Educational Administration: Theory and Practice
2024, 30(3), 2503-2515
ISSN: 2148-2403
https://kuey.net/
Research Article

Generative Ai In Medicine And Health Care: Promises, Opportunities And Challenges

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Citation: Ms. Manishaben D. Bhatol et.al (2024), Generative Ai In Medicine And Health Care: Promises, Opportunities And Challenges, *Educational Administration: Theory and Practice*, 30(3), 2503-2515
Doi: 10.53555/kuey.v30i3.6756

ARTICLE INFO	ABSTRACT
	Machine learning and other types of "Generative AI, such as OpenAI's ChatGPT" can trained for generating an assortment of material by following precise instructions. This story provides a comprehensive review of various uses of "Generative Artificial Intelligence (AI)" in the fields of "remedial & medicine". The focus is specifically on a chosen set of example situations. Next, we will briefly examine some associated obstacles, including as integrity, openness, reliability, and safety in clinical settings, as well as privacy concerns, copyright issues, ownership matters, and the possibility of conversational user interfaces enhanced by AI to improve human-computer interaction. As "Generative AI" advances and becomes more adapted towards inimitable circumstances & requirements for "remedial domain", as well as laws, regulations & legislation regulating its usage starts to solidify, we anticipate that it will progressively assume a crucial role in "remedial & medicine". **Key Words:** Generative Artificial Intelligence (GAI), Remedial & Medicine, Human-Computer Interaction, Machine Learning, Interfaces.

INTRODUCTION

The impact of "Artificial Intelligence (AI)" on remedial is particularly substantial, despite the fact that it has had a considerable impact on a number of different industries via the implementation of ground-breaking innovations. The extraordinary "Neural language processing (NLP) capabilities of generative artificial intelligence models, such as OpenAI's Generative Pre-trained Transformer (GPT) models", have garnered a lot of interest. In particular, the ChatGPT model has garnered a lot of attention. Because of their superior natural language processing capabilities, these models have the potential to completely transform the remedial industry [1, 2]. These sophisticated language models are well-suited for a variety of industries, including "remedial & medicine"; as a result of their remarkable capacity to comprehend and generate text that is eerily similar to human language. There is the potential for "GPT models" to revolutionise "clinical decision support, patient communication, and data management". These models can harness substantial remedial data and expertise. With regard to their capacity to revolutionise remedial procedures by means of the analysis and interpretation of intricate remedial data, we have a favourable perspective. When used for clinical decision support, "GPT models" have the potential to increase the ability of remedial practitioners to make improved recommendations so that decisions may be made that will have a beneficial impact on the health and well-being of patients [3]. In the field of illness diagnosis and prognosis, for example, "GPT models" can be useful in a number of different situations. These models are able to detect and forecast a broad variety of remedial disorders since they are able to carry out the analysis of huge remedial datasets. Rapid identification and individualised treatment options are made possible as a result of this. When integrated with a variety of technologies, "GPT models" have the potential to improve diagnostic accuracy and minimise the amount of time required for interpretation of remedial pictures, which is beneficial to radiologists in the process of clinical diagnosis [4].
Furthermore, "GPT models" have the potential to speed up the process of developing new drugs and treatments by offering prospective drug candidates that are more likely to be successful and safe. This might be accomplished by suggesting potential drug candidates. Because they are able to grasp intricate chemical connections, this is something that is quite possible [5]. The use of "GPT models" is having impending at

improvement of remedial treatment & to change communication between patients and their physicians. “GPT models” provides prospective for communicating with “patients, provide educational materials, and respond to remedial questions as interactive AI language models” [6]. This is done with the goal of increasing patient participation and autonomy in the management of own health. Additionally, “GPT models” have the capacity to simplify clinical documentation and the administration of “Electronic Health Records (EHRs)”, which may make it possible for doctors to devote more attention to patient care and minimise the amount of administrative work they have to complete [7]. The usage of generative models has the potential to bring about a significant transformation in the remedial industry; nevertheless, there are a number of ethical questions and problems that need to be resolved before they can be fully implemented. It is still of the utmost importance to guarantee the dependability and precision of judgements that are driven by artificial intelligence, particularly in crucial remedial situations. The opaqueness and lack of clarity that are associated with artificial intelligence systems that are utilised in the remedial industry are a result of concerns over the interpretability of choices generated by these models, particularly generative ones, due to the “black box” nature of these models. With that being said, it is of the utmost importance to give careful consideration to ethical problems of biases in artificial intelligence models, the confidentiality of remedial information, and the privacy of data [8]. Because of the delicate nature of the remedial information that is handled by these models, it is essential to adopt stringent controls that “protect patient privacy & ensure data security in order to preserve public faith in remedial solutions that are powered by artificial intelligence”.

This research offers a comprehensive summary towards current industry state & research on usage for generative artificial intelligence models in the disciplines of “remedial & medicine”, while also taking into consideration recent breakthroughs in the field. The purpose of this research is to make a contribution to the ongoing discussion on the ethical use of “artificial intelligence’s transformative capacities” through the enhancement of remedial practice and the promotion of patient welfare. This will be accomplished by outlining the significant possibilities, advantages, and problems connected with the adoption of “artificial intelligence”, as well as the ethical norms at play. In order to investigate the influence that generative models have on “remedial & medicine”, it is necessary to navigate the ever-changing terrain of artificial intelligence. It is necessary for us to adhere to ethical rules, place a high priority on patient-centred care, and encourage collaboration between those who research “artificial intelligence”, those who practise medicine, and legislators.

RESEARCH BACKGROUND

“Neural language processing (NLP)” provides significant field of “Artificial Intelligence (AI)” which spotlights at analysis & understanding of “human language” in order to facilitate communication between machines and people. The basic objective points towards enabling computers to “comprehend, interpret, and generate” significant, contextually aware “human language”. Numerous activities in the field of “Neural language processing (NLP)” strive to close the divide among “human communication & computational understanding”. The activities encompassed in this category are “language translation, sentiment analysis, speech recognition, text summarization, question answering” & other related tasks [9]. The remarkable capability of “Neural language processing (NLP)” for extracting & evaluating priceless insights by extensive amounts of unorganised “clinical data, including Electronic Health Records (EHRs), remedial literature & patient-generated content”, - resulted at its extensive application in remedial [10]. Named entity recognition and other “Neural language processing (NLP)” tasks has provided noteworthy pledge at structuring clinical notes that were previously unorganised, facilitating the identification of “remedial conditions, medications, and lab test labels” [11,12]. Moreover, “Neural language processing” has been employed to analyse unstructured “Electronic Health Record Data” for the purpose of detecting and identifying adverse drug events by examining prescription drugs and their combinations [13]. “Neural language processing (NLP) - driven models have also contributed to the early detection of illnesses, enabling timely treatments and improving patient outcomes” [14]. “OpenAI’s GPT models” are notable among developments in “Neural language processing (NLP)”. “GPT models” are subsets to intricate “language models” which may utilise to optimise the capabilities of deep-learning neural networks as well. “GPT models operate using transformer architecture, which was first proposed by Vaswani et al. in 2017” [15]. Utilisation of “self-attention” renders this “neural network architecture” exceptionally proficient at dispensation textual and other chronological input. During the processing phase, the model exhibits the ability to comprehend the importance of individual words and their connections through self-attention. This enables the model to give priority to words that have strong semantic relationships and preserve a greater amount of contextual information. The Transformers’ ability to efficiently handle distant relationships among “language sequences” enhances their knack at interpreting idiom in context and comprehending meaning, making it a groundbreaking feature.

Rapid and substantial progress has been achieved in the development and refinement of “GPT models” since their adoption. The publication of the initial “GPT-1 model by OpenAI in June 2018 marked the commencement of the GPT model’s chronological progression. GPT-1 demonstrated that extensive collections of text may be utilised to train Transformer models, enabling them to generate speech that is both coherent and contextually aware. GPT-2, which was released in February 2019, is the follow-up to OpenAI’s previous successful model, GPT-1. GPT-2, with its impressive 1.5 billion parameters, represented a significant advancement". However, concerns arose over its potential for maltreatment owing to its aptitude of generating language that closely resembles human speech. This capability raised worries about the spread of misinformation and fake news. "As a result, OpenAI initially limited access to GPT-2 by only providing smaller versions of the model. In November 2019, OpenAI released the GPT-2 model to the public, making it accessible to researchers and developers. Subsequently, there has been an overwhelming amount of research conducted on GPT-2, resulting in quick advancements and its widespread use in several domains, including text generation, chatbot development, language translation, and others" [1, 16]. Introduction of "GPT-3 in June 2020 resulted in a significant increase in the period. At the time, this model was the largest language model ever constructed, with an impressive 175 billion parameters, which is a remarkable achievement. GPT-3 possessed impressive language generation abilities, including "translation, summarization, question-answering, and creative writing", the success of "GPT-3" has stimulated several new findings and practical applications for LLMs. At its heart, the GPT-3.5 architecture is utilised. In November 2022, OpenAI introduced their revolutionary ChatGPT concept". The model is a sophisticated conversational artificial intelligence. The tool's capacity to facilitate impromptu and captivating talks renders it a versatile and pragmatic instrument with several possible tasks. Clients can connect to "ChatGPT" by posing inquiries or providing textual directives. "ChatGPT" is capable of generating responses that are both coherent and relevant to the provided context, thanks to the knowledge it acquired from the pre-training data. "GPT-4, which was launched in March 2023, is a large multimodal model capable of processing both text and image inputs. It demonstrates even greater performance than ChatGPT. The trained models are occasionally referred to as Large Language Models (LLMs)" [16] because to the extensive pre-training phase. The impressive ability of these models to independently produce language that resembles human speech is due to their inherent "generative" nature; this has extensive implications for "several domains, including remedial". "Pre-training is a crucial aspect" at developing "GPT models". At such phase, model acquires a comprehensive understanding of language by its interaction with an extensive assortment of texts and datasets. By integrating "pre-training with transformer architecture, GPT models" have ability to imitate the contextual coherence of human language and produce text that exhibits fluency comparable to that of humans. This makes them highly suitable for many applications in "Neural language processing (NLP)" [17]. Pre-training, similar to the first phase of learning, enables "GPT" to develop a strong understanding of language by assimilating vast amounts of unlabeled textual data. The next stage in training a "GPT model" is fine-tuning, which entails utilizing task-specific labelled data [17], like remedial information. Such technique may be used to do many remedial-related "Neural language processing (NLP)" tasks, such as translating remedial records, categorising clinical texts, and answering remedial questions. Due to pre-training, fine-tuning, and the advanced language comprehension skills of GPT, the model exhibits high performance in several remedial natural language processing tasks related to remedial language. Training a full model requires less time and resources, resulting in improved performance of the model. "Language generation models (LLMs)" have verified significant capability in the development of "AI-powered remedial solutions" by generating natural-sounding text & applying their language comprehension to remedial-related tasks. The use of "Generative AI in remedial" has significant commitment to enhance patient care & empowering remedial personnel to make well-informed decisions. These improvements encompass improved communication with patients, quicker detection of diseases, and stronger support for clinical decision-making [7].

LLMs AND GENERATIVE AI IN REMEDIAL: EFFORTS & CURRENT SCENARIO

In this analysis, we examine the current initiatives and investigations aimed at enhancing remedial practice through the use of "Generative AI and Language Models (LLMs)". The studies and activities encompass a diverse array of subjects, ranging from aiding in clinical administration to developing tools for educating remedial providers & patients. Possible results of integrating such progressive technologies include enhanced patient care, streamlined remedial research, and reduced stress for remedial professionals. The purpose of our research on current advancements is to comprehend the potential impact of "AI language models on the remedial industry" in the next years.

Assistance with Clinical Administration

Using "Generative AI models in remedial" to automate clinical documentation and assist with clinical administration is a widely recognised use. "ChatGPT" enables efficient and precise drafting of clinical notes by busy doctors, especially in situations where they are burdened with excessive note-taking. If data privacy is ensured, clinicians can save time by creating comprehensive and contextually appropriate clinical records using either a concise verbal summary (referred to as a "prompt") or relevant patient data. "Microsoft Copilot" [18] is a corporate solution that improves productivity by incorporating "Generative AI" into commonly used programmes such as "Word, PowerPoint, Teams, and others". There is significant potential for this integration to enhance communication and coordination among remedial practitioners from many disciplines. An example of a meeting tool utilising "Generative AI" might assist in complex scenarios that include many specialisations. This tool serves the aim of generating meeting agendas, identifying suitable team members for follow-up, and summarising the key points of the meeting. "Nuance's remedial solutions,

utilising artificial intelligence”, enhance the efficiency & effectiveness of remedial professionals across various hospital settings. By utilising “Nuance’s advanced voice recognition technology”, clinicians have the ability to verbally record their notes straight at electronic health record system, resulting in a significant enhancement of clinical documentation. This enhances the accuracy of patient data input while also reducing processing time. The programme has the capability to capture the verbal notes of a haematologist while they evaluate “blood smears in real time” [19]. “Suki Assistant” [20] is a technology that automates the creation of clinical notes by hearing to conversations between physicians and patients, making it useful for administrative duties. Furthermore, it provides a range of engagement options, such as dictation and ambient note generation, in addition to recommending diagnostic codes.
Haematologists can optimise time efficiency during consultations for “chronic lymphocytic leukaemia by utilising Suki”; an automated tool that takes notes and generates clinical reports. As a result, documentation becomes more streamlined, hence reducing physician fatigue and allowing for more time to be dedicated to direct patient treatment. The applications of “Suki Assistant” demonstrate how “Generative AI” may improve remedial workers' health and productivity by streamlining clinical processes. In addition, “Corti” [21] offers “real-time transcription, guidance, and coding using Generative AI technology” in many forms of communication. “Corti” reduces the likelihood of human transcription errors and delays by automating the process of transcribing patient conversations in many languages and in real-time. This ensures that important information is preserved. “Corti’s” ability to extract crucial information from transcripts, including specific ailments, mentioned medications, and essential queries, is particularly useful for analysing key aspects of conversations. By utilising the retrieved data, “Corti’s AI” can determine the optimal course of action for patient care by analysing a extensive database including a variety of data points. “Corti’s automated coding system” for treatment and diagnostic codes like “ICD-10 & CPT”, accurately records the patient’s visit, resulting in time savings and a decreased risk of human error. It [21] guarantees precise patient data & efficient functioning. “Google Bard” [22] offers innovative remedial applications built on “Med-PaLM 2”, these programmes specifically aid professionals and offer round-the-clock patient support. “Google Bard, with the help of Med-PaLM 2”, may enhance the precision of its remedial information by assimilating knowledge from diverse sources like as patient data, clinical notes, textbooks, and magazines. The application is beneficial for aiding patient questions, providing diagnosis ideas, and enhancing therapy programmes. In the field of haematology, people grappling with blood disorders might benefit from receiving informative guidance, prompt responses, and appropriate recommendations to seek remedial attention, if required. It is imperative to never depend on “AI-generated” responses as a substitute for real remedial professionals; their usage should be limited to instructional purposes only, the advancement of “Google Bard” holds promising potential for the future of “remedial interactions and patient care”. “Ellen AI” [23], an algorithm that complements “Generative AI” technologies such as “ChatGPT”, is having several useful uses in remedial. “Ellen AI” offers audio explanations using a text-to-voice interface layer to assist with patient care. Remedial professionals can improve patient access and communication by transcribing textual instructions into high-quality audio. “ChatGPT’s extensive Generative AI” capabilities might be advantageous in many clinical & administrative tasks, such as data analysis, decision support, as well as understanding & adherence to treatment plans. By integrating “Ellen AI with ChatGPT”, we can generate sophisticated written content and provide innovative voice-driven interactions, therefore improving patient care and optimising remedial efficiency [24].

Support with Clinical Decision

Enhancing topic expertise and improving comprehension of human language empower “GPT models” to assist in making therapeutic decisions. “Glass AI, an experimental platform powered by LLM” [25], offers clinical decision help. When targeting a clinical audience, it serves as a diagnostic aid by proposing possible diagnoses and treatment approaches. A clinician can input symptoms such as weakness, dyspnoea, or pallor into “Glass AI” [26] when a patient reports experiencing them. The system may provide a complete differential diagnosis, which includes possible suggestions for disorders such as myelodysplastic syndromes, leukaemia, or anaemia, “Glass AI” assists’ haematologists at formulating clinical approach that guides them in doing additional tests and therapies. Regard [27] is a valuable contribution to the field of AI tools that integrate with “Electronic Health Records (EHRs)”. It enhances the efficiency of remedial by assessing patient data, making diagnoses, generating clinical notes, and rapidly disseminating relevant information. By automating certain administrative tasks, it allows doctors to allocate more time to patients and reduces the amount of time they spend dealing with electronic health record systems. Regard’s “Generative AI” utilises patient data to generate a comprehensive list of probable diagnoses that are both novel and reliable, hence assisting in the diagnostic process. “Remedial professionals (HCPs)” can utilise this tool to enhance their investigation of probable causes, validate or exclude diagnoses, and maximise treatment plans. Regard provides evidence-based suggestions that can enhance the efficiency and accuracy of diagnosis for general care providers, haematologist-oncologists, dermatologists, and other specialists. Regard acts as a knowledgeable assistant, enhancing remedial professionals’ use of “electronic health records (EHRs)” by emphasising that it complements rather than substitutes their clinical expertise and judgement. This enables them to make more informed and timely choices. Evidence from experimental programmes has demonstrated that Regard has the potential to substantially reduce doctors’ diagnostic time and improve their accuracy. The use of “Redbrick AI’s Fast Automated Segmentation Tool (F.A.S.T.)” [28] can significantly enhance the field of remedial imaging by facilitating the annotation and segmentation of “CT scans, MRI images, and ultrasounds”. “Redbrick AI” provides a possible solution for enhancing the accuracy and efficiency of remedial diagnostics with their SaaS platform called “F.A.S.T. for radiology”. This platform utilises “Meta’s Segment Anything technique” [29] to annotate remedial image data. Due to its adaptive nature, this technique is beneficial for accurately segmenting radiological objects and features, even with limited data. The system allows real-time observation of mask computation by clinicians, hence simplifying segmentation. The automation of manual segmentation by “F.A.S.T.” leads to two positive results: enhanced diagnostic speed and improved accuracy.

“Paige FullFocus, software powered by Generative AI”, provides remedial practitioners to see, arrange, and exchange digital slides of tissue samples. This technology enhances diagnostic confidence, streamlines processes, and enhances accuracy, while also providing novel perspectives for treatment decisions. Analysing and identifying complex tissue patterns can assist in several challenging tasks, such as quantifying cancer cells in breast and prostate biopsies and identifying biomarkers for medication selection. Additionally, “FullFocus” assists remedial personnel in enhancing their clinical practice and education by enabling them to investigate diverse tissue patterns, expand their knowledge on cancer and blood illnesses, and stay updated on the latest advancements in pathology. Remedial practitioners may enhance patient care by continuously learning with “FullFocus” and improving their diagnostic skills and breadth of knowledge. Raciti et al. [31] demonstrated that “Paige tools” had the capacity to enhance the accuracy of tumour diagnosis in their study on prostate cancer. The symptom checker application “Kahun” is powered by a conversational “chatbot” that is integrated with the “EHR”. The programme utilises patient input and remedial knowledge to provide a list of ranked differential diagnoses and options for further investigation, enabling clinical assessments of patients. “Kahun’s AI inference engine” efficiently prioritises potential diagnoses and provides a concise list of them, so assisting clinicians in saving time and reducing their workload. Ben-Shabat et al. discovered that “Kahun outperformed other AI symptom checkers” when tested against a similar group [33]. In order to conduct a comprehensive evaluation of the patient, it is advisable to consider other diagnostic options. Kahun’s developing network of links between illnesses, issues, and outcomes enables remedial practitioners to keep updated on the latest remedial research.

Engagement of Patient

The objective of “Hippocratic AI” [34] is to create a remedially specialised LLM. The objective is to adopt a patient-centric approach that prioritises the needs of patients, focusing on empathy, compassion, and the creation of easily comprehensible and applicable solutions. In their work, Ayers et al. demonstrated the significance of “generative AI empathy”. They discovered that responses from a “chatbot powered by LLM (ChatGPT)” were both more empathic and more favoured compared to those from doctors [35]. “Hippocratic AI” focuses on ensuring patient safety by improving remedial access and results using non-diagnostic apps that are directly used by patients. Remedial coding and licensing tests are complex administrative tasks that might potentially be improved with the help of “Hippocratic AI”. Furthermore, it has demonstrated its reliability in maintaining remedial standards by obtaining compliance certificates. The model’s exceptional performance on several remedial certification assessments illustrates its practical utility in clinical settings. “Hippocratic AI” enhances patient care, establishes a reliable and effective remedial system, and aids remedial workers with both empathy and precision. “Gridspace” [36] enables the automation of patient involvement through phone calls, question answering, and administrative tasks using “Generative AI” technology. This system enables the reception of incoming calls and the ability to contact patients in a manner that is cost-effective, scalable, and easily available at all times. “Gridspace” can automate several general administrative tasks such as scheduling appointments, sending appointment reminders to patients, confirming insurance information, and more. To provide more time for critical patient care responsibilities, remedial personnel may opt to delegate these requests to automated voice bots. Furthermore, “Gridspace” has the potential to offer valuable insights by efficiently sorting and guiding patient inquiries in real-time. “Generative AI” has the potential to transform doctor-patient communication, streamline back-office procedures, and enhance remedial productivity and satisfaction.

Making Artificial Data Sets

“Syntegra Remedial Mind” [37] utilises real remedial data, such as EHRs, to generate precise synthetic remedial records. This is achieved by employing “Generative AI” techniques, which ensure the protection of patient privacy. Remedial practitioners can utilise this data for study, instruction, and decision-making without compromising patient privacy. Synthetic records assist experts in identifying diverse patterns of sickness by comparing the statistical characteristics of the original data, including anomalies and unusual groups. “Syntegra” not only ensures fair treatment plans but also actively promotes algorithmic fairness and tackles data bias. The synthetic data layer eliminates barriers to data accessibility, therefore enhancing remedial treatment and fostering innovation. The study conducted by Muniz-Terrera et al. [38] shown that the integration of “Syntegra with virtual cohorts” has the potential to advance dementia research. Another “OpenAI model for generating images from text is DALL-E 2” [39]. In order to acquire the skill of producing realistic fake images, the model underwent training using a vast dataset consisting of millions of text-image pairs. "DALL-E 2" exhibits significant potential for enhancing remedial education and research through its comprehensive pre-training. It may serve as a valuable resource by complementing or substituting inadequate or restricted remedial data, all the while ensuring the confidentiality of patient information. Adams et al. [40] conducted a study where they compared the outcomes of generating remedial pictures based on short descriptions with the outcomes of recovering radiological images that already had missing parts. The focus of their investigation was the domain knowledge of "DALL-E 20s" in the field of radiology. The study showcased that "DALL-E 2" was capable of producing disease-free x-ray images that closely resembled genuine images in terms of style and anatomical proportions. However, the generation performance of "DALL-E 2" was shown to be less effective when dealing with complex imaging techniques such as "CT, MRI, and ultrasound". By fine-tuning "DALL-E 2" with remedial data and relevant language, it is possible to develop a customised model for generating and enhancing radiological data. However, it should be noted that using "DALL-E 2" directly for remedial image synthesis has limitations.

Training for Careers

The April 2023 UNESCO fast start guide provides a comprehensive overview of many potential uses of "Generative AI", such as "ChatGPT", in higher education. The guide includes specific examples of how this technology might be applied in both classroom teaching and academic research [41]. Although these apps were originally designed with a wider scope in mind, specifically for higher education, they may be readily adapted to cater to the specific requirements of remedial education at all stages, encompassing undergraduate, graduate, and "continuing remedial education (CME)". Furthermore, they can be utilised in the context of public health and the dissemination of information to patients. The individual who collaborated on this article held the position of a guest editor for a specialised edition of JMIR Remedial Education that focused on "ChatGPT and Generative Language Models in Remedial Education". Within a few months, a large number of submissions were received for the matter. By July 31, 2023, more than twelve of them had already been made available on the internet, covering a range of topics related to generative artificial intelligence in remedial and professional training [42]. Remedial practitioners may improve patient outcomes by tailoring treatment plans, monitoring patient progress, and making informed judgements. Digital twins facilitate clinical research and personalised therapy recommendations by modelling the biological outcomes of various therapies using real-world data. For instance, haematology practitioners can utilise digital twins to simulate the evolution of illnesses in response to different therapies [43]. This, in turn, aids in making informed decisions regarding therapy. Furthermore, the utilisation of digital twins in clinical investigations might enhance the acquisition of valuable insights, particularly in the absence of extensive control groups. Forgetting necessitates the process of acquiring knowledge anew. The methodology of artificial intelligence enhances efficacy, hence facilitating remedial training and patient monitoring. Bertolini et al. argue that digital twins are valuable in enhancing remedial procedures due to their ability to properly replicate the progression of illnesses [44]. There is a continuous investigation into the utilisation of patient-recorded remedial visits to enhance "electronic health records (EHRs)" by acquiring valuable information for patients and extracting organised data. Abridge [45] is a digital application that uses "Generative AI" to record remedial talks, hence eliminating the necessity for clinicians to manually take notes. "Abridge's consumer app" plays a crucial role in patient education by sending patients after-visit reports, aiming to enhance patient engagement and adherence to treatment. Individuals diagnosed with polycythemia Vera may experience difficulties in accurately remembering particular details spoken during their remedial consultations. In order to address this issue, Abridge offers patients a comprehensive transcript of the conversation that they may refer to at their convenience. In addition, the platform enhances the clarity of complex remedial language by emphasising important elements from the discourse. Patients are more inclined to adhere to their treatment regimens and achieve improved health outcomes when they possess a comprehensive understanding of their diagnosis, treatment alternatives, and subsequent actions. In addition, Krishna et al. collaborated with Abridge to provide a comprehensive guide on how to extract extensive and semi-structured clinical summaries, known as "SOAP notes", from patient interviews [46]. Their strategy involved utilising a distinct collection of transcripts and "SOAP notes". The major focus of the approaches is to break down summarization activities into abstractive and extractive subtasks and progressively shift the effort from the former to the latter.

Asian & European Examples

While the majority of the "Generative AI tools discussed in sections 3.1-3.5 were developed in the United States, other areas, especially Asia and Europe, are rapidly making progress in this field". Philips, a Dutch remedial technology company, is currently developing "Generative AI" applications to enhance the diagnostic capabilities and image processing of their "PACS (Picture Archiving and Communication System) and optimise clinical operations" [47]. In August 2023, "SayHeart", an Asian firm operating in Malaysia & Singapore, unveiled a novel algorithm capable of visually illustrating intricate remedial terminology, reports, and photographs [48]. "Riken", a prominent Japanese scientific research institution founded in 1917, has initiated an eight-year plan (2023-2031) to utilise "Generative AI" technology for developing remedial and scientific ideas. This involves learning from study papers and images.

DISCUSSION

“Generative AI” has the potential to significantly transform the remedial business in the next years [50]. The article’s examples of applications just provide a superficial glimpse of what is still to be revealed. A “PubMed query using the term ChatGPT resulted in 924 published records as of July 31, 2023 (4 records in 2022 and 920 records in the first seven months of 2023), when the same query was repeated 18 days later on August 18, 2023, it produced 1049 records” [51]. Although “ChatGPT” has gained significant attention in 2023 as a “Generative AI”, it is crucial to acknowledge that it is only a single model and architecture inside the broader “GPT framework”. “Generative AI” is expected to maintain its popularity in the next months and years. The subsequent discussion will address common concerns, challenges, and opportunities associated with “Generative AI and related products such as ChatGPT”.

Can Generative AI be trusted? Is it reliable and secure for clinical application?

The efficacy of “Generative artificial intelligence (AI) in the field of remedial & medicine” is contingent upon the establishment of trust and validation. The consistency and dependability of “ChatGPT’s” responses have exhibited substantial fluctuations and, notably, were not anticipated. The primary challenge associated with “Generative AI” is its inherent “unpredictability,” which poses difficulties in determining the reliability of its outputs and deciding whether to accept or dismiss them. This is especially accurate when the user does not possess the knowledge or skills to assess the thoroughness and precision of a specific answer. An instance of this is “ChatGPT”, which has gained a reputation for fabricating information, including referencing non-existent scholarly articles and creating new ones [52-54]. To reduce this phenomenon, known as “Generative AI” “hallucinations”, techniques such as “Retrieval Augmented Generation (RAG)” might be employed [55]. “Generative AI” can have biases that vary depending on its training [41] and may not perform effectively with all languages [56]. Discussions on trust always involve the peripheral issues of clinical safety and reliability. The presence of trust, safety, and reliability problems will consistently hinder the widespread use of “Generative AI” in the remedial field until we develop a version that is thoroughly vetted and trained specifically for remedial applications. “ChatGPT” does not possess specific remedial expertise. When we refer to a model as being “remedially trained”, we mean that it has undergone thorough and exact training utilising a comprehensive set of reliable remedial literature that specifically cover a certain area of medicine.

Challenges in the assessment, treatment, and validation of clinical practices

The difficulty is exacerbated by the dynamic nature of remedial and clinical information. In order to stay abreast of this, it is necessary to employ a form of generative artificial intelligence that can be regularly and continually educated and updated. The fast advancement of large language models and “Generative AI” presents challenges in terms of clinical assessment, regulation, and certification. “OpenAI’s ChatGPT has multiple versions, including GPT3.5, GPT-4, and DALL-E 2” [57]. “Meta also offers Llama 1 and 2 in collaboration with Microsoft” [58], while “Google has Bard” [59]. However, it should be noted that “Bard” currently lacks the capability to answer specific clinical case questions, possibly due to an artificial limitation imposed by Google. There is no guarantee that a newer version of a model will have improved performance, but it is generally the case [60, 61]. Upon prompt implementation, we expect that “generative artificial intelligence and extensive language models” particularly designed for remedial applications will undergo several rapid iterations. However, the process of clinical assessment and certification is usually time-consuming, which means that there is a possibility that the AI being reviewed may have experienced substantial modifications by the time the evaluation is completed, therefore requiring a fresh examination. Regulatory bodies are endeavouring to establish the necessary protocols to handle AI as a remedial device [62]. However, unlike AI-based technologies that are now regulated, LLMs present new challenges that will require further regulatory modifications [63].

Concerns Regarding the Protection of Personal Data

Italy banned access to ChatGPT in April 2023 due to concerns over the collection and retention of personal user data for the purpose of enhancing its model [64]. Italy regained access after a few weeks [65] due to the implementation of new functionalities in ChatGPT. These capabilities allow users to deactivate chat history and choose which conversations to utilise for model training [66]. Nevertheless, it is imperative that users refrain from inputting any confidential or personal data into these programmes [68]. This is particularly applicable in situations when the data involved is confidential, such as patient records, and will continue to be so until remedial organisations are financially capable of operating their own locally hosted and controlled versions of these models and tools [67]. (On the other hand, the use of text-to-image “Generative AI” can assist remedial educators in producing top-notch instructional images of various clinical conditions without the need for actual patients. This is particularly beneficial when full-face images are necessary, as it addresses concerns regarding confidentiality and consent.) At now, both the training data and the code utilised to train these models are not being released to the public [69]. Currently, there is a case filed in a US court about the unauthorised acquisition of data sources for the specific aim of training and learning “Generative AI” [70]. Several experts have already suggested that AI models should comply with privacy legislation, including the “right to be forgotten” and the ability to deselect or reverse their previous learning about specific persons or situations [71].

Issues pertaining to ownership and copyrights

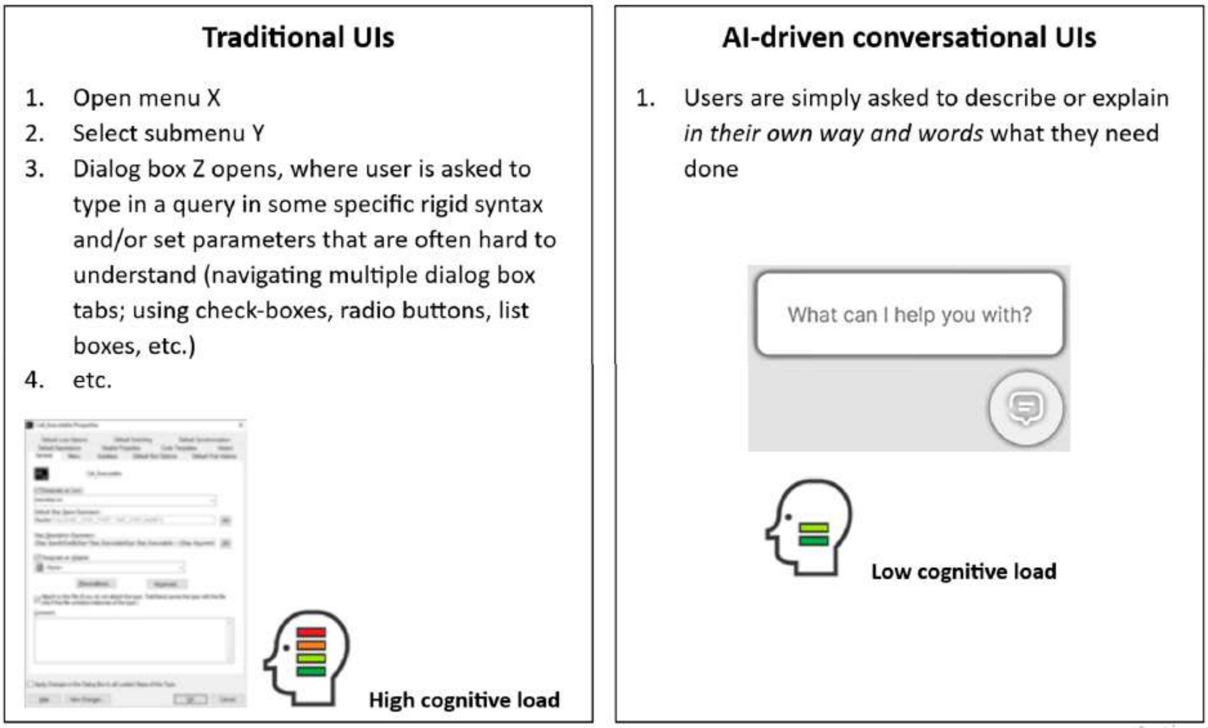
The aforementioned "access without consent" case [72] has raised potential copyright problems about the data used to train these algorithms. Furthermore, the ownership and copyright of the content produced by these models are ambiguous. For example, when the user provides text as input, "DALL-E 2" creates novel radiological images [40]. Regarding content generated by artificial intelligence, the question arises as to who holds the copyright. In the event of damage or loss, who would bear the responsibility? When AI-generated material utilises sources that are legally safeguarded, the challenges become more complex [73, 74]. Notably, as of September 30, 2023, Microsoft has included a new clause to their Services agreement specifically addressing AI services. In this particular provision, the definition of "Your Content" was expanded to include "content that is produced as a result of your utilisation of our AI services" [75].

Potential Future Resolutions

The pertinent laws and regulations often lag behind and necessitate time to align with, similar to other novel and rapidly advancing technologies. While there are now no definitive answers or solutions to several concerns surrounding "Generative AI", such as trust, safety, reliability, privacy, copyrights, and ownership, it does not mean that these issues cannot be overcome. As technology advances and becomes more established, and as rules, regulations, and legal frameworks related to its use begin to arise, these challenges will gradually be resolved. "The European Union (EU) will soon implement the AI Act" [76] to regulate the use of "Artificial Intelligence (AI)", specifically "Generative AI". This law, which is expected to come into force in mid-2024, will be groundbreaking and unique. It will have a grace period of 24-36 months before its main features become legally binding. One of the new transparency requirements for "Generative AI" imposed by the "EU AI Act" is the publication of summaries of copyrighted content utilised for training. Currently, there is ongoing work to update or replace existing regulatory frameworks in order to specifically handle "Artificial Intelligence (AI)" as a remedial device [62]. An example of this occurrence may be observed at the "Medicines and Remedial Products Regulatory Agency (MHRA) in the United Kingdom". Regulators have not yet determined the frequency at which remedial AI algorithms will require re-approval, as these algorithms are expected to continue learning from new data even after gaining their original certification.

Possibilities for User-Friendly, Tailored Solutions

The API and plugins offered by leading "Generative AI" providers, such as "OpenAI" [77-79] and "Google" [80], have simplified the process for external developers to construct their own applications and solutions. Consider "GPT-trainer, Software as a Service (SaaS)" provided by "Petal/Paladin Max, Inc.", as an illustration. Customers may utilise their data to design and deploy "ChatGPT" helpers without requiring coding knowledge [81]. Just like how speech, touch, and "Neural language processing" have revolutionised our interactions with mobile devices and computers, the area of user experience design is now on the verge of being altered by "Artificial Intelligence (AI)" - powered conversational user interfaces (UIs) like ChatGPT [82]. UIs will respond to users' requests in a more natural manner, rather than necessitating users to conform to and become proficient in rigid (pre-programmed) interfaces. Users are just required to provide a description of their wants, using their own words (Figure 1). "GPT-OSM" simplifies the process of finding features in "OpenStreetMap" by allowing users to utilise Neural language queries instead of needing to remember complex syntax or query languages [83]. Enhanced user interfaces for accessing "health digital twins (HDTs) and electronic patient records (EPRs)" and combining them together are only a couple of instances where this same approach might be advantageous for various remedial user interfaces [84]. Within the realm of HDTs, a user interface like ChatGPT can facilitate the connection between complex HDT data and models and the understanding and needs of its human users, including individuals who are in good health, patients, and clinicians.



In addition, “Generative AI” can expedite the development of some health applications by streamlining or automating the coding process. For instance, ChatGPT effectively programmed a version of the well-known virtual reality fitness game Beat Saber [85]. Tao and Xu demonstrated the utilization of publically accessible or supplied geospatial data for generating thematic maps in ChatGPT. In relation to the previously described “OSM-GPT project”, ChatGPT successfully produced the whole code required for map creation [86]. “Generative AI” [87] has the potential to provide significant benefits to the “IoMT (Internet of Remedial Things)”. It can facilitate the generation of innovative concepts for health monitoring and remedial devices that are developed on the edge, as exemplified by reference [88]. By adapting to user preferences, such as those of clinicians or patients, software development activities can operate certain devices and enhance user interfaces and overall user experience [89, 90]. Furthermore, it may evaluate and improve the precision of machine learning algorithms, which are the driving force behind several intelligent remedial devices, by producing artificial and improved data. This can be done when there is a lack of genuine patient data or when the available data is insufficient. “Generative AI” can enhance “IoMT security” by automatically generating suitable mitigation steps in response to changing variables.

CONCLUSIONS

In this analysis, we examined many prominent examples of generative artificial intelligence in use within the remedial sector. The discussion then briefly touched upon trust, authenticity, clinical safety, reliability, privacy, copyrights, ownership, and the potential for using the technology to create more user-friendly conversational interfaces powered by artificial intelligence for remedial applications. As legislation and laws regarding “Generative AI” develop over time, we expect that the aforementioned concerns will gradually be addressed. We concur with Lee, Goldberg, and Kohane [47] that “Generative AI” will increasingly play a crucial role in providing remedial treatment and patient care as it evolves and becomes more tailored to the unique situations and requirements of the remedial business. In the near future, it is reasonable to anticipate the development of new models that are trained using extensive and reliable collections of evidence-based remedial literature, including many clinical specializations. Both the remedial community and their patients will derive significant advantages from these models. In this analysis, we examined many prominent examples of generative artificial intelligence in use within the remedial sector. The discussion then touched upon trust, authenticity, clinical safety, reliability, privacy, copyrights, ownership, and the potential for using the technology to create more user-friendly conversational interfaces powered by “artificial intelligence for remedial” purposes. As legislation and laws regarding “Generative AI” develop over time, we expect that the aforementioned concerns will gradually be addressed. We concur with Lee, Goldberg, and Kohane [47] that “Generative AI” will increasingly play a vital role in providing remedial treatment and patient care as it evolves and becomes more tailored to the unique circumstances and requirements of the remedial business. In the near future, it is reasonable to anticipate the development of new models that are trained using extensive and reliable collections of evidence-based remedial literature, including many clinical specializations. In the near future, both physicians and patients will derive significant advantages from these models. Over time, it is seen that AI does not replace people (clinicians), but rather the use of AI by clinicians replaces clinicians who do not employ AI [93].

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