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The Impact of AI on Reducing Medical Errors

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ABSTRACT

Medical errors, which result in millions of injuries and thousands of deaths annually, are a critical concern in healthcare. AI presents transformative potential in addressing these errors, particularly by assisting with early diagnosis, improving clinical decision-making, automating workflows, and enhancing patient safety. This paper investigates the application of AI in preventing medical errors, specifically in diagnostics, medication management, and clinical care. Therefore, by analyzing case studies, current implementations, and potential challenges, this discussion highlights the critical role AI plays in minimizing human errors and its prospects for enhancing healthcare systems. Furthermore, recommendations for advancing AI technologies and strategies to overcome barriers to widespread adoption are proposed.

Keywords: Artificial Intelligence, Medical Errors, Patient Safety, AI in Healthcare, Healthcare Automation

INTRODUCTION

Healthcare is complex. 2.7M Americans die annually. There are 35M hospitalizations and 1B outpatient visits per year. 1B prescriptions are issued yearly. Over 1M work in medical groups. The system involves emergency care, routine treatment, research, education, and development. It generates vast amounts of electronic and printed data. Errors occur, harming millions and costing billions. Medical errors cause more deaths than HIV, breast cancer, and accidents, ranking eighth in leading causes. Improvements are needed for patient safety and error prevention [1]. This discussion revolves around the topic of how artificial intelligence (AI) has the potential to decrease medical errors and enhance patient safety. This review discussed three distinct categories of AI applications within the healthcare sector. An in-depth analysis of various systems used to identify and avert errors will be conducted. Moreover, this discussion will encompass an explanation of the advantages and challenges posed by automation, along with an examination of the existing systems [2].

UNDERSTANDING MEDICAL ERRORS

Nearly all people are affected by healthcare, with most interactions not resulting in injury. However, when injuries do occur, they are often due to factors within the healthcare system and not negligence. Medical errors are unintended actions or wrong plans in healthcare. In developed countries, an estimated 1 in 10 patients are harmed while receiving hospital care, with even higher numbers in developing nations. In the US alone, it is suggested that 230 million patients are injured and up to 90,000 die from medical errors each year, while up to 50 million patients are injured in developing countries. As medical care becomes more complex, patients feel increased risk, pushing for improved safety. Errors are exacerbated as patients receive care at multiple sites, leading to catastrophic results from system flaws [3]. Medical errors can be categorized into two types: errors of omission and errors of commission. Errors of omission occur when intended actions are not carried out, while errors of commission happen when the wrong action is taken. Medical errors can also be classified into specific types, such as diagnostic failures, performance problems, communication failures, and the use of improper equipment or prescriptions. Variations in practice can contribute to medical errors as well. These errors can be influenced by various factors, including human factors like cognitive limitations and attention problems, as well as organizational factors like coordination difficulties and lack of procedures [4]. Medical errors

can cause significant harm or even lead to the untimely demise of patients, making it imperative to implement robust safety measures. Astonishingly, the number of deaths occurring annually in hospitals ranges from 44,000 to a staggering 98,000 due to these unfortunate errors. It is crucial to understand that these errors can be categorized based on their nature, such as diagnostic, treatment, preventive, or other, as well as their discipline, including clinical, nursing, and non-clinical aspects. Such classification aids in identifying areas of improvement and developing targeted interventions to prevent future mishaps [5].

CAUSES OF MEDICAL ERRORS

Medical errors can be classified by various criteria: by severity, by the types of harm done, and by stages in the clinical cascade. Various classifications emerge from the work of different researchers and institutions. The most famous is probably the human factors classification. Classification of errors by factors causing them includes: - "One-off" – an isolated incident, - Poor supervision – the level of oversight was insufficient, - Task-related – inefficiency of processes due to task design or organization, - Knowledge-related – the absence of necessary knowledge, - Negligence – personal mistakes caused by a wish to disregard procedural rules. Another famous classification of errors can be presented in the following way: - Knowledge-based mistakes, - Rule-based mistakes, and skill-based mistakes. The assessment stage in assessment cascades illustrated above uses typical techniques for the classification of errors. - Scale of consequences: 1. No consequences, 2. Minor injury/Ineffective intervention, 3. Prolonged hospitalization, 4. Severe injury/Disability/Death, 5. Permanent injury/Disability/Death, - Safety of the process itself: 1. Safe, 2. Potentially unsafe, 3. Unsafe, 4. Harm. The most popular assessment method based on such classifications is HAZOP. It originated in the chemical process industry and is used for the identification and evaluation of safety problems in engineering systems by investigating deviations from the design intent. Each deviation is considered in the context of many causes and associated safety issues, such as the possibility of explosion or poisoning arising out of the deviation. The HAZOP methodology was adapted for medical applications. Like at all stages, failures may occur. Failure analysis enables the identification of potential problems in a system, their causes, and consequences. In other words, it enables understanding of what can go wrong, how, and what the consequences can be. Typical methods used for failure analysis that can be applied in medical cases are: - FMECA, - PHA, - HAZOP. In medical applications of such methods, failures are usually classified: - By severity, - By nature. Classification by severity: - Catastrophic: "Death", - Critical: "Significant injury", - Marginal: "Injury requiring professional medical intervention", - Minor: "No injury". Classification of failures by their nature: - Human - "wrong actions of doctors/nurses", - Technical - "wrong functioning of medical devices", - Organizational - "wrong organization of the work of delivery care facilities", - Social - "procedural rules violated by patients/society" [6].

ROLE OF AI IN HEALTHCARE

Several areas of healthcare and medicine have exhibited immense promise for AI applications, already assisting in addressing diverse medical challenges using different types of clinical data. Although the list of AI applications in nascent stages is long, some applications have begun to mature and unleash their benefits across the healthcare ecosystem. Healthcare delivery and payment systems have evolved considerably in the past three decades, posing increased challenges in terms of efficiency, safety, and delivery. AI, particularly machine learning, has already begun to address numerous challenges in this arena. Clinical data, such as electronic health records and medical orders, have also become an invaluable part of patient care. What once was a paper-centered world is now an electronic world for healthcare delivery. Concurrently, vast amounts of clinical data, including clinical notes, laboratory results, prescriptions, diagnostic reports, etc., have been generated using structured and unstructured formats. AI applications have begun to drive transformative innovations in healthcare connected with clinical data-centric challenges. These applications fall into five main categories involving the reuse of clinical data in the following areas: disease and patient risk prediction, workflow automation, clinical decision support, assistant technologies, and healthcare quality analysis. Disease and patient risk prediction aims to detect candidates that are at risk of certain diseases. Innovations involve early disease detection, readmission prediction, and disease progression prediction. Workflow automation concentrates on improving the efficiency of workflows. Innovations involve task routing, recruitment automation, and patient flow automation. Clinical decision support assists healthcare professionals in making better decisions. Innovations involve drug discovery, treatment analytics, and medication recommendations. Assistant technologies provide intelligent assistants to support patients' daily living. Innovations involve symptom-related chatbots, automated meditation, and home care robots. Healthcare quality analysis concentrates on improving the quality of healthcare delivery. Innovations involve quality surveillance, performance benchmarking, and safety studies. Each of these five categories is further split into multiple use cases based on different clinical data and techniques used, including textual data, laboratory results, medical

orders, images, and waveforms. Different AI techniques, namely machine learning algorithms, deep learning architectures, natural language processing algorithms, and software and hardware integrations, are utilized in these use cases to achieve goals that have been long pursued by healthcare organizations [7].

APPLICATIONS OF AI IN MEDICINE

Artificial Intelligence (AI) mimics human cognition and reasoning to improve healthcare. It has potential in patient safety, cost reduction, and pattern recognition. AI can be classified into three categories: Narrow AI, Artificial General Intelligence, and Artificial Superintelligence. Narrow AI, particularly machine learning, is relevant to medical practice. It helps in identifying cancers, optimizing nutrition orders, improving symptom triage, and resource allocation. AI also shows promise in identifying drug interactions and abuse potential [8]. Conversely, there are AI applications capable of causing patient harm, creating a need for those developing and installing such systems to be even more prudent. Malicious usage, like hacked doses of anesthesia, can be disastrous, as can wrongly targeted clinical alerts that feed one group of patients contraindicated drugs. Artificial intelligence programs can also be developed and deployed with a lack of transparency, and a diminished quality of care, or they can become obsolete and thus rendered unintelligible. Such artificial intelligence also inherently reflects societal biases, entrenching discrimination found in training databases, and potentially exacerbating inequities in medicine regarding race and care access. There are hurdles to AI, compounded by the emergence of the COVID-19 pandemic, such as a reduced inquiry into how experiments and innovations are developed, propagated, and sustained, as well as the necessity for transparency and understanding of AI systems among users and concerned parties [9].

CASE STUDIES

The digitization of medical records has significantly transformed and revolutionized the healthcare industry, bringing with it an abundance of valuable data that can be harnessed for numerous purposes. Artificial Intelligence (AI) plays a crucial role in this digital revolution, as it has proven to be highly effective in detecting and diagnosing complex conditions such as Atrial Fibrillation, offering preventive measures to avoid potentially severe complications. Moreover, AI's capabilities extend to tackling the issue of inappropriate antibiotic prescriptions, a pressing concern in healthcare due to the rise of antibiotic resistance. Through the power of AI, healthcare providers can now better address and mitigate this problem, thus safeguarding patient well-being and ensuring optimal treatment outcomes. The integration and utilization of AI in healthcare represent a significant leap forward, enhancing precision and efficiency in medical practices and contributing to a reduction in errors. By embracing AI, healthcare professionals can deliver superior patient care and elevate overall healthcare standards to unprecedented levels [10]. AI has the potential to significantly impact medical errors at various levels, encompassing patient care, healthcare management, data security, and medical education. The successful integration and utilization of AI in the medical field require careful consideration of several influential factors. In the digital age of medicine, understanding and addressing errors have become increasingly complex and multifaceted. To illustrate this, a compelling case study explores different approaches for effectively detecting instances of maltreatment in blood glucose measurements. Through the implementation of sliding windows, hospitals can now efficiently identify missed values, aiding in the prevention and mitigation of potential errors. By leveraging the power of AI, the medical community is poised to revolutionize patient care and enhance the overall quality and safety of healthcare practices [11].

CHALLENGES AND FUTURE DIRECTIONS

AI technologies hold great potential in the medical field, especially in addressing the persistent problem of medical errors. Despite the promising advances in AI systems, their adoption in the healthcare industry encounters significant difficulties and limitations. Accordingly, further research, development, and exploration are necessary to find appropriate solutions. One of the concerns about AI systems is how they make decisions and reach conclusions. Unlike human professionals, such as doctors, AI systems do not provide reasoning or explanations regarding their decisions, the problems that led to their conclusions, or the evidence supporting their suggestions. Questions about the reliability and accountability of AI systems arise when they fail to perform correctly or effectively. Consequently, individuals in the healthcare field may hesitate to use AI technologies. The inability to understand how AI systems work, how they handle unexpected situations, and the possibility of their decisions adversely affecting patients and hospital systems foster this reluctance. To build trust in AI technologies, researchers and professionals need to make improvements and adjustments. AI systems need to provide insights into how they perform and help people comprehend the considerations behind their recommendations. AI systems could perform better if they admit limitations and offer further analysis of the factors, datasets, or cases that could lead to negative outcomes. This would help healthcare professionals assess whether they

should accept the suggestions provided or take the responsibility to evaluate alternatives. The priority in building confidence in AI systems is not simply providing explanations but providing understandable explanations given the level of training and education of different users. AI systems should provide alternative insights regarding the same 'question,' illustrating how different conclusions, suggestions, or actions are performed. Healthcare professionals should be specifically trained to recognize errors effectively and respond accordingly when explanations are provided by AI systems. Meanwhile, researchers and developers of AI technologies should strive to create systems that could cater to the specific needs of different users, considering their position within the healthcare system [12].

CONCLUSION

AI has emerged as a powerful tool for reducing medical errors, enhancing patient safety, and improving the overall quality of healthcare. Its ability to process vast amounts of data and provide real-time insights helps clinicians make informed decisions, particularly in high-stakes environments. However, the adoption of AI comes with its challenges, including concerns about transparency, trust, and bias. By addressing these limitations and fostering collaboration between AI developers and healthcare professionals, the medical field can harness the full potential of AI to revolutionize patient care, reduce errors, and save lives. Further research and development are essential to overcome existing challenges and ensure that AI-driven solutions are fully integrated into the healthcare ecosystem.

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