

Artificial intelligence in rehabilitation: comparing OpenAI ChatGPT recommendations to evidence-based meta-analyses

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Abstract

Background: ChatGPT, short for Chat Generative Pre-Trained Transformer, is a language model developed by OpenAI that is capable of generating human-like text responses to various prompts. In the field of rehabilitation, ChatGPT has the potential to be a valuable resource for patients and clinicians alike. In light of the open, easy access to this tool, its application in rehabilitation should be considered and evaluated.

Aims: This study aimed to test the feasibility of using the OpenAI ChatGPT tool to generate clinical recommendations in rehabilitation and compare its findings with recent meta-analyses.

Material and methods: The selection of rehabilitation areas was based on a report on the global estimates of the need for rehabilitation, with the top three disorders being musculoskeletal disorders, neurological disorders, and chronic respiratory diseases. The authors evaluated the responses of ChatGPT to clinical questions in these areas

against the existing evidence on rehabilitation interventions from systematic reviews and meta-analyses in the Cochrane Library database.

Results: The findings of the study indicate that the AI's recommendations align with the current scientific knowledge on rehabilitation interventions, as demonstrated through a comparison with the Cochrane Library database.

Conclusions: Using AI language models like ChatGPT can help identify effective rehabilitation methods for common conditions.

Key words

rehabilitation, Artificial Intelligence, AI, ChatGPT.

Introduction

Within two months of its release, ChatGPT has exerted significant influence on e-commerce and disrupted the education and entertainment industries [1]. ChatGPT, short for Chat Generative Pre-Trained Transformer, is a language model developed by OpenAI that is capable of generating human-like text responses to various prompts. This model is based on the Transformer architecture, which was introduced in 2017 by Vaswani et al. [2] and has since become the dominant approach in Natural Language Processing (NLP). The Transformer architecture is designed to handle sequential data, such as text, using self-attention mechanisms to weigh the importance of different input parts. This allows the model to capture long-range dependencies between words, which is crucial for tasks such as language translation, where the meaning of a word can depend on its context within a sentence [3].

ChatGPT is a variant of the Transformer architecture that has been pre-trained on a large corpus of text data from the internet, including websites, books, and social media. Once pre-trained, the model can be fine-tuned for a wide variety of NLP tasks, including text classification, question answering, and text generation. In the case of text generation, ChatGPT can generate coherent and fluent text responses to a given prompt, making it useful for conversational agents, chatbots, and other applications that require natural language interaction [4]. ChatGPT boasts a noteworthy capability of producing real-time, high-quality text outputs, rendering it a useful tool for applications requiring human-like communication [5]. However, it was rapidly established that this tool could be extremely effective in completing homework, taking exams, and even writing complex essays (1). As a result of this, access to ChatGPT was blocked in New York public schools in January, and similar bans have been reported in other schools across the United States. However, considering that a simple mobile phone is enough to access the full capabilities of the AI tool, these bans are symbolic in nature [6].

OpenAI's tool, ChatGPT, has demonstrated versatility in multiple domains, such as writing motivational letters for job applicants, generating high-quality recipes based on available ingredients, and creating investment strategies based on the user's asset structure. It has also been tested by scientists from Axios, who reported that the answers provided by the algorithm were consistent, comprehensive, and in-depth, passing the United States Medical Licensing Examination (USMLE) [7]. Moreover, Springer Nature has taken a clear stance on using AI-based tools in preparing scientific works. Neither ChatGPT nor any other similar tool can be signed as the authors of works that are published by the publisher. However, the publisher still needs to completely cut off from this technology and allow its use as long as the authors properly inform about the use of AI-based tools in the writing process [8]. Furthermore, the Chris Stokel-Walker article identified four articles in which ChatGPT was shown as a co-author, two of them being indexed in the PubMed resources. Therefore, it is likely that utilization of this kind of instrument will experience a substantial rise.

In the field of rehabilitation, ChatGPT has the potential to be a valuable resource for patients and clinicians alike. It can provide patients with a convenient and accessible way to engage in rehabilitation exercises and receive feedback on their progress. For clinicians, it can be used to automate the delivery of rehabilitation programs, reducing the time and effort required to create and manage these programs. However, while the potential benefits of ChatGPT in rehabilitation are significant, it is important to note that its use in this context must be carefully considered and evaluated. As with any technology, some potential risks and limitations must be taken into account, such as privacy concerns, the potential for incorrect or biased responses, and the need to ensure the quality and validity of the rehabilitation programs being delivered.

In light of the open, easy access to this tool, its application in the field of rehabilitation should be considered and evaluated. Furthermore, an examination of the PubMed scientific repository revealed a mere five publications that investigate the prospective utilization of ChatGPT in the medical domain; however, none of these works pertain to the subject of rehabilitation. As a result, the purpose of this narrative review was to test the feasibility of using the OpenAI ChatGPT tool to generate clinical recommendations in the rehabilitation field and compare its findings with recent meta-analyses in various rehabilitation areas. The structure of this narrative review is organized as follows: The second section outlines the electronic search resources employed. The Results section is divided into three distinct subsections, each highlighting the top three most frequently rehabilitated conditions. The ensuing portion features a discussion of the findings, while the final section offers conclusive remarks.

Electronic search

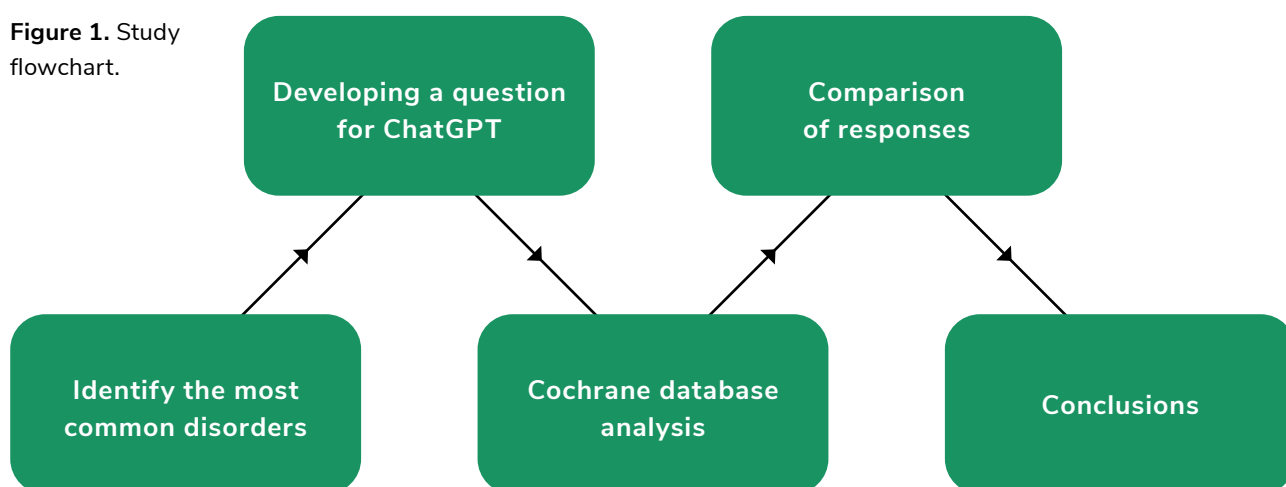
It was decided that the process of comparing answers to clinical questions will be presented according to the following diagram (**Fig. 1**). The Cochrane Library database is a well-established and respected source for systematic reviews (SR) and meta-analyses on the effectiveness of healthcare interventions. These types of studies provide a comprehensive and rigorous synthesis

of the available evidence, considering the quality and limitations of individual studies [9]. It was presumed that searching for answers to a clinical question about treatment effectiveness in the Cochrane Library could provide a high-level overview of the current state of knowledge and increase confidence in the conclusions drawn from the available evidence. The responses were examined on February 3rd and 4th, 2023.

Selection of conditions

The selection of rehabilitation areas was based on a report, "Global estimates of the need for rehabilitation based on the Global Burden of Disease Study 2019: a systematic analysis for the Global Burden of Disease Study 2019", published in the Lancet (10). The results indicated that in 2019, 2.41 billion individuals worldwide had conditions that would benefit from rehabilitation, leading to 310 million years of life lived with disability. The findings of this study challenge the commonly held view that rehabilitation services are required only by a small portion of the population and highlight the need for rehabilitation to be integrated into primary healthcare and made accessible to communities globally. Therefore, it was decided to prioritize the top three disorders: musculoskeletal disorders (2412 million cases), neurological disorders (255 million cases), and chronic respiratory diseases (118 million cases).

Figure 1. Study flowchart.



Results

Musculoskeletal disorders

The report found that musculoskeletal disorders contribute the most to the need for rehabilitation services. Approximately 1.71 billion people have musculoskeletal conditions, with low back pain being the most prevalent and leading health condition contributing to the need for rehabilitation services in 134 of the 204 countries analyzed.

ChatGPT question:

“What are the effective treatments for chronic lower back pain?”

ChatGPT answer:

“The most effective treatments for chronic lower back pain in comparison to no treatment, usual care, or placebo can vary depending on the individual's specific condition and symptoms. However, some commonly used and evidence-based treatments for chronic lower back pain include:

- Exercise therapy: This can include physical therapy, strengthening exercises, and aerobic exercises.
- Medications: Over-the-counter pain relievers such as ibuprofen and acetaminophen, as well as prescription pain medications, can be effective for managing chronic lower back pain.
- Spinal manipulation: This may include chiropractic care, osteopathic manipulation, or massage therapy.
- Acupuncture: This traditional Chinese medicine technique involves the insertion of fine needles into the skin at specific points to relieve pain.
- Interventional procedures: This can include nerve blocks, epidural injections, and spinal cord stimulation.

It is important to consult with a healthcare professional to determine the most appropriate and effective treatment plan for an individual's specific condition and symptoms.”

Verification of responses to the Cochrane Database's Systematic Reviews

It was decided to evaluate the responses against the existing evidence on rehabilitation interventions. One of the most recently founded meta-analyses was a study by Hayden et al. [11], which aimed to evaluate the effect of exercise therapy on pain and functional limitations in adults with chronic non-specific low back pain in comparison to control conditions such as no treatment, standard care, placebo, and other conservative treatments. Authors found moderate-certainty evidence that exercise therapy is probably effective for treating chronic low back pain compared to no treatment, usual care, or placebo, as demonstrated by small but significant improvements in pain and functional limitations outcomes. A study evaluating the effectiveness of acupuncture for chronic non-specific low back pain was also found [12]. Mu et al. [13] noticed low-certainty evidence that acupuncture may provide short-term pain relief compared to a sham intervention, but the difference did not meet a clinically important threshold. The results of the analysis indicate that adverse events were similar in the acupuncture and sham intervention groups and included injection site pain, bruising, and worsening of lower back pain. The Cochrane resource also includes a study evaluating the effectiveness of spinal manipulative therapy for chronic low-back pain. Rubinstein et al. found high-quality evidence that spinal manual therapy had a small, statistically significant but not clinically relevant, short-term effect on pain relief and functional status compared to other interventions. The effect was seen when SMT was added to another intervention as well, but the quality of evidence in these cases varied from low to high.

A study by Wieland et al. [14] revealed low-certainty evidence from 11 trials showed a small improvement in back-specific function with yoga,

and moderate-certainty evidence from nine trials showed a small improvement in pain compared to no exercise at three months. Williams et al. [15] reported that Cognitive Behavioral Therapy (CBT) has small or very small beneficial effects for reducing pain, disability, and distress in chronic pain, while Schaafsma et al. [16] not found CBT to be conclusively superior to physical conditioning, either as an alternative or as an adjunctive therapy. Also, a systematic review was found on the effectiveness of superficial heat or cold for low back

pain. French et al. [17] found limited evidence to support the use of superficial heat and cold for low back pain. The evidence showed that heat wrap therapy provided a small short-term reduction in pain and disability for a population with a mix of acute and sub-acute low-back pain, and the addition of exercise further reduced pain and improved function. However, there is insufficient evidence to evaluate the effects of cold for low-back pain, and the evidence for the application of cold treatment is even more limited (**Table 1**).

Table 1. Verification of responses regarding musculoskeletal disorders.

ChatGPT	Cochrane Database
Exercise therapy	Confirmed
Manual therapy	Confirmed
Cognitive-behavioral therapy	Not confirmed
Mind-body interventions	Confirmed
Heat and cold therapy	Not confirmed
Acupuncture	Confirmed

Neurological disorders

Global Burden of Disease Study 2019 revealed that, among neurological disorders, stroke represented the greatest need for rehabilitation (86 million people).

ChatGPT question:

“What are the effective methods of rehabilitation after stroke?”

ChatGPT answer:

“Rehabilitation after stroke typically involves a combination of physical, occupational, and speech therapy. Effective methods of rehabilitation may include:

- Physical therapy: to improve mobility, balance, and coordination through exercises and movement training.
- Occupational therapy: to help with activities of daily living such as dressing, eating, and grooming.
- Speech therapy: to improve communication and swallowing abilities.
- Cognitive rehabilitation: to improve thinking, memory, and problem-solving skills.
- Aquatic therapy: to take advantage of the buoyancy and resistance of water for rehabilitation exercises.

- **Electrical stimulation:** to improve muscle strength and coordination using electrical stimulation.

It is important to note that the type and intensity of rehabilitation will vary depending on the individual's needs and the severity of the stroke. A multi-disciplinary approach that involves close collaboration between rehabilitation professionals and the patient's family is often the most effective.”

Verification of responses to the Cochrane Database's Systematic Reviews

The Cochrane Library database was re-examined to identify and evaluate the efficacy of rehabilitation interventions. The study by Pollock et al. [18] highlights the abundance of systematic reviews related to interventions for improving upper limb function post-stroke; however, the current evidence for these interventions is insufficient to make informed clinical decisions. A comprehensive literature search was conducted, but no updated publications were found in the database resources related to the indicated 2014 paper. Concerning occupational therapy, a systematic review and meta-analysis by Gibson et al. [19] was found. The study revealed low-certainty ev-

idence of a small improvement in basic activities of daily living immediately after the intervention (Functional Independence Measure) and at the three- and six-month follow-ups.

Moreover, Loetscher et al. [20] similarly noted that the effectiveness of cognitive rehabilitation for attention deficits after stroke remains unproven (20). In contrast, strong evidence has been found for the effectiveness of speech therapy in post-stroke patients. According to Brady et al. [21], speech and language therapy resulted in statistically and clinically significant benefits for functional communication, reading, writing, and expressive language. Evidence was also found to indicate the effectiveness of water-based exercises for improving activities of daily living after stroke [22]. Mehrholz et al. [22] found that, water-based exercises after stroke showed a significant improvement in activity of daily living and muscle strength; however, significant improvement was found in gait speed, postural balance, or fitness. Price et al. [23] revealed that while ES around the shoulder after a stroke may not influence reports of pain, there do appear to be benefits for passive humeral lateral rotation, possibly through the reduction of glenohumeral subluxation (**Table 2**).

Table 2. Verification of responses regarding neurological disorders.

ChatGPT	Cochrane Database
Physical therapy	Partially confirmed
Occupational therapy	Confirmed
Speech therapy	Confirmed
Cognitive rehabilitation	Confirmed
Aquatic therapy	Confirmed
Electrical stimulation	Confirmed

Chronic respiratory diseases

ChatGPT question:

“What are the effective rehabilitation treatments for chronic respiratory diseases?”

ChatGPT answer:

“Pulmonary rehabilitation is an effective rehabilitation treatment for chronic respiratory diseases, which may include:

- Aerobic exercise: to improve cardiovascular function and increase endurance
- Strength training: to improve muscle strength and support breathing
- Breathing techniques, such as pursed lip breathing and diaphragmatic breathing, to improve breathing control and reduce shortness of breath
- Education: to provide information and support for managing symptoms, medication use, and healthy lifestyle changes

Nutritional counseling: to maintain a healthy weight and support respiratory function.

It is important to work with a rehabilitation specialist to create a personalized rehabilitation plan that meets your needs and goals.”

Verification of responses to the Cochrane Database's Systematic Reviews

The resources of the Cochrane Library were also searched in this area to investigate rehabilitation interventions. The analysis encompassed both obstructive and restrictive respiratory disorders. The analysis of Dowman et al. [24] on interstitial lung disease revealed that both inpatient and home-based rehabilitation interventions show efficacy in enhancing exercise tolerance as evaluated using the 6-minute walk test. However, the evidence regarding the improvement of dyspnea and quality of life in the short term is of low certainty, with similar benefits observed in individ-

uals with Idiopathic Pulmonary Fibrosis. Osadnik et al. [25] conducted a SR to evaluate the efficacy of pulmonary rehabilitation compared to the standard of care for adult patients with asthma. The results suggest that pulmonary rehabilitation, compared to usual care, may increase maximal oxygen uptake and improve functional exercise capacity as measured by the 6-minute walk distance with a moderate level of evidence.

In contrast, Silva et al. [26] found no definitive evidence for or against the use of inspiratory muscle exercises in the treatment of asthma. A significant proportion of the available systematic reviews regarding rehabilitation interventions has been examined on patients with Chronic Obstructive Pulmonary Disease (COPD). The recent evidence regarding the impact of exercise and specific exercises aimed at improving breathing muscle strength on breathlessness, physical fitness, and quality of life in patients with weakened breathing muscles is inconclusive [27]. Malaguti et al. [28] reported evidence of low to moderate certainty, suggesting that supervised maintenance programs subsequent to pulmonary rehabilitation may enhance health-related quality of life between 6 to 12 months when compared to standard care. The findings regarding the efficacy of educational interventions for healthcare professionals in primary care to manage COPD are uncertain. The interventions could potentially influence the proportion of COPD diagnoses confirmed using spirometry, patient involvement in pulmonary rehabilitation, and the utilization of guideline-recommended COPD respiratory medications [29]. However, among the studies reviewed, a systematic review with meta-analysis by Cox et al. reported on the effectiveness of tele-rehabilitation interventions was identified. These results were not included in the output from the ChatGPT tool (**Table 3**).

Table 3. Verification of responses regarding chronic respiratory diseases.

ChatGPT	Cochrane Database
Aerobic exercise	Confirmed
Strength training	Confirmed
Breathing techniques	Confirmed
Education	Confirmed
Nutritional counseling	Confirmed
-	Telerehabilitation

Discussion

This review aimed to evaluate the performance and concordance of the newly developed ChatGPT tool by comparing its responses to the scientific literature on the efficacy of rehabilitation interventions for three of the most prevalent categories of functional disorders: musculoskeletal, neurological, and chronic respiratory diseases. In 2019, these three categories accounted for a combined total of 2785 million cases.

In terms of AI responses to treatments for chronic lower back pain, ChatGPT lists several commonly used treatments. A correspondence between the treatments listed by AI and the systematic reviews with meta-analyses found in the Cochrane Library database has been noted. The treatments listed by ChatGPT, such as exercise therapy, manual therapy, spinal manipulation, acupuncture, and interventional procedures, are also evaluated in the available scientific evidence regarding their effectiveness in scientific databases. The AI's answer generally aligns with the results found in the Cochrane Library, with some differences in the level of certainty of the evidence for rehabilitation interventions in stroke. Based on the analysis of available meta-analyses, the benefits

of "Cognitive-behavioral therapy" and "Heat and cold therapy" compared to a control group with no intervention or a placebo intervention are inconclusive. Therefore, the current ChatGPT's evidence base in this area appears limited. In the field of neurological disorders, the scientific evidence found in Cochrane Library resources showed that the effective methods recommended by the chatbot were consistent with the evidence. However, it was noted that there is inadequate quality of evidence to support the use of physical therapy for this purpose. Interestingly, the effectiveness of therapies for motor learning skills after stroke after stroke revealed that the neurophysiological rehabilitation methods that have been widely used for more than 80 years lack "hard" scientific evidence of their effectiveness. The AI's responses in the area of chronic respiratory diseases were found to be consistent with established scientific evidence. Notably, the chatbot did not mention telerehabilitation methods, which have garnered significant attention since the COVID-19 pandemic began. This approach has been the focus of recent research on respiratory diseases.

Although ChatGPT has shown a potential to identify effective rehabilitation methods for three of the most frequent health problems, it would be necessary to reflect now if ChatGPT could make a recommendation, not only about the method but also of identifying the dose, intensity, and frequency of the interventions to be done for the patients. In this sense, for example, physical exercise as an effective intervention against low back pain presents in the scientific literature a high variability in the different possibilities of exercises (volume and intensities) that are effective depending on the clinical moment, patient, and process. At this point, it would be worth reflecting on whether ChatGPT will be able to refine its response to indicate, among the different methods identified in the present review, whether it could analyze which of them may have a better response, thus identifying classification algorithms for complex clinical decision-making.

It is challenging to predict the future utilization of AI in scientific papers. Nonetheless, there have been instances of experimentation with AI in scientific writing, specifically regarding text generation and proofreading. The use of ChatGPT was tested by researchers at Northwestern University in Chicago (USA), where the tool generated abstracts of scientific publications. Results showed that in a survey, one-third of participants were unable to differentiate between text generated by ChatGPT and text written by a human. A review of PubMed on February 6, 2023, revealed twenty-one articles related to the use of AI in scientific writing, with only five related to the field of medicine. In a paper by Biswas, the potential use of ChatGPT in medical writing was explored [30]. The paper argues that chatbots and NLP technology, such as GPT, could enhance the efficiency of the medical writing process by automating certain tasks and improving the accuracy and consistency of documents. For example, chatbots could extract information from electronic medical records, generate draft text, and assist with literature searches. However, the paper acknowledges that ChatGPT can only partially replace

human medical writers as they lack the level of expertise and understanding in the field of medicine. The use of language models in medical writing also raises ethical concerns, and it is important for organizations and individuals to carefully consider these issues to ensure the quality and accuracy of the generated documents. The paper by Shen et al. [31] describes the potential use of AI-based chatbots in the healthcare industry. The authors highlight the use of ChatGPT in improving the accuracy of radiology imaging exams. The authors emphasized the significance of utilizing the capabilities of this technology to facilitate clinical decision-making processes, as well as for evaluating the accuracy of imaging techniques. The study conducted by Huh compared the parasitology knowledge and interpretation capabilities of ChatGPT to that of medical students in Korea [32]. The results showed that AI performed lower than medical students, and its correct answer rate was not related to the difficulty level of the items. The study concluded that ChatGPT's knowledge and interpretation ability in the field of parasitology is different from that of medical students in Korea. The study by O'Connor raises concerns about the fact that it may soon become difficult to distinguish between a student's labor and that of an AI chatbot, especially at the post-graduate level, and calls for a re-evaluation of the types of assessment used in nursing education [33]. The last publication in Stem Cell Reports presented an interview with the guest editors, Cahan and Treutlein [34], who discussed their utilization of AI for computational systems biology. They highlighted ChatGPT's capability to effectively handle vast amounts of data, identify patterns and trends, optimize stem cell culture conditions, and construct comprehensive models to simulate stem cell behavior.

Remarkably, ChatGPT consistently advises users to consult with a rehabilitation specialist, providing a valuable safeguard for practitioners. This tool may serve as a helpful resource for individuals with limited medical knowledge, particularly in countries where rehabilitation services within

the healthcare system are limited. Raising awareness among patients of the various therapeutic options available for a given dysfunction or disorder could increase the range of interventions they receive. The effectiveness of ChatGPT as a diagnostic tool remains uncertain, but it may offer a more reliable solution than "Dr. Google."

Conclusions

Based on the analysis, it can be concluded that using a freely available AI language model, such as ChatGPT, has the potential to assist in identifying effective rehabilitation methods for common conditions. The analysis of one-sentence questions on therapeutic methods across all areas indicated the presence of established scientific methods, although not all available rehabilitation methods were demonstrated in certain areas. The AI's responses were generally consistent with the evidence found in the Cochrane Library, with some differences in the level of certainty of the evidence. In the area of chronic lower back pain, the AI listed commonly used treatments that align with the available scientific evidence. At the same time, the benefits of CBT and heat and cold therapy are inconclusive. The scientific evidence found in Cochrane Library resources showed that the effective methods recommended by the chatbot were consistent with the evidence in neurological disorders. However, there is inadequate quality of evidence to support the use of physical therapy for this purpose. The AI's responses in the area of chronic respiratory diseases were consistent with established scientific evidence, but it did not mention telerehabilitation methods, which have been the focus of recent research in this area. The results of this study provide valuable insights into the potential applications of AI in the field of rehabilitation and may serve as a basis for future research in this area.

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Competing interests:

The authors declare no conflict of interest.

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