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DISCOVERY SCIENTIFIC SOCIETY

Artificial Intelligence in Emergency Radiology - A Review

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ABSTRACT

This article discusses the growing role of artificial intelligence (AI) in radiology, with a particular focus on its application in emergency departments. Due to the rise in imaging tests, which often involve medical emergencies, radiologists are experiencing an increase in workload. That is why artificial intelligence has great potential in developing new algorithms based on different machine learning methods. Recent clinical studies show that artificial intelligence can match, and sometimes even surpass, human specialists in detecting conditions such as pulmonary embolism, stroke, fractures, and small bowel obstruction. Despite promising research results, we have to take into account the irregularities that AI may exhibit, such as regulations concerning data privacy, bias in AI training, and the lack of transparency in how it makes decisions, known as the "black box" problem. Further research should focus on preparing AI protocols with medical professionals and algorithm programmers. Researchers should carry the work forward to validate the sample volume and its diversity.

Keywords: artificial intelligence, radiology, emergency diagnostic, machine learning

1. INTRODUCTION

Radiology is a diagnostic branch of medicine that has experienced the most significant technological growth. Over the years, its development has closely followed the advances in IT engineering. From the discovery of X-ray radiation to the current use of artificial intelligence to help reduce the misinterpretation of results, medical imaging has come a long way. Each period of automation development significantly changes the way we use and rely on new solutions. Artificial Intelligence (AI) is a current alternative that offers a wide range of possibilities. AI's ability to quickly process and link large amounts of information is one of its key advantages, particularly in emergency patient diagnosis situations. AI has weaknesses; problems arise when there is a lack of human judgment, experience, and intuition. Jones et al., (2022) highlight a growing concern: patients are spending more time in emergency departments, and those who remain in the

ED for more than five hours after being admitted face a greater risk of death within 30 days.

This study shows that delaying treatment for more than 6 to 8 hours causes one additional death for every 82 patients. We can assume that a large proportion of patients require diagnostic imaging to make a correct diagnosis. Doctors specializing in emergency medicine require a rapid description of the imaging study, and radiologists must work quickly to provide a precise response (Forsberg et al., 2016), which can significantly impact the outcome of the final diagnosis and the selected treatment. Therefore, Artificial Intelligence has a broad potential for use in radiology and emergency departments.

2. REVIEW METHODS

This work is a review paper on the topic of artificial intelligence in radiology within the Department of Emergency Medicine, identifying, analyzing, and synthesizing relevant studies. We took into account scientific studies using literature browsers such as PubMed, Google Scholar, Web of Science, and Scopus. The search encompassed studies published between January 2017 and April 2025. Keywords and search terms included "radiology in the emergency department", "AI in radiology", "recognition of patterns in trauma radiology", and "radiology workload". To ensure the quality of the cited studies, we excluded non-peer-reviewed articles, abstracts, editorials, papers that focused solely on theoretical models without practical applications in radiology, and studies that were not available in full text.

Inclusion Criteria: Studies on the link between radiological and emergency department factors and AI usage outcomes, published in English, with quantifiable or qualitative data.

Exclusion Criteria: Studies with weak methodologies, small research samples, and articles older than 10 years. The article screening process adhered to the PRISMA guidelines (Figure 1).

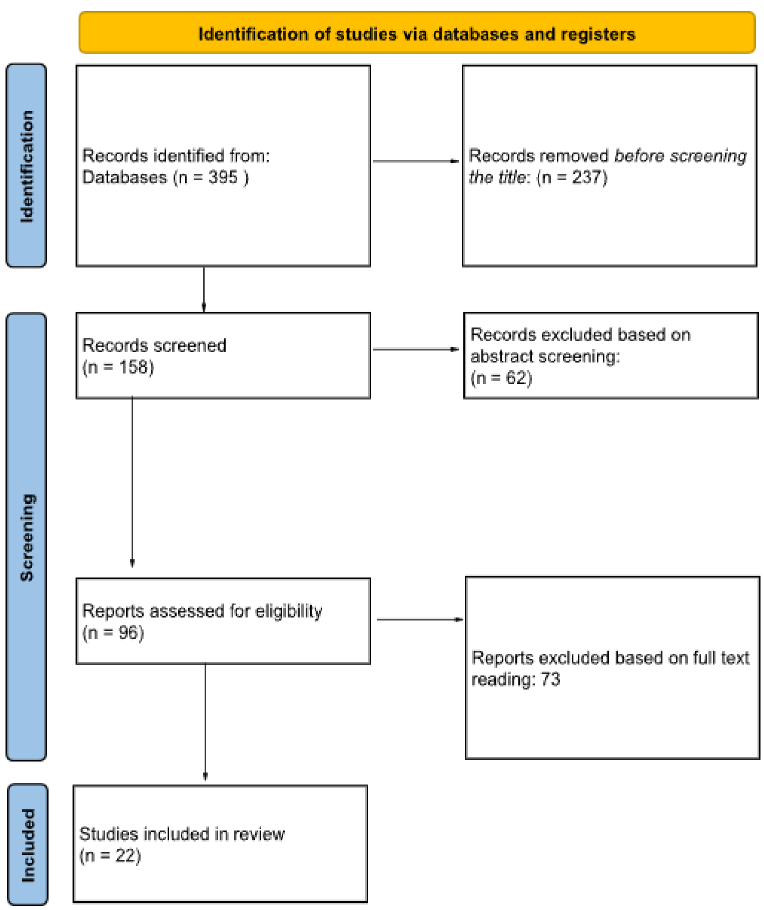

Figure 1 PRISMA flow chart

3. RESULTS AND DISCUSSION

Overview of Machine Learning

Artificial Intelligence's main advantage is Machine Learning. It combines advantages from technology, such as the ability to evaluate a large portion of data, making inferences based on statistics and research of the collected database for the most likely solution, and also characteristic of human holistic thinking that it also reflects how humans think holistically, drawing on years of experience, focusing on the broader context, and using information that they may sometimes choose to override. The primary advantage of AI is its capability for continuous learning and improvement. The more data we enter transparently, the more benefits will be available to doctors and patients in the future. There are four main types of machine learning: supervised, unsupervised, semi-supervised, and reinforcement learning (Table 1).

According to Cellina et al., (2022), supervised learning (SL) is a good option for situations where classification is necessary. This model learns by being exposed to an appropriate number of cases, and it seeks correlations between each case and the final diagnosis result. An unsupervised learning (UL) model works by discovering hidden information that researchers did not provide beforehand and is expected to draw its conclusions through data-driven analysis.

Semi-supervised learning (SSL) integrates both aspects of SL and UL, primarily focusing on interpreting unlabeled data while also taking into account a smaller portion of labeled data. As a result, it can fill in missing information from unlabeled data. Reinforcement learning (RL) operates based on previously programmed regulations and has to perform a specifically defined task (Cellina et al., 2022).

Table 1: Terminology and characteristics of ML

Machine Learning approach	Qualities	Mode of operation
Supervised learning	Coached with known outcomes, labeled data	Provides results backed by classification
Unsupervised learning	Unlabeled data	Finding patterns
Semi-supervised learning	Mix data, labeled and unlabeled	Self training
Reinforcement learning	Unlabeled data	Advanced decision-making process

The most frequent imaging used in the emergency department

The X-ray is one of the most widely used imaging techniques in medicine. As a result, physicians provide a large volume of X-ray images, accompanied by prior diagnostic descriptions. Research conducted by Wu et al., (2020) has created a comparison between chest radiograms evaluated by radiologists and AI Algorithms. The sensitivity results of this study showed that both AI and resident doctors were equally accurate in identifying true positive radiograms. In terms of predicting truly positive results, AI (0.730) had a better outcome than the group of residents (0.682), and the P value was < 0.001. Other studies received similar conclusions about specificity; AI had a higher percentage of accurate negative results (0.980) than doctors (0.972), and the P value was <0.001. This particular study suggests that properly programmed AI algorithms, when supported by radiologists who provide numerous data points with accurate diagnoses, hold great potential for future patient examinations.

CT scans are used in emergency departments to diagnose urgent medical cases, including acute pulmonary embolism (PE). If diagnosed promptly, there is a chance to deliver swift treatment and improve the likelihood of recovery. CTPA (computed tomography pulmonary angiography) is the preferred imaging modality for this purpose. It provides a clear view of thromboemboli in the pulmonary vasculature, including subsegmental arteries, and is very easy to read. Prospective outcome studies validated it for effectiveness. Soffer et al., (2021) interpreted a meta-analysis of 5 retrospective studies; they found that the pooled sensitivity was 0.88 and the specificity was 0.86 for AI algorithms in detecting PE on CTPA. A different survey by Cheikh et al., (2022) evaluated AI models for improving the performance of radiologists, which included an analysis of 1,202 medical cases.

Evidence from this research showed that more than 60% of radiologists, who participated in this study, appreciated the use of AI in situations where negative findings of PE had to be confirmed, and in ensuring the absence of distal pulmonary embolism in low-quality scans. For better understanding and progress in developing accurate AI models, databases containing collections of CTPA test results were created (Colak et al., 2021). CTPA and AI collaboration enable the development of the best AI model, significantly reducing the waiting time for results for patients at risk of death from pulmonary embolism.

Stroke is another example of a serious threat we encounter in the emergency department. Magnetic Resonance Imaging (MRI) offers high-sensitivity tests and is capable of detecting acute ischemia in cases where the onset of stroke is unknown and potentially reversible through revascularization. An evaluation of 33 studies by Bojsen et al., (2024) on AI for stroke detection in MRI revealed considerable variability in study design and data quality, with most research focusing on ischaemic stroke and only one AI algorithm holding CE marking.

In a review of nine studies, artificial intelligence achieved 93% sensitivity and specificity in identifying DWI-positive ischemic strokes. Lower sensitivity was often associated with small lesion sizes or the image processing techniques used. Researchers linked reduced specificity to limited training data or the method of setting detection thresholds. One study showed that using multiple AI models together with an iterative voting method improved accuracy. However, this technique demands a lot of computing power, which may limit its practical use in everyday clinical environments.

Several studies focus on assessing the prediction of stroke complications by reviewing previous cases. A study by Nielsen et al., (2018) focused on utilizing a CNN (convolutional neural network), which handles stroke heterogeneity by learning from databases that include tissue outcome data from previous patients. Their predictive performance can further improve as more patient data becomes available. Results of this experiment showed that CNNdeep indicated better performance in predicting the final tissue outcome. The algorithm evaluated data based on contrast, providing more accurate predictions that outperformed all comparator models ($P \leq 0.003$). CNNdeep seemed able to detect the effects of treatment, shown by a statistically significant difference in final infarct volume between patients who received tPA (tissue plasminogen activator) and those who didn't ($P = 0.048$). This scientific publication is valuable as it enables radiologists, emergency physicians, and neurologists to evaluate and determine the most beneficial treatment approach for individual patients.

Small bowel obstruction (SBO) contributes to approximately 12–16% of emergency surgical admissions and 20% of emergency surgical procedures. Patients who are dealing with this health issue have intense abdominal pain, which may lead to serious health complications, such as a high potential risk of bowel ischemia or perforation; evaluation from a physician and further diagnostic tests are essential (Tong et al., 2020).

A paper published by Li et al., (2024) evaluated 1932 abdominal radiographs and programmed an AI algorithm. Outcomes were later compared with the work of junior and senior radiologists. According to their findings, junior radiologists achieved an accuracy rate of 78%, while senior radiologists achieved a rate of 84%. We have to notice that AI-assisted analysis improved the accuracy of small bowel obstruction recognition, raising the AUC from 0.780 to 0.887 for junior radiologists, and from 0.840 to 0.913 for senior radiologists. Researchers conducted a test as part of the study demonstrating that the Xception model achieved an accuracy of 0.807, which surpassed the performance of other models and the junior radiologist (0.780), but did not reach the level of the senior radiologist (0.840).

These results show that small bowel obstruction (SBO) is challenging to diagnose, emphasizing how helpful AI could be in interpreting and explaining the findings. A separate study by Kim et al., (2021) came to similar conclusions using a different method that combined radiology reports, follow-up CT scans, surgical notes, and a detailed radiological review.

This approach enabled the design of an algorithm with strong confirmatory accuracy. The AUC reached 0.961, and the Youden J index had 91% sensitivity and 93% specificity. Whereas, evaluation of the data and imaging findings took approximately 146 ms per test. Further studies should be considered with a larger probe number, as this ensemble method has the potential for broad application across various medical imaging classification tasks and holds great promise in providing more accurate diagnoses with reduced time spent.

The implementation of AI in diagnosing abdominal trauma has great potential in improving speed and image quality. Levy et al., (2023) analyzed data from 6,608 images obtained from a quaternary care level 1 trauma center; their work reviewed the system capabilities of four different convolutional neural network architecture models (DenseNet121, InceptionV3, ResNet50, VGG11BN). Algorithms assessed images of ultrasonograms by the FAST protocol, which had to detect free fluid in the abdomen of trauma patients. The team noted the positive outcome if there was evidence of fluid in the area of the left upper quadrant, where the spleen and left kidney are situated, or the right upper quadrant, where the liver and right kidney lie. At the same time, we can describe adequacy as the visualization of the liver and kidney in the right upper quadrant view, or the spleen and kidney in the left upper quadrant view. AI achieved a sensitivity of up to 83% and a specificity of 94% in evaluating the adequacy of imaging. With augmentations, it achieved a sensitivity of up to 94% and a specificity of 96.5% in detecting positive imaging findings.

Evaluation of time spent on individual cases

The rising volume of diagnostic imaging examinations, combined with advances in imaging technology, such as increased sequences, has led to a significant growth in the number of images requiring review per patient. Reducing exam reading time may help offset this increasing workload. Study by Ieong et al., (2024) displays an enormous increase of radiological tests in Macao (China), according to information's gathered from the period 2019-2023, the number of radiographs escalated by 25%, CT scans saw a rapid 96% increase, starting at 20,000 to 39,000, while MRI scans doubled from 7,600 to 15,200 a 100% growth. This increase in diagnostic imaging is not an isolated situation. Similar findings were reported by the Royal College of Radiologists (2024) in England, showing that the number of CT and MRI examinations increased by 8% between 2023 and 2024. Request for this kind of diagnostic has been getting higher each year, by about 5% annually, with the majority of the increase coming from unplanned scans, particularly in emergency settings. Back in 2019, unscheduled CT and MRI scans made up 24% of the total. By 2024, that number had grown to 33%, putting even more strain on imaging services in acute care.

Work by Jeong et al., (2025) reviewed a total of 51 articles to evaluate the impact of AI on reducing the time taken to identify abnormal anatomical structures. Over half of the studies reported a time efficiency improvement of more than 75%.

Study by Duron et al., (2021) found that using AI support noticeably improved radiologists' performance, increasing sensitivity from 70.8% to 79.4% and specificity from 89.5% to 93.6%. It also reduced the average number of false-positive fractures per patient from 0.113 to 0.066 (a 41.9% reduction; P = .02), without significantly increasing reading time (67.0 seconds vs. 57.0 seconds; P = .12). The algorithm helped speed up the detection of bone fractures on standard X-rays. In summary, the conclusions from this paper suggest that AI can help physicians work more easily by reducing the time needed to review images. However, further research is necessary to back up these results.

Challenges and ethical considerations

Technical innovations that come with the use of AI provide several methodological and ethical challenges. Ensuring the privacy of data generated by AI algorithms is essential and should be upheld by established ethical and regulatory standards (Mehr, 2019). According to information analyzed by Vayena et al., (2018), a proper example of data privacy regulation is the new form of the European General Data Protection Regulation (GDPR), which defines precise conditions for the use of confidential data. Without appropriate data analysis, we can't improve the performance of the algorithm. Significant and more diverse data sets allow for more accurate reading and evaluation of cases. However, scientists must prioritize data privacy and protection, as they remain the primary focus of the ethical and responsible use of artificial intelligence (Jones et al., 2018).

"Black box" problem challenges scientists who develop artificial intelligence algorithms, which occurs when the parameters of deep learning are too complex to understand. Because the process is unclear, doctors feel less confident using AI as an addition to their diagnostic procedure. Physicians should play an active role in the development and inspection of new algorithms. Valuable cooperation is vital for developing increasingly accurate and reliable artificial intelligence systems.

Furthermore, the "black box" dilemma applies to issues that may reveal biases against certain ethnic groups due to the lack of data diversification. Gathering sufficient data and providing it to AI algorithms relies on human involvement; scientists working in that field have considerable influence on the representation of ethnic groups. By collecting and analyzing data, we can help prevent biases in healthcare from affecting the quality of AI outcomes. To stop discrimination and inequalities, additional studies are required (Goisauf et al., 2022).

4. CONCLUSION

Artificial intelligence in healthcare has a wide range of applications. We can observe this in radiology and emergency medicine, and it could significantly impact the way physicians make diagnoses and enhance workflow efficiency. This review demonstrates that, when we integrate diagnostic imaging such as X-ray, CT, MRI, and ultrasound with AI systems, they are capable of performing at a level comparable to medical specialists and, in some instances, even exceeding their accuracy in identifying critical conditions like pulmonary embolism, stroke, fractures, and small bowel obstruction. AI is helping departments run more smoothly, and it can enhance logistics, daily workflow, and prepare for unexpected events. It also shortens the time doctors spend reading medical images, an essential advantage in emergency settings, where fast and accurate diagnoses can directly affect patient outcomes. Studies included in this review indicate that AI assistance not only improves diagnostic performance but also helps manage increasing imaging workloads without compromising quality.

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Conflict of interest
The authors declare that there is no conflict of interest.

Data and materials availability
All data associated with this work are present in the paper.

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