Artificial Intelligence in Healthcare: A Review of Diagnostic Applications and Impact on Clinical Practice

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Abstract

Objective: This study aims to explore the benefits and challenges of integrating Artificial Intelligence (AI) in healthcare, focusing on diagnostics, Clinical Decision Support Systems (CDSS), and the impact on healthcare professionals and patient outcomes. Methods: A literature review was conducted, analyzing relevant articles and journals on AI applications in healthcare. Thematic analysis was employed to identify, analyze, and report key patterns and insights across the collected data. Results: AI has significantly enhanced diagnostics, particularly in pathology, dermatology, and radiology, where it often surpasses human accuracy in cancer detection. CDSSs provide healthcare professionals with timely and relevant information, improving decision-making processes and patient outcomes. Despite these advancements, AI integration faces resistance due to perceived threats to professional autonomy and increased workload. This resistance manifests at behavioral, perceptual, and dispositional levels, hindering full adoption. Conclusion: AI is revolutionizing healthcare by improving diagnostic accuracy and supporting clinical decision. The successful integration of AI requires addressing user resistance and balancing technological innovation with human adaptability. Overcoming these challenges is crucial to maximizing AI's potential in enhancing patient care and medical decision-making. As AI continues to advance, it is essential to ensure that it complements rather than compromises the work of healthcare professionals, ultimately leading to better health outcomes.

Keywords: Artificial Intelligence (AI), Diagnostics, Clinical Decision Support Systems (CDSS), Medical Imaging, User Resistance.

Significance | AI's integration into clinical medicine enhances diagnostic accuracy, improves patient care, and addresses challenges in healthcare decision-making.

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Introduction

The early detection of health problems in a hospital setting is essential and should be supported by a high-quality hospital service system. This can be achieved through an integrated Hospital Management Information System (HMIS), which plays a crucial role in ensuring efficient service delivery. According to Yulianti and Mahardi (2019), the existence and functionality of the HMIS bring significant benefits to all hospital users, including patients, doctors, nurses, management, partners, and other stakeholders. Through the HMIS, every transaction is systematically recorded, processed, and utilized to improve service delivery and patient outcomes.

An effective HMIS not only collects data but also processes it based on scientific principles, thereby assisting decision-makers in making informed decisions that benefit patients and the overall hospital management. Nekoel-Moghadam and Amiresmaili (2018) note that information systems are one of the biggest needs of hospitals, as they help overcome common challenges such as irregular patient data, errors in the queuing system, incomplete identity information, and unclear medical prescriptions.

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Implementing information systems can minimize these issues, leading to a significant positive impact on the overall quality of hospital services.

As management communication technology rapidly evolves, marked by systems like Interwar that offer data connections between computers and networks, their application in healthcare has become critical. These systems facilitate various data communication links, both standard and non-standard, which are essential for clinical health systems (Ayanlade et al., 2019). The dynamic nature of healthcare services, combined with the increasing demand for high-quality and quantity information systems, underscores the importance of advancing hospital information technology. Despite these advancements, there are ongoing challenges related to the slow improvement of hospital information technology, human resource capabilities in utilizing information technology, software crises, and user complaints. As highlighted by Schmidt et al. (2015), questioning the latest technology used by hospital administration, customer service, engineers, and medical employees is vital for ensuring user satisfaction. To enhance the quality of information systems in the health sector, hospitals are building better and more capable systems that support faster and more accurate medical service decisions. Initially, information management systems were introduced to support administrative functions and information and communication technology. Over time, these systems have been adopted to support clinical activities in health organizations. Hospital management information systems are now implemented for electronic medical record purposes, integrating information from pharmacies, radiology, and laboratories, and providing access to a comprehensive view of a patient's health, treatment, and background (Arvanitis and Loukis, 2016). As Ayaad et al. (2019) and Park et al. (2020) suggest, HMIS capabilities are becoming increasingly integral to many work processes in health organizations and have been proven to improve health services, reduce antibiotic use, and streamline work processes.

Despite the benefits of HMIS and healthcare services for patients, the extensive integration of information systems in healthcare has impacted the working conditions of healthcare professionals, particularly doctors and nurses. Petrakaki and Kornelakis (2021) found that the introduction of Electronic Systems for Disease Management (ESDM) increased the standardization of work tasks performed by healthcare professionals, thus limiting their flexibility. Existing research indicates that the presence of information technology in daily work often restricts the autonomy of health professionals (Bansler, 2021), increases workload (Dupret, 2017), facilitates surveillance, and negatively impacts relationships with other professionals and patient groups. The knowledge and expertise of health professionals can mitigate the negative impact of information systems on their working conditions. Health professionals acquire legal status from society, granting them the jurisdiction and privilege to exercise occupational discretion and self-regulation within their field of expertise (Currie and Croft, 2015). Self-governance provides these professionals with the ability to organize their own work, develop training programs, and maintain collegial control over their areas of expertise. As Molleman and Rink (2015) suggest, the differences in expert knowledge and discretionary power place physicians at the top of the professional hierarchy compared to other medical-based health occupations. Medical expertise enables physicians to challenge and refine standards in information systems, whereas registered nurses may find themselves constrained by standards based on medical algorithms integrated into information technology (Russell et al., 2016). Therefore, as the healthcare sector progresses and evolves, the performance of doctors and nurses must be able to adapt and collaborate with information technology.

Research Methods

This study utilizes a literature review methodology. The literature review method involves systematically collecting and analyzing a broad range of articles and journals relevant to the research problem and objectives. This approach helps to uncover and synthesize various theories and findings that provide a solid foundation for discussing and interpreting the research results. Data analysis in this study employs thematic analysis, a method designed to identify, analyze, and report patterns or themes within the collected data. Thematic analysis enables the researcher to discern meaningful connections and insights by following a structured process. As outlined by Braun and Clarke (2006), the stages of thematic analysis include comparison, which identifies and evaluates the similarities across multiple sources of literature. This stage involves synthesizing data to highlight commonalities that may contribute to a deeper understanding of the research topic. Contrast: Exploring and elucidating the differences between the sources. This step is crucial for understanding the diversity of perspectives and drawing nuanced conclusions that acknowledge the complexity of the subject matter. Critique: Formulating and presenting the researcher's own informed opinions based on the critical evaluation of the sources reviewed. This stage allows the researcher to engage with the literature critically and contribute original insights to the discourse.

Results and Discussion

Artificial Intelligence (AI) has become an integral component of modern clinical medicine, revolutionizing various aspects of healthcare (Hamet & Tremblay, 2017). While the utilization of AI in medical imaging dates back to the early 1970s, with applications such as neural network imaging for interpreting electrocardiograms (ECGs) and diagnosing myocardial infarctions, recent advancements in AI technology have significantly expanded its

capabilities. Early applications faced criticisms for inconsistent performance and low specificity (Kohli & Jha, 2018). However, breakthroughs in deep learning, a second-generation AI method, have enhanced the power and effectiveness of AI in medical contexts, allowing it to contribute to areas like image analysis, drug discovery, gene mutation prediction, and chronic disease management (van Ginneken, 2017; Angermueller et al., 2016).

AI in Medical Diagnostics

Diagnostics is a key area where AI's impact is evident. Research indicates that AI is poised to fundamentally alter the diagnostic and predictive analysis of medical images (Miller & Brown, 2018; Zhou et al., 2017). In fields such as pathology and dermatology, AI has demonstrated capabilities that rival or surpass human expertise in detecting and classifying various types of cancer (Esteva et al., 2017). In radiology, computer-aided diagnosis (CAD) systems are used for breast cancer detection on mammograms, lung nodule diagnosis, and interstitial lung disease detection on CT scans. While the possibility of fully automated diagnostics is on the horizon, current AI algorithms primarily function as a supplemental "second opinion" in various medical subspecialties (Venkatesh et al., 2017).

In the past four years, there has been a surge in AI-based medical applications globally. Several applications, such as AI for CT stroke diagnosis, CAD for digital breast tomosynthesis, and algorithms for CT brain hemorrhage diagnosis by AiDOC and MaxQ, have received regulatory approval. AI-powered software like Transpara for breast cancer detection and solutions for diagnosing liver and lung cancer via MRI or CT scans are commercially available in the United States, approved by the Food and Drug Administration (FDA) (Topol, 2019). In China, major hospitals have adopted Tencent Miying's Intelligent Clinical Decision Support Systems (ICDDSS) to assist in early lung and esophageal cancer screenings (Pan et al., 2019).

AI in Banglades's Healthcare Sector

In Bangladesh, global tech giants are playing a pivotal role in integrating AI into healthcare practices Bangladesh, classified as a low-middle income country (LMIC), is facing a significant challenge with cardiovascular disease (CVD) prevalence, compounded by insufficient primary care services. CVD risks are alarmingly high, with 99.6% of males and 97.9% of females in the country exposed to at least one risk factor (NIPORT N.I., 2013). The increasing number of heart disease patients far exceeds the capacity of available cardiologists, creating a critical gap in the healthcare system. Doctors are often overwhelmed by the sheer volume of patients, leading to shorter consultations and less personalized care. Furthermore, many individuals struggle to find time to visit doctors, making convenience and timeliness key factors in healthcare decisions.

AI-enabled smartwatches are emerging as a promising solution. These devices are user-friendly, convenient, and capable of providing accurate health assessments, sometimes surpassing the precision of medical practitioners in delivering healthcare information. With a population of 166.7 million, including 21.74 million residing in Dhaka, the demand for alternative healthcare solutions is evident (Islam et al., 2019). The elderly population, accounting for 14.23% of those aged 65 and above and 6.82% in the 55-64 age bracket, is particularly vulnerable to chronic conditions such as chronic obstructive pulmonary disease (7%), heart disease (6%), stroke (5%), and diabetes (3%), contributing to 18% of total deaths in the country (CDCP C., 2014). Alarmingly, Bangladeshis are prone to developing heart disease a decade earlier than their global counterparts, with 40% of cases occurring in individuals below 50 years old (Collazos C.A., 2019)

As awareness of health issues grows and Bangladeshis are strongly inclined towards interconnectedness, more are turning to smartwatches for health monitoring. This trend is part of a broader movement in which developing countries, including Bangladesh, are increasingly adopting telehealth platforms to improve healthcare delivery.

Clinical Decision Support Systems (CDSS)

Clinical Decision Support Systems (CDSS) are another area where AI has significantly influenced healthcare. These systems are designed to assist healthcare professionals in clinical decision-making tasks by providing timely and relevant information. CDSS can be categorized into knowledge-based and non-knowledge-based systems. Knowledge-based systems utilize a knowledge base and a reasoning engine to combine data with patient information, while non-knowledge-based systems rely on advanced AI techniques such as machine learning to learn from past experiences and identify patterns in clinical data. CDSS technology facilitates improved health outcomes by enhancing the accuracy and efficiency of clinical decision-making processes.

Challenges and Resistance to AI Integration

Despite the potential benefits of AI in healthcare, its integration has faced significant challenges, particularly concerning user resistance. Research on information systems indicates that resistance to technology remains a considerable barrier to successful implementation (Sahmhan, 2018). User resistance is not simply the opposite of acceptance but is influenced by factors such as perceived threats and loss of power due to changes in intra-organizational dynamics. The introduction of new information systems can disrupt the status quo, leading to resistance based on equity theory, where users evaluate changes concerning their impact on equity status (Bhattacherjee & Hikmet, 2017). Resistance can manifest at different levels, including behavioral resistance (passive or active), perceptual resistance to change (perceptions that inhibit change), and dispositional resistance to change (personal tendencies to resist change).

Future of AI in Healthcare

The integration of AI in healthcare is essential and inevitable, as the technology offers significant advantages in enhancing efficiency and improving the quality of care. AI can assist in various aspects of healthcare, including disease diagnosis, risk assessment for mental illnesses, and patient care through intelligent robots (Hazarika, 2020; Lu, 2019). In the context of the COVID-19 pandemic, the use of AI and robotic assistants has been particularly beneficial in reducing physical contact between healthcare providers and patients, thereby minimizing the risk of infection among healthcare workers (Marlon et al., 2020). As AI continues to advance, its role in healthcare is expected to expand, leading to improved patient outcomes and more efficient healthcare delivery.

Conclusion

Artificial intelligence (AI) is revolutionizing clinical medicine, particularly in diagnostics and predictive analysis of medical images. AI has proven to outperform human diagnostics in fields like pathology, dermatology, and radiology, significantly enhancing cancer detection and differential diagnoses. Clinical Decision Support Systems (CDSS) provide timely, tailored information, improving healthcare outcomes. Despite these advances, user resistance remains a significant challenge in AI implementation, affecting technology adoption at behavioral, perceptual, and dispositional levels. Overcoming these challenges is crucial to fully harnessing AI's potential in distinguishing between benign and malignant diseases and assessing mental health risks, including suicide. The successful integration of AI in healthcare will require a balance of technological innovation and human adaptability, ensuring AI serves as a powerful tool for improving patient care and medical decision making.

Author contributions

T., conceptualized the project, developed the methodology, conducted formal analysis, and drafted the original writing. A.R.S contributed to the methodology, conducted investigations, provided resources visualized the data, and contributed to the reviewing and editing of the writing.

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Competing financial interests

The authors have no conflict of interest.

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