., Ramsundar, B., Kuleshov, V., DePristo, M., Chou, K., ... & Dean, J. (2019). A guide to deep learning in healthcare. *Nature medicine, 25*(1), 24-29.
16. Jha, S., & Topol, E. J. (2016). Adapting to artificial intelligence: radiologists and pathologists as information specialists. *Jama, 316*(22), 2353-2354.