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ChatGPT in medicine: opportunity and challenges

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Abstract

Chat generative pre-trained transformer (GPT) is a large language model (LLM) artificial intelligence (AI). Indeed, ChatGPT is a chatbot able to participate in a conversation by pretending to be a human. ChatGPT is able to write convincing academic texts which are hard to be distinguished from a human-written manuscript. In the medical context, ChatGPT demonstrated its ability to write abstracts and texts related to the given questions. It could answer medical questions whether they are asked by students or researchers. ChatGPT is able to enhance the knowledge of students by designing tests and answering personalized questions, consequently reducing the burden on teachers. This AI system can participate in healthcare programs by providing information for patients and acting as the connector between patients and healthcare providers. Also, it could serve as a translator and a text generator for patients who speak a different language or those who have speech difficulties. ChatGPT is also able to provide and categorize medical information necessary for healthcare providers and physicians. Nonetheless, the major concern is the level of reliability of generated data. In some cases, ChatGPT produced misleading information and fake citations which warned medical researchers. Worryingly, these false data could distract the process of treatments and or the projects of medical researchers. Regarding the inevitable necessity of AI utilization in the medical field, strict criteria should be enforced in order to improve the efficacy and reduce the safety of the application of any AI chatbot like ChatGPT.

1. Introduction

Artificial intelligence (AI) is simply defined as the type of intelligence adopted and utilized by a machine instead of a living animal or human. AI was basically an academic discipline that was founded in 1956 and after that, this major faced several kinds of optimism and disappointed opinions. All those struggles led to the development of machines able to do tasks formally performed by humans. Accordingly, AI is capable to adapt, learn, memorize, interpret, and generate notions while it could also express human-like emotions (1-3). Nowadays, AI is broadly used in several aspects of modern humans e.g., internet search engines, recommendation systems, auto-driving vehicles, understanding and translation of words to

do tasks, games, and generation of data. In this regard, Chat generative pre-trained transformer (GPT) (ChatGPT) is an AI-based chatbot developed by OpenAI in November 2022 capable to generate data (4). As it is clear, ChatGPT is a pre-trained AI meaning that this system was trained using Large Language Models (LLMs). LLM is an AI-based model consists of a neural network with billions of parameters to mimic human languages by means of self-supervised learning. In simple words, LLMs utilize deep learning to read and train several sources of human texts such as websites, articles, and books. They keep learning the connections and patterns and at the end of all analyses, LLMs are trained and able to predict the missing word or phrase in a text by understanding how words are associated which is called comprehension (5). Therefore, ChatGPT is an LLM with the ability to interact in a conversation meaning that it could respond to questions asked in a dialogue form. ChatGPT is the sibling model of InstructGPT which both are trained using Reinforcement Learning from Human Feedback (RLHF) (6). The initial version of GPT (released by OpenAI in 2018) was trained with various transformer architectures on a dataset of 40GB of text with 1.5B parameters model size (4). In the following, GPT-3 was released in 2020 with significant elevations in size (570GB dataset and 175B parameters model size). Then, ChatGPT is designed for dialogue and was fine-tuned from a model in the GPT-3.5 series that had finished the training process in early 2022; however, has data up to June 2021(6). The latest version of the OpenAI GPT series is GPT-4 released on March 14, 2023, and available for paid subscribers on a limited basis (7). An overview of AI, LLMs, and the position of ChatGPT is illustrated in **Figure 1**.

ChatGPT can perform a vast range of activities from writing computer programs and debugging them to composing songs, writing stories, poetries, and essays, and also performing tests, Nonetheless, the ability of this AI system to answer real-world inquiries in complex fields such as medicine and biology is a big challenge (8,9).

2. Medical/healthcare academic writing and education

According to the ability of ChatGPT to understand texts, its capacity in writing an interpretation of medical texts has been evaluated. According to Nature, some research abstracts were generated by ChatGPT which confused the scientists whether those have been produced by a machine or written by a human (10). The major concern in this context is that LLMs like ChatGPT are able to generate unreliable text which could be owned by a deceitful researcher. In this regard, some preprint and/or published papers listed ChatGPT as their author (11). In a study, the "Background", "Methods", and "Results" sections provided in the "Abstract" of five published clinical trials in the New England Journal of Medicine (NEJM) (12-16) were given to ChatGPT and they asked to write a conclusion of an abstract based on given data with no more than 40 words. The outcome was amazing and ChatGPT showed its ability to correctly understand the setting of the studies and summarized the primary results. However, due to addressing secondary findings, ChatGPT ignore the 40 words limitation (17). Another study evaluated the ability of ChatGPT in writing a medical text in the context of systemic lupus erythematosus (SLE) and HIV. ChatGPT wrote a text about the association of HIV infection in patients with SLE. According to the authors, the generated text seemed clear and comprehensible, and even the AI found relevant references in the Vancouver style. However, a deep look demonstrated that the text indeed was fluent but didn't provide any informative data regarding a scientific publication. Another defect was that major cited references were not actually real (18). Regarding the capability of ChatGPT in writing texts, some journals such as Nature and all Springer Nature journals enforced rules to prohibit the authorship of any LLM like ChatGPT in papers. Also, any contribution of LLM systems in articles should be documented with the aim of transparency (19). Similar rules have been enforced by Elsevier and the Lancet family of journals which state that any AI system could not be an author of an article; however, their contribution to the papers should be acknowledged (20). It is worth mentioning that there is AI-based software able to generate a whole article called article builder/generator software. Although they could generate academic texts like what ChatGPT can do, their databases and the way they were educated through learning systems differ. Indeed, what makes ChatGPT a great AI system is its enormous database and also the method of learning which was based on self-supervised learning and a pre-trained manner. However, it could be possible for article builder software to use these methods of learning and consequently generate accurate and human-like academic texts; a phenomenon which has been utilized by some software like Contentbot, Rytr, and PepperType that used GPT-3 AI engine (21).

Another aspect is the education of students. In this regard, ChatGPT could generate a full essay just in a blink of an eye letting students make their papers
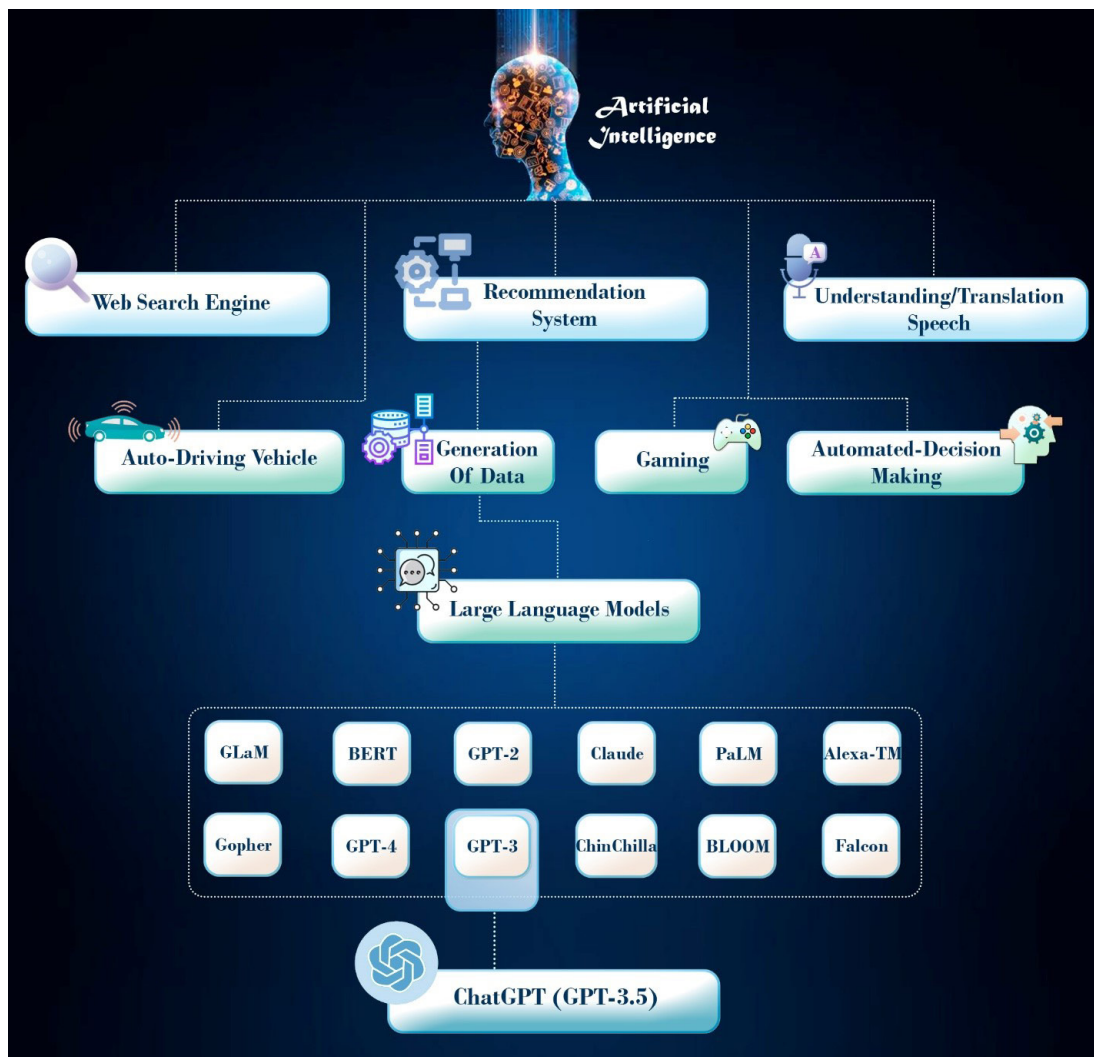
Figure 1. **Artificial intelligence (AI), large language models (LLMs), and the position of ChatGPT.** AI has been developed to facilitate human tasks, and therefore, these systems are integrated into our routine life. Today, AI is certainly a part of advanced search engines like Google. Also, it could advance the recommendation systems utilized in popular websites such as Amazon and YouTube. AI systems are also able to understand human speech which has been used in the speech-to-text process. Besides, they could translate languages and help communicate with people. By processing data regarding the surrounding environment of a vehicle, they could be used in auto-driving systems. In fields like economics, business, and law, AI is able to provide automatic decision-making systems useful for process acceleration. AI is also involved in the gaming industry by playing a human role in a competitive strategy game. Furthermore, another interesting aspect of AI is its ability to generate concepts like LLMs. They are a neural network that is trained by means of self-supervised learning to predict missing phrases in texts, and thus, they are able to understand the human patterns of texts. There are lots of LLMs produced by Tech Giants (big tech companies) such as Google (BERT, GLaM, PaLM) and Amazon (Alexa-TM), and some of them are produced by other IT companies like DeepMind (Gopher, Chinchilla), Anthropic (Claude), and OpenAI (GPT-2/3/4) that shows benefits and advantages. Among them, ChatGPT is an advanced model for GPT-3 which has been fine-tuned via reinforcement and supervised learning models.

rapidly or even fill out online tests with no intellectual activities (22). How about putting the advantages of ChatGPT and similar AI systems together with the professional education guidelines? In a study, researchers asked ChatGPT "if it could be of value for cardiovascular nurses working in clinical practice". Indeed, ChatGPT is of value in the education of patients, management of medication, providing up-to-date information for cardiovascular nurses, and aiding patients who speak a different language by translation. Although ChatGPT could provide data and summarize texts for convenience usage of cardiovascular nurses, the correctness of information should be investigated by cardiovascular nurses (23). An interesting study investigated the understanding of ChatGPT from parasitology examination in comparison with medical students in Korea. Indeed, a computer-based test in the context of parasitology was administered to 77

first-year medical students at Hallym University as well as ChatGPT (in the form of a dialogue). According to the results, the correct response rate of ChatGPT was 60.8% (48 out of 79 questions) which was lower than the average quantity for students (90.8%). Although the correct response rate was lower for ChatGPT, it could not indicate the weakness of ChatGPT in the interpretation for some reasons. The chief reason is that ChatGPT was not trained in medical information due to their instinct restriction in this area; however, students were trained. Thus, interpretations of ChatGPT are mainly based on medical data without enough depth. Besides, some tests in the parasitology examination were based on figures, graphs, and charts which are out of ChatGPT's ability (24). ChatGPT could be a helpful system in order to score student papers automatically. This AI system is able to investigate the structure of sentences and vocabularies and thus could dedicate scores according to what the student wrote (25, 26). Moreover, ChatGPT has the ability to produce tests and examinations which could be utilized by teachers as assistant (27). Obviously, one of the advantages of ChatGPT is its capacity to improve the knowledge of students in a personalized manner meaning that each student with a unique characteristic can ask ChatGPT personalized questions which consequently reduces the burden of teachers. Although the medical knowledge given to ChatGPT is not specialized, ChatGPT could provide data on medical topics in a second and summarize topics into the related categories which is necessary for teachers as well as students to rapidly organize their projects (28).

3. Providing clinical practices

ChatGPT could be used to carry out tasks regarding patient care and clinical practices. An AI system like ChatGPT is able to provide information for patient education, scheduling appointments, and the management of symptoms. Also, it could manage the triage of patients and consequently control the burden of the emergency department. The communication of patients and healthcare providers could be facilitated by providing the remote management (29). A study evaluated the understanding of ChatGPT in medical situations. They gave data concerning the blood gas analysis parameters, laboratory samples ongoing treatments, and respiratory and hemodynamic parameters of a patient in the ICI ward to ChatGPT and asked it to produce a medical note. They figured out that ChatGPT was able to understand abbreviations and ordered parameters into the suitable

sections perfectly. However, as ChatGPT was restricted to answer medical questions the interpretation of this system is remarkably more accurate when the type of the given data is more general instead of medical-related records. Therefore, ChatGPT showed limitations toward addressing casual associations among situations like acute respiratory distress syndrome and septic shock. Besides, ChatGPT interestingly suggested treatments based on the given data (17). The ability of ChatGPT to provide clinical practice could be evaluated for patients with brain and nervous system conditions. Although it could provide information for patients leading to more suitable patient management, the chief concern is the misdiagnosis and false information which could be life-threatening. Also, the privacy of transmitted information should be guaranteed as medical (here neurological) data could be sensitive (29). In a study, the performance of ChatGPT was assessed in the context of cirrhosis and hepatocellular carcinoma. They showed that ChatGPT is able to answer correctly 79.1% and 74% of questions regarding cirrhosis and hepatocellular, respectively. The provided knowledge was better in subjects like primary information, lifestyle as well as treatment approaches; nevertheless, ChatGPT answered questions related to the diagnosis and preventive medicine. Although ChatGPT was able to provide practical advice for patients, it could not properly provide data concerning regional guidelines variations such as the screening criteria of HCC (30).

The patient-healthcare provider relationship could be improved if each speak the same language to make the communication. Indeed, the quality of how strong is a patient connected to the healthcare system guarantees the performance of therapeutic strategies in various pathologic conditions from mental health to malignancy (31, 32). Accordingly, ChatGPT could enhance the healthcare system by serving as the translator between the patient and the healthcare provider. In addition, ChatGPT and similar LLMs are able to make communication easier further than a translator, by aiding patients with speech impairments. For instance, in cases such as aphasia or some neurodegenerative disorders, the ability to speak loses progressively. AI systems like ChatGPT could be served as the instrument of speech facilitating the way those patients can communicate and compensate for the loss of vocabulary in a personalized manner for each patient (33).

4. Limitations and challenges

One of the major ChatGPT limitations is that it doesn't have data after September 2021 which is stemmed from the model of training meaning that in the training process,

an enormous volume of data was given to the ChatGPT until a specific moment (34). Moreover, providing false information is another limitation of ChatGPT that OpenAI had mentioned. ChatGPT is an LLM able to understand the connections. For instance, it figures out that any academic written text should be related to references. Therefore, when we ask ChatGPT to write an academic article about a subject, it starts to generate fake and unreal references (in some cases) instead of citing real work. According to OpenAI, "ChatGPT sometimes writes plausible-sounding but incorrect or nonsensical answers". A common phenomenon in LLMs called interestingly "hallucination" (6).

Although the notable performance of ChatGPT in writing scientific texts seems promising at first look, it could also be an alarm as well. For instance, ChatGPT wrote 50 research abstracts that confused researchers and they didn't recognize that texts were generated by an AI system (35). It could be inferred that ChatGPT and any similar AI can move further in the future and gain the ability to write a correct and complete scientific paper just with the results given to them. However, these LLMs are able to suggest texts based on what they have understood and not based on the interpretation of given data. In other words, they pretend to be a human and they learn how to write texts to convince the audiences that those texts are generated by a human based on what people acted before. Accordingly, it was shown that ChatGPT lacked deep data and expertise in writing reliable manuscripts in the context of drug discovery and indeed, there should be human assistance to guarantee the scientific aspect of articles (36). Besides the lack of depth in medical records, ChatGPT might generate false information that initially sounds very logical. For instance, ChatGPT could generate fake references for an academic text (37). Knowing the fact that all cited references could not be covered by reviewers in a peer review process makes this phenomenon more dangerous. Generating false texts with incorrect contents has been indicated in several studies as one of the main shortcomings of ChatGPT (38-41). According to a systematic analysis, studies evaluating ChatGPT in healthcare mentioned ethical issues like plagiarism, bias, and data privacy were the major challenges of ChatGPT (55%). After those, providing incorrect data, transparency problems, and false citations or inadequate referencing were at the next levels (42).

Another challenge concerning ChatGPT utilization is the reality that nowadays, people tend to find the cause of their medical problems on the internet. It was shown that more than one-third of US individuals search the web data for their medical issues and self-diagnosis (43), and that was when there were no ChatGPT and other similar AI models. Therefore, the emergence of ChatGPT is certainly a concern if people try using it as the main source of medical information. The extended use of AI will be a definite event in the near future and in this regard, the utilization of ChatGPT for seeking medical problems should be considered carefully and strict criteria should be implemented. Nonetheless, a simple warning alarm for general users representing the unreliability of ChatGPT or similar LLMs in generating medical information and the necessity of counseling with a real physician could be extremely helpful to reduce the risks of misunderstanding and errors of self-diagnosis (33). To provide a better understanding, the pros and cons of ChatGPT are depicted in **Figure 2**.

5. Conclusion and future prospects

The presence of AI involved in our routine life has been sensed more than ever. Therefore, the extended utilization of AI chatbots as members of the LLM family like ChatGPT is an inevitable phenomenon, even in healthcare systems and medical contexts. In this regard, ChatGPT demonstrated a remarkable capacity in answering questions and acting instead of a human responder. This AI chatbot showed a potent ability in the medical field by enhancing academic manuscript writing, analyzing databases and categorizing them, facilitating academic education by providing personalized learning and acting as the teacher assistant, and also by playing the role of a connector of patient and healthcare provider via documenting and categorizing medical records, answering the problems of patients about the manner of treatments and by serving as a translator for patients with different language or with speech difficulties. Nevertheless, there are some challenges regarding how ChatGPT works and how we are interacting with it. Limited date of given data to ChatGPT on one hand and the hallucination phenomenon, on the other hand, could induce some shortcomings for ChatGPT. One of the main concerns in the context of medical academic sciences is the generation of false or fake information by ChatGPT. Not only the main text could have some incorrect data, but also the citations and references can be fake. However, it is easier to write a manuscript or respond to queries in a second instead of putting time into them, and thus, there are certain troubles regarding ChatGPT utilization. Regarding the vast capacity of ChatGPT and similar systems, it is necessary for medical scientists

Figure 2. The pros and cons of ChatGPT in medicine. ChatGPT has demonstrated several advantages which can be categorized into medical/healthcare writing, medical/healthcare education, and clinical practice. One of the challenging aspects of ChatGPT is its ability to write an academic text. In the medical context, ChatGPT is able to gather information, categorize them, provide a summary of gathered data, and ultimately, write a manuscript. Moreover, ChatGPT can provide data for professionals in the education system. It is able to answer students' questions in a personalized manner and help them to write their essays. Also, ChatGPT could generate tests and score an examination as well which consequently reduces the burden on teachers and the education system. In the clinic, ChatGPT has the ability to provide information for patients and for specific diseases. It could schedule appointments and remotely control the burden of the emergency department. Furthermore, ChatGPT is capable of translating languages and helping patients and also it could generate texts for patients with speech difficulties. Nevertheless, ChatGPT has exhibited shortcomings as well. This AI system has limited information until 2021 means that ChatGPT is not aware of what is going on today. Another challenge is a phenomenon called hallucination by OpenAI. This defect lets ChatGPT generate false or fake information like fake citations which are hard to detect. Generating and providing incorrect information together with fake referencing turn the ChatGPT-generated manuscripts more than ever unreliable. In the medical field, false information could lead to a project distraction or a risky life-threatening clinical practice. Besides, the majority of medical records should be kept under strict privacy. Utilizing ChatGPT could compromise the privacy of patients which is another ethical issue of this AI system.

communities to consider ethics in using those AI technologies and enforcing strict criteria in order to limit shortcomings and improve efficacy. One possible way could be the training of ChatGPT in the medical field to assist professionals. Although ChatGPT exhibited shortcomings, it notably played magnificent roles when acting as an assistant. Besides, the speed of evolution in ChatGPT and similar systems is much higher than in controllers. Therefore, it is important to warn medical regulators, developers, researchers, students, patients, healthcare providers, and the government of the enforcement criteria of how to gain the most benefits from AI systems.

Conflicts of interest
The authors declare that they have no conflict of interest.

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