Artificial Intelligence in the Emergency Room

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Not too long ago, the idea of artificial intelligence (AI) predicting cardiac arrest or drafting a patient's discharge summary was considered science fiction. Today, it's taking place in real time, right in front of us.

In emergency rooms throughout the United States, AI systems are assisting healthcare workers with various day-to-day activities, facilitating improvements in workflow and accuracy.[1] Machine learning engines are being developed to effectively assist physicians in the interpretation of data and diagnosis. Other tools exist that mimic well-established scores relied on by the emergency room, like the HEART score, allowing for immediate risk stratification in patients.[2] Additionally, AI technologies have proven to enhance efficiency, therefore addressing the issue of overcrowding in the emergency room.

AI in Data Interpretation

Several AI-run tools exist for the interpretation of data. This includes reading EKGs, which is considered a staple in the emergency department, deciphering lab work, and interpreting imaging studies. Machine learning applications have been developed to assist physicians in the interpretation of EKGs efficiently,[3] the detection of patterns in cardiac biomarkers,[4] and based on retrospective data and clinical variables such as vitals, medical history, medication usage, physical exam, and symptoms.[2,5] **Figure 1** depicts an example of the complexity contained in these AI models, which utilize various clinical factors to predict patient outcomes.[6] Among the AI models that recognize STEMI in EKGs, their accuracy was found to be up to 99.6%, with similar percentages for diagnosing other conditions like atrial fibrillation. Overall, clinical decision-making tools developed by AI have proven to augment diagnostic accuracy, decrease delays, and improve clinical decision-making in the emergency department.[7]

Recently FDA-cleared imaging platforms, such as *Aidoc*, are now being deployed in over 900 hospitals in the United States, including major academic centers.[8] These systems aid in detecting life-threatening conditions such as pulmonary embolism and intracranial hemorrhage, hastening time-to-diagnosis.

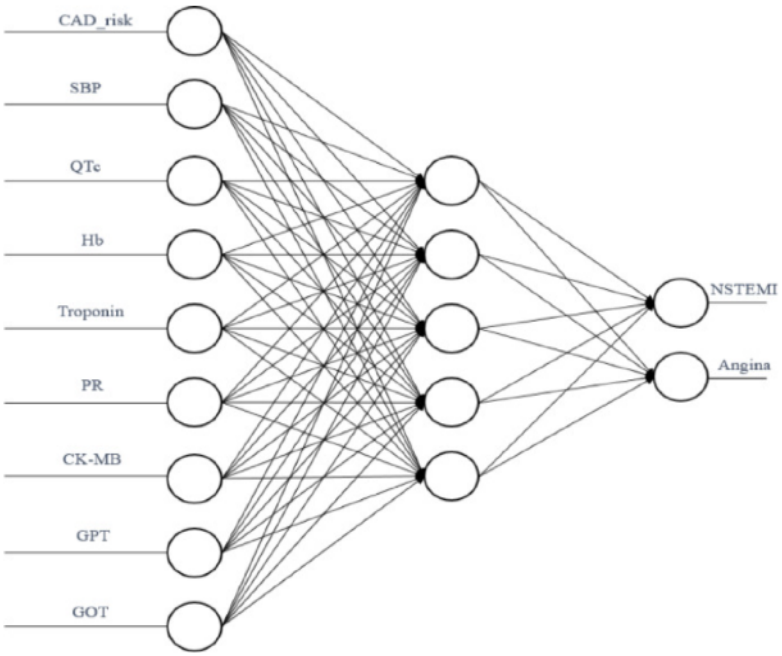

Fig 1. Architecture of a neural network model developed for predicting NSTEMI patients. This AI-derived model was found to have the best outcomes as a prediction model in its respective study. It draws input from qualitative predictors associated with NSTEMI to properly discern it from chest pain. These predictors were found to be cardiac risk factors, hemoglobin, systolic blood pressure, corrected QT interval (QTc), GOT, GPT, CK-MB and troponin.[6]

AI in Documentation

The days of writing countless patient notes from scratch in a single shift may be behind us. Several scribe tools are making an appearance in the emergency room, many of which healthcare workers have begun to rely on daily. AI-powered ambient listening software (e.g., *Microsoft Dragon Ambient Experience, Ambience Healthcare, Abridge*) has been widely adopted to automate clinical documentation. Health systems report up to a 75% decrease in emergency department documentation time and a 42% reduction in clinician cognitive load.[9,10] These applications not only boost efficiency but may also lighten physician burnout—a growing concern in the field of emergency medicine.

Additionally, AI-derived large language models (LLMs) are emerging as powerful agents for clinical decision support in emergency rooms. It was recently demonstrated that an LLM achieved 89% accuracy in identifying patients requiring higher acuity care, which is comparable to physician judgment.[11] Additionally, AI-generated summaries and discharge documentation provide benefits in efficiency, with studies reporting considerable time savings and improved workflow integration.[12,13]

AI as a Predictor of Risk Stratification

Calculating risk is a common practice in medicine, as it plays a significant role in guiding management. Several risk calculators are used multiple times a day in the ER and have been committed to many healthcare workers' memories. Instead of having to input risk factors into a specific calculator, AI algorithms are now being developed to do the work for us, streamlining risk stratification. For example, an AI model that employs a classification algorithm was able to accurately predict major adverse cardiac events (MACE) 15% more than the classically applied HEART score in the diagnosis of acute coronary syndrome.[2]

AI Models for Patient Flow and Overcrowding

Advancements in efficiency have been reported with several AI-run models. Up to a 20% shrinkage in overcrowding in the emergency room was observed, in addition to a 15% reduction in average length of hospital stay in patients with acute coronary syndrome.[14] Notably, some of these models have outperformed skilled clinicians, particularly in interpreting EKGs. One such AI model demonstrated an accuracy rate of 98.7%, while internal medicine physicians demonstrated an accuracy of 96.2%, emergency medicine physicians demonstrated an accuracy of 97.3%, and cardiologists demonstrated an accuracy rate of 98.2%.[3] Because of these impactful tools, patients can immediately undergo necessary treatment, and contact-to-door time has been reported to be as low as 18.5 minutes.[15]

AI is also assisting with forecasting emergency department occupancy to alleviate overcrowding. For example, advanced time-series models such as *TSiTPlus* and *XCMPlus* predicted waiting room occupancy with an average count of 18 patients.[16] These tools enable proactive staffing and prevent bottlenecks before they occur.

In addition, AI-driven triage systems have significant promise in lessening emergency room wait times. A recent meta-analysis discovered that AI-assisted triage reduced average patient wait times by almost 20 minutes.[17] In Connecticut, hospitals have adopted AI models that input weather, holiday, and historical data to forecast patient volume, aiding staffing and resource allocation.[18]

Barriers to Using AI in the Emergency Department

Despite its vast potential in the world of emergency medicine, AI faces several challenges, including its interpretability, legal liability, and bias in data interpretation.[19,20] Applications may be rejected by clinicians in certain scenarios, such as if it is not timely enough, has no effect on the management of the patient, or if it is simply not user-friendly enough.[21] Additionally, the issue of whether healthcare workers should rely solely on AI-fueled devices to make clinical decisions is being debated.[21] It must also be taken into consideration that the risk of disease can be overestimated by AI-powered devices.[22]

AI-powered technologies are remodeling emergency care in the United States. They play an effective role in reducing wait times, improving predictive accuracy, accelerating imaging diagnostics, reducing physician workload, along much more. However, widespread implementation of these technologies will depend on overcoming barriers and ensuring transparency, fairness, and patient safety. Future research should prioritize linking AI implementation to patient-centered outcomes as well as cost-effectiveness and reliability.

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