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Research Article

The Impact of AI-Generated Content on Customer and Patient Service Optimization with Clinical Decision Support

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ABSTRACT

Clinical Decision Support Systems (CDSS) are revolutionizing healthcare by providing real-time, evidence-based insights that support accurate and timely clinical decisions. This paper investigates the role of AI-generated content (AIGC) in enhancing patient care and customer service through its integration with CDSS. Leveraging AI technologies such as machine learning (ML), natural language processing (NLP), and deep learning (DL), CDSS can significantly improve clinical outcomes. However, challenges like alert fatigue, inefficient notifications, and the need for ongoing system optimization persist. This study explores the use of ChatGPT-based solutions to refine clinical alerts, offering a scalable, cost-effective method to improve their relevance, timing, and clarity. Rather than replacing clinicians, the goal is to support and enhance human decision-making. The paper also examines the broader role of AI in shaping clinical guidelines and improving patient communication, emphasizing its growing influence in modern healthcare.

1. INTRODUCTION

Clinical Decision Support (CDS) systems play a vital role at the point of care by providing healthcare professionals and patients with timely information and actionable recommendations [1]. The widespread adoption of Electronic Health Records (EHRs), partly driven by government investments exceeding $34 billion [2], has significantly contributed to the expansion of CDS systems. Certified EHRs are required to incorporate rule-based CDS alerts that offer patient- and task-specific guidance [3]. These alerts have been shown to improve clinical practice [4], bridge quality gaps, and mitigate racial and ethnic disparities in healthcare delivery. For instance, a review of cardiovascular disease studies revealed that CDS alerts led to a 9.6–45.6% increase in guideline-recommended testing and examinations among Black and Hispanic populations. To maximize their effectiveness, CDS tools should align with the classic CDS design framework—delivering relevant recommendations to the right patient, at the right time, through the appropriate healthcare provider, using the correct format and delivery channel [5].

Clinical decision support systems (CDSS) powered by AI aim to assist healthcare professionals in making more accurate and timely decisions by delivering real-time, evidence-based insights[6]. AIGC improves patient outcomes and relieves healthcare providers' burdens by generating personalized recommendations. Simultaneously, AI-generated content in customer service, such as personalized responses and FAQs, optimizes customer interactions by improving response time, accuracy, and overall satisfaction.

Most clinicians ignore or ignore alerts for justifiable reasons (e.g., impropriety, poor timing, or incomplete characterizations of clinical conditions) despite these potential benefits [7]. Clinical alert fatigue occurs when clinicians encounter poorly performing alerts that threaten the safety of their patients [8]. Research has proposed several methods for optimizing alerts. Optimizing alert content, timing, and target audience reduces 9–35% of alerts [9]. VUMC's 24 physicians and informaticians reviewed alerts with a structured process [10]. 70,000 unnecessary weekly alerts were eliminated, reducing them by 15%.

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There are, however, several downsides to this approach, including resource requirements, cognitive bias, and premature closure. The process of identifying further improvements after identifying all simple improvements requires disproportionate effort on the part of reviewers [11]. A clinician involved in a manual review often uses a single workflow or practices in one area. Therefore, improvements may not be visible to other team members who use a different workflow. CDS maintenance can be efficiently and effectively automated using simple rules and ML techniques [6], [12]. CDS alert tuning based on ChatGPT might be able to address current challenges quickly and cost-effectively in order to analyze a large volume of CDS alerts. This study evaluated whether ChatGPT would be able to generate useful suggestions compared with human suggestions for improving clinical decision-support logic. ChatGPT suggestions were not compared to human suggestions and were instead used to demonstrate that they may enhance traditional CDS maintenance and optimization techniques. As stated by the fundamental theorem of medical informatics [13], the goal is not to develop computer systems that are superior to human intellect, but to develop systems that augment human intelligence so that both humans and computers perform better than a single human.

Following a general presentation of AI technologies, a detailed examination of various machine learning algorithms follows. The introduction of new contexts further complicates the development of AI-driven tools in clinical practice. In addition to routing on decision trees, AI can predict guideline concordance of clinical actions and generate progress questions[14]. Figure 1 showcases the application of AIGC in delivering creative services to patients. Its ability to handle multi-turn conversations allows for a seamless generation of contextual responses. This tool proves highly beneficial for physicians by streamlining research, supporting documentation, and enabling quick responses to medical inquiries. In addition, healthcare professionals can devote more time to direct patient care when administrative tasks are minimized.

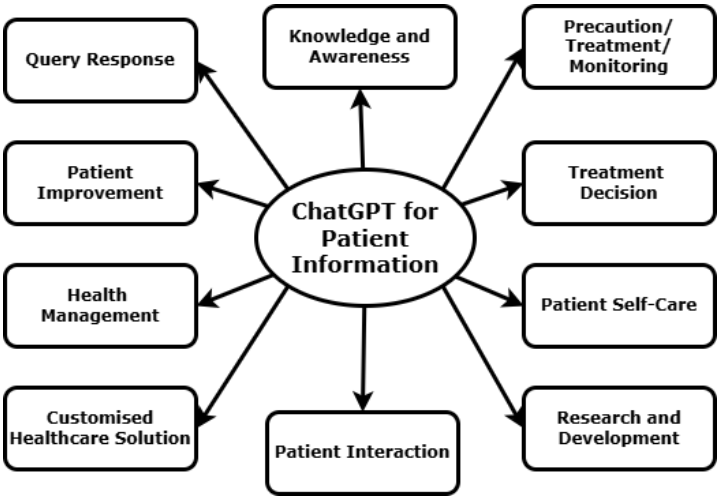

Fig. 1. AIGC-based Patient Information.

AI has emerged across diverse industries as a transformative force in the rapidly evolving digital landscape. AI-generated content is reshaping the way organizations provide customer and patient services in this field. AI-generated content offers unprecedented opportunities for service optimization, ranging from improving user engagement to streamlining communication workflows [15]. Clinical Decision Support (CDS) systems are particularly effective when integrated with this technological advancement in healthcare. Healthcare providers can improve both the quality and efficiency of care delivery by using intelligent content generation tools. In this paper, special emphasis is placed on the synergistic effects of AI-generated content with clinical decision support systems.

Clinical decision support systems (CDS) are becoming increasingly dependent on artificial intelligence (AI). This technology could transform health management, diagnosis, and treatment, serving as a catalyst for a new era of health innovation. Data volume and diversity in healthcare are rapidly increasing, creating both opportunities and challenges. A clinical decision-making tool, AI's based advanced algorithms and ML capabilities enable clinicians to process and analyze this data at an unprecedented scale and speed [16]. In the field of Electronic Health Records (EHR) analysis, artificial intelligence can provide vital insights, detect disease patterns, and predict patient risks with remarkable accuracy. Strengthening these capabilities plays a vital role in improving clinical decisions and fostering the evolution of personalized healthcare. By analyzing factors such as genetic makeup, lifestyle choices, and medical history, treatment plans can be more precisely tailored to meet individual patient needs [17].

AI-driven decision-making is significant because it can transform multiple industries, particularly healthcare, finance, and production, by analyzing vast datasets and extracting significant insights from them [18], [19]. By identifying patterns, predicting, and automating complex activities, artificial intelligence can increase productivity, accuracy, and speed. AI-driven decision-making can be used to diagnose diseases, personalize treatment mechanisms, and allocate resources in medical care. Further, AI can help businesses manage risks, plan their strategies, and engage their consumer s. As businesses navigate the increasingly data-driven economy, AI helps them remain competitive, innovate, and remain competitive by analyzing large amounts of data and providing intelligent recommendations [20].

In modern medical systems, it is critical since they allow for the systematic and digitized management of patient data, electronics health records (HER), as well as management tasks [21]. The use of these technologies simplifies the collection, storage, and retrieval of medical data. The use of EHRs allows clinicians to communicate in an automated way, providing consistent and accurate patient information. As a result, care is better coordinated and informed as a result [22]. The HIS also reduces the possibility of physical record-keeping errors, which increases patient security. Data analytics also helps healthcare businesses gain valuable insight, optimize resource allocation, and improve patient care. It is essential to arrange and utilize information systems effectively to present treatment, optimize patient results, and advance clinical studies and development in the healthcare environment [23].

Healthcare providers must be able to evaluate complex patient data with the help of AI-driven decision-making in HIS. AI could help detect early disease, modify treatment, and allocate resources by using machine learning algorithms and predictive analytics. With the ability to manage large volumes of healthcare data, it is possible to uncover patterns and correlations that are not apparent with standard approaches, thus improving patient outcomes. Automation of regular duties through AI enhances operational efficiency, allowing healthcare practitioners to focus on more intricate and essential elements of patient care. The healthcare ecosystem is developed and improved through a significant contribution to medical research, medical development, and healthcare policy planning [24].

2. RELATED WORK

Healthcare professionals benefit from artificial intelligence, which enables precise diagnostics and better care design, resulting in better patient outcomes. Through evidence-based suggestion platforms, deep learning models have transformed clinical operations within healthcare industries, reducing human errors as well as performing real-time clinical determinations. The use of AI by doctors and healthcare providers forms the basis of modern healthcare, which includes CDSS, robotic-assisted surgeries, and natural language processing (NLP). A systematic review of CDSS empowered by AI was conducted by [25]. Towards the convergence of AI and healthcare, a study was conducted on developing and evaluating CDSS based on human factors. The systems are designed to meet user requirements, integrate workflows, and provide an overall user experience. A comprehensive overview of AI-driven clinical decision support standards, issues, and opportunities is presented by integrating existing literature.

An Author [26] conducted a systematic review concentrating on the use of artificial intelligence in cardiopulmonary intensive care units (ICUs) for monitoring patients. A thorough literature review was conducted to identify AI-based systems capable of improving the decisions made in cardiology intensive care units. AI applications for tracking and controlling cardiovascular illness patients were explored in their study using AI technologies. Author [27] investigated the use of AI-enabled decision support in the field of nephrology. An analysis of existing studies, techniques, and results for AI usages in nephrology was presented in their paper, which aimed to develop medical decision-making by applying recent technology. AI algorithms and decision support systems can be used to recognize, control, and treat kidney-related illnesses. Author [28], examined both technological and medical perspectives of CDSS interpretability based on AI. Author reviewed the current literature to develop the interpretability of AI-driven CDSS in the healthcare field using methodologies, tools, and frameworks. It provided transparency, explainability, and comprehension of AI-based decision support systems by gathering data from several studies.

Author [29] explored the potential of AI-driven technologies in supporting the achievement of the United Nations Sustainable Development Goals (SDGs), with a particular focus on women's health. Through an extensive review of academic literature and relevant research, the study assessed how AI can address key health issues affecting women while contributing to the broader objectives of the SDGs. Author [30] provided an overview of cutting-edge research and development efforts utilizing AI to examine the determinants of human longevity. This study highlighted how AI methodologies can be employed to detect biomarkers, forecast health trends, and develop personalized treatment strategies aimed at promoting a longer and healthier life. Scientists, healthcare practitioners, and scientists working in the field will benefit from the publication because it combines findings from current literature and studies. Table 1 shows the specifications of these related works.

TABLE I. DIFFERENT CDS INTERVENTION FORMATS

Format Type	Examples	Useful Tips
Relevant Data Presentation	Flow-sheets, Surveillance	When appropriate information is provided before a decision is made, the user may be able to address their needs better.
Order Creation Facilitators	Order Sentences, Order Sets	A set of orders can be particularly effective when addressing a specific problem or condition, such as admitting a pneumonia patient to the hospital.
Reference Information	Infobuttons, Web links	Offer reference information during key stages of the workflow and clinical processes—such as during problem list or medication list reviews—to support informed decision-making.
Unsolicited Alerts	Interruptive Warnings	CDS interventions are generally used as a last resort when other 'upstream' interventions do not work.
Documentation Templates	Patient History, Visit Note	There is a great deal of effectiveness in clinical documentation when order sets are clearly defined.
Protocol Support	Pathways	Formal policies can guide a coordinated care team's activities. Post-operative management of hip replacement patients, for example

Author [31], Generative AI can enhance healthcare by personalizing treatments, advancing research, and improving patient care. Clinical decision-making is supported by the generation of synthetic data, analysis of medical images, and automation of administrative tasks, which can reduce clinician burnout and improve operational efficiency. An AI-enabled PC CDS tool provides evidence-based, patient-specific clinical guidance to inform care decisions. These tools use predictive and generative AI models to analyze and synthesize health information and engage patients and caregivers in shared decision-making. In AI-supported tools, trust, transparency, and explainability are key challenges. The use of AI-generated content in patient communication has shown to be more empathetic and detailed than physician-generated content. Disclosing AI authorship can influence a patient's trust and satisfaction, highlighting the need for transparency in AI-assisted communications [32].

TABLE II. SIX DOMAINS AND 12 FUNCTIONS WHERE AI ENHANCES CDS

S. No.	AI CDS Domain	AI CDS Functions
1	Data-Driven Insights and Analytics	EHR Analysis: Using artificial intelligence to uncover meaningful insights from complex patient data.
		A technique for identifying health trends, predicting disease outbreaks, and assisting with epidemiological research using big data and predictive analytics.
2	Diagnostic and Predictive Modelling	In imaging-intensive fields like radiology and pathology, diagnostic assistance increases the accuracy of diagnoses.
		The use of risk assessment and predictive analytics can assist with early intervention and individualized care planning for patients with various conditions.
3	Treatment Optimization and Personalized Medicine	AI algorithms generate recommendations based on current research and clinical guidelines.
		Manage medication safety and tailor drug therapies based on individual genetic profiles through drug interactions and personalized therapy.
4	Patient Monitoring and Telehealth Integration	Monitoring of patient health using AI-enabled devices provides real-time data for proactive care.
		Artificial intelligence-driven preliminary assessments and patient triage for telehealth and virtual care.
5	Workflow and Administrative Efficiency	Scheduling, billing, and data management tasks can be automated.
		AI-driven optimization of hospital staffing, resource use, and patient flow.
6	Knowledge Management and Decision Support	Improve the quality of care by keeping healthcare providers informed about the latest research, clinical trials, and treatment protocols using Artificial Intelligence (AI).
		Improved communication and coordination with healthcare teams and patients to ensure cohesive care.

3. CLINICAL GUIDELINES IN HEALTHCARE

Clinical guidelines are increasingly being used to provide care that follows best clinical practices in healthcare. A clinical guideline is a set of recommendations aimed at standardizing patient care. The purpose of clinical guidelines is to provide practical patient care directives and therapeutic approaches that are based on treatment evidence and expert consensus. In most cases, these procedures outline how a disease progresses and what actions should be taken to diagnose or treat it. Consequently, patient outcomes may be improved, and medical practices may become more appropriate. In addition to improving patient safety, guidelines help medical professionals make better decisions. In the absence of conventional treatment, they are particularly important. When treating such an illness, it is crucial to adhere to practice guidelines since drug-resistant bacteria are spreading, and antibiotics are losing their effectiveness. As long as the basis of treatment recommendations is given sufficient attention, an acceptable standard of care can be provided, which will contribute to a

decrease in mortality. Guidelines for clinical practice are complex documents intended to be used collaboratively by a variety of stakeholders. As guideline development involves a blend of clinical practitioners, medical academia, and regulatory bodies, establishing equilibrium is quite a challenge. Even when the clinical study literature is not extensive, medical academia and objectives usually endorse consensus guidelines.

The issue of evidence-based clinical practice support, on the other hand, stems primarily from the integration of the most recent data and research findings. Consensus efforts can lead to guidelines that are not sufficiently comprehensive. While the most recent data are reasoned out, expected changes will be applied through a 5-year cycle to adjust the parameters as new data becomes available. As the medical field develops rapidly, it is crucial to analyze all new information and incorporate it into guidelines thoroughly. Figure 2 highlights several essential enablers and dimensions involved in enhancing customer and patient experiences, grounded in the diverse features, attributes, and functionalities of the AIGC support framework [33],[34]. The study explores various capabilities, including contextual comprehension, adaptability to specific tasks, multilingual support, iterative interaction, advanced language processing, fine-tuning, and scalability. Additionally, Figure 2 provides a detailed overview of key characteristics and conventional practices linked to AIGC.

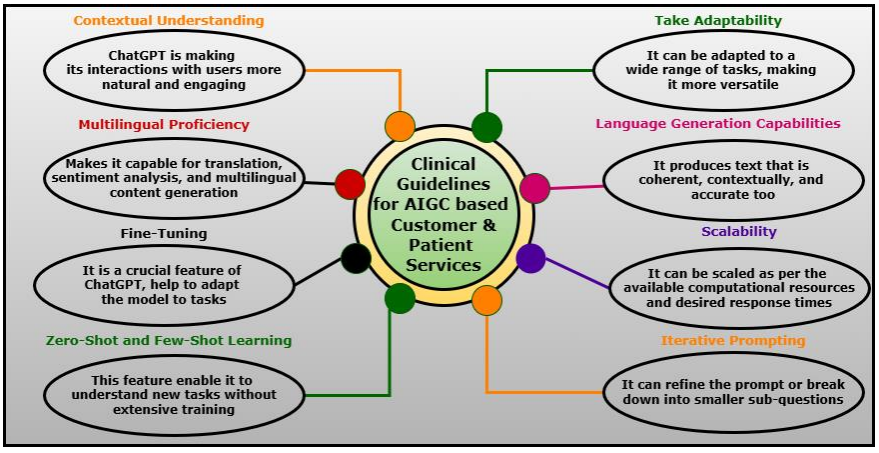

Fig. 2. AIGC-based Clinical Trials.

4. AI-GENERATED CONTENT IN HEALTHCARE

Clinical decision support systems and optimizing patient care are two areas where AI-generated content has vast applications in the healthcare sector. For clinical decision support, AI technologies, such as ML, DL, and NLP, play a pivotal role. Figure 3 demonstrates how enhancements in patient and customer service are achieved through various components of the AIGC framework. The discussion also highlights key aspects such as effective and conventional communication, handling complaints, providing timely responses, managing interactions, developing virtual assistants, and addressing inquiries. Moreover, the operational mechanisms of AIGC can facilitate smoother information flow and more efficient knowledge transfer, ultimately optimizing service delivery for both patients and customers.

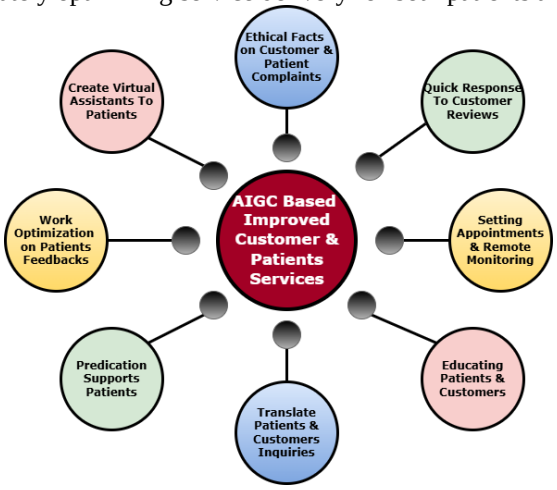

Fig. 3. AIGC-based improved patient support.

a Clinical Decision Support Systems (CDSS)

Using patient data, clinical guidelines, and medical literature, CDSS supports healthcare professionals' decision-making. In CDSS powered by AI, insights such as diagnostic recommendations, treatment recommendations, and risk assessments can be automatically generated. Medical imaging data can be analyzed with machine learning models to identify potential conditions like cancer and neurological disorders and suggest treatment options. A CDSS based on AI can also learn from new data continuously, generating updated recommendations for improving patient care.

b Personalized Patient Communication

The use of chatbots, virtual assistants, and automated messages is also improving patient communication using AI-generated content. Based on a patient's health history, preferences, and health conditions, these systems can generate personalized messages. A platform powered by artificial intelligence can remind patients about their appointments, medications, and lifestyle changes, ensuring greater adherence to treatment plans and better health outcomes.

4.1. AI in Diagnostic Content Generation

In diagnostic content generation, such as summarizing test results and medical histories, artificial intelligence is increasingly used. This process can be automated to save healthcare providers time and enable them to focus on more complex tasks. Based on historical data, AI models trained on medical datasets can quickly generate summary summaries and treatment recommendations.

5. AI-GENERATED CONTENT IN CUSTOMER SERVICE

With AI-generated content, traditional customer service models have been transformed. Chatbots, virtual agents, or automated content creation are all ways AI helps businesses provide quicker, more efficient customer service.

5.1. Chatbots and Virtual Assistants

Customer service has become an integral part of AI-powered chatbots and virtual assistants. In order to provide appropriate responses to customer inquiries, these tools utilize natural language processing (NLP). Using machine learning algorithms, AI-powered systems can continually improve their responses. These systems can reduce customer wait times and improve customer satisfaction in sectors such as banking, e-commerce, and healthcare.

5.2. Customer Data Analysis for Service Optimization

Customer feedback, behaviour patterns, and service history are analyzed using AI technologies. AI systems can predict customer needs, anticipate issues, and automatically generate solutions by analyzing large datasets. Businesses can address concerns proactively, resulting in improved customer service.

6. BENEFITS AND CHALLENGES OF AI-POWERED CLINICAL GUIDELINES

Guidelines and protocols of increasing complexity and sophistication are being mandated by healthcare systems worldwide. Research-based evidence underpins these systems. Clinical guidelines and protocols are complex and often lead to errors or omissions that harm patients. Due to these developments, there is considerable excitement in the field about 'Gen AI-powered Clinical Guidelines', which are generated, personalized, and communicated to clinicians by the use of artificial intelligence. The potential benefits and challenges of automating clinical guidelines are, however, ambiguous - with conflicting accounts. Some are lauding the potential benefits of Gen AI-powered Clinical Guidelines. The use of AI technologies to present medical information to clinicians will facilitate clinical decisions. In the future, AI-powered guidelines may be able to analyze Electronic Health Records and other data sources to (re)structure current information about a patient's medical conditions and provide this information to health care providers. In combination with prior test results and treatment responses, AI-powered guidelines can improve clinicians' diagnostic accuracy. By utilizing machine learning methods, AI technologies can also derive/predict optimal treatment plans, thereby ensuring that medical guidelines are tailored to a patient's particular condition, as well as to their particular subpopulation based on their genetic, molecular, and whatever else 'omic' properties that have been linked to their illnesses or treatment outcomes. In only the past few years, 80% of the entire world's data have been generated, making machine learning techniques an ideal tool to generate meaningful insights. By leveraging the data and other technologies available, AI can enhance clinical decision-making, which is impossible for people to do. The various challenges are listed in Figure 4. All these accomplishments imply that the use of Gen AI-powered Clinical Guidelines may facilitate more precise and timely decisions, eliminate human error in reading best practices, and optimize the use of resources in healthcare systems, eventually leading to better patient outcomes.

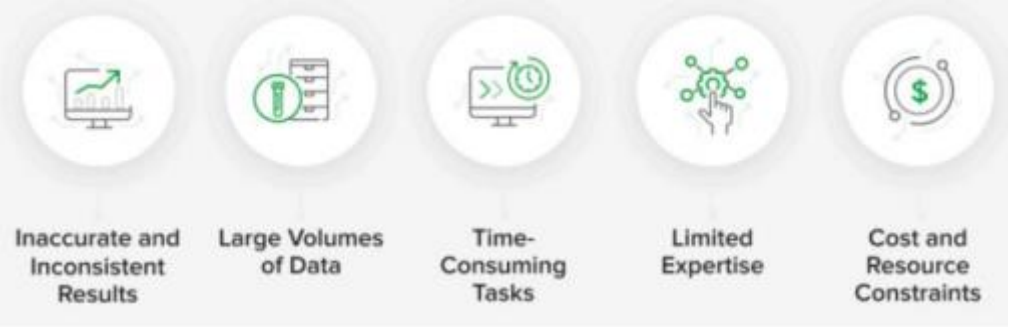

Fig. 4. Challenges.

7. APPLICATION OF AIGC FOR CLINICAL DECISION SUPPORT

Healthcare professionals can leverage AIGC to support evidence-based clinical decisions by analyzing patient data and relevant medical knowledge. AIGC can enhance clinical decision support across several key areas, including

- AIGC can aid in diagnosis by analyzing a patient's symptoms, medical history, and diagnostic test results. Medical literature and database patterns can be used to generate potential diagnoses. By doing so, healthcare professionals can consider many possibilities and refine their diagnostic assessments. When patients present with unclear symptoms, AIGC can offer insights and suggest differential diagnoses to support a more accurate evaluation. By drawing on evidence-based guidelines, clinical knowledge, and medical literature, AIGC also helps tailor personalized treatment plans. In addition to considering factors such as demographics, medical history, and comorbidities, it can provide healthcare professionals with treatment recommendations. It is possible, for example, to explore various therapeutic options for a specific condition using AIGC. Medication regimens, dosages, and side effects are included.
- In complicated cases where specialist knowledge is scarce, AIGC can provide meaningful guidance by examining comparable cases in medical literature to suggest potential diagnostic or therapeutic options.
- AIGC is a tool for analyzing clinical research data, extracting relevant information, and identifying key findings. Furthermore, it can provide insights into treatment outcomes and prognostic factors. As an example, AIGC provides summaries of clinical trial results. This allows healthcare professionals to make informed treatment decisions.

8. LIMITATIONS OF AIGC IN CLINICAL DECISION SUPPORT

When used for clinical decision support, AIGC has significant potential, but its limitations and challenges must be considered [35].

- It is possible for AIGC's responses to be biased by its training data and model outputs. AIGC's recommendations may be inaccurate and unreliable if certain demographics or medical conditions are not adequately represented in training data. These biases must be addressed in order for decision support to be unbiased and equitable. Though AIGC can understand medical situations' contexts, it may not generate responses that are specific or detailed enough to accurately interpret them. The AIGC's responses must be overseen and critically evaluated by humans in order to be appropriate and relevant in a clinical setting. The role of human oversight in evaluating AIGC recommendations is crucial. While AIGC can offer valuable support in clinical decision-making, healthcare professionals must apply their own judgment and carefully assess its suggestions. Ensuring the accuracy, relevance, and clinical appropriateness of AIGC outputs requires ongoing critical review by medical experts.

9. FUTURE PROSPECTS

In healthcare and customer service, AI-generated content looks promising. The capabilities of AI technologies to optimize service delivery and enhance decision-making are expected to continue to improve as they evolve. AI will be instrumental in early diagnosis, individualized treatment plans, and patient monitoring in healthcare. With AI, businesses can provide more efficient and personalized customer service. As long as AI ethics, data privacy, and bias mitigation research are ongoing, customers and patients will benefit from these technologies. Further, AI-generated content will be more effective and secure when it is integrated with other emerging technologies, such as the Internet of Things (IoT) and blockchain.

10. CONCLUSION

In both patient care and customer service, artificially generated content (AIGC) is reshaping the healthcare landscape. Its integration with Clinical Decision Support Systems (CDSSs) provides healthcare professionals with valuable insights and personalized recommendations. Even though AI-driven systems like AIGC can improve alert optimization and provide evidence-based suggestions, addressing issues like alert fatigue and bias remains challenging. As AI can augment human decision-making rather than replace it, healthcare applications require human oversight to ensure relevance, accuracy, and ethical considerations. It is expected that AI technologies will expand their role in personalizing treatment plans, improving diagnostics, and enhancing patient communication as they evolve. Future research must focus on addressing biases, improving data privacy, and refining AI tools to ensure they can be responsibly deployed, ultimately leading to better healthcare outcomes and more efficient service delivery in both healthcare and customer service domains.

Conflicts Of Interest

The author's affiliations, financial relationships, or personal interests do not present any conflicts in the research.

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