

ChatGPT's Success in the Board-Certified Pharmacotherapy Specialist (BCPS) Exam

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ABSTRACT: The advent of artificial intelligence (AI) and natural language processing technologies has ushered in a new era of innovative educational tools and resources. ChatGPT, a prominent AI-powered language model, has demonstrated remarkable potential in various fields. In this study, we aim to explore the ability of ChatGPT to answer Pharmacotherapy Specialist (BCPS) exam questions and provide justifications for its answers. We conducted a comprehensive content analysis to scrutinize the applicability and competence of ChatGPT in addressing BCPS exam inquiries while substantiating the correctness of its responses. Our findings reveal that ChatGPT was able to answer 94 out of 128 questions (73.43%) correctly and justify 80.16% of the correct answers appropriately and 76.18% of the noncorrect answers in all questions. **Conclusion:** The ChatGPT's ability to answer the Pharmacotherapy Specialist (BCPS) exam and justify the answers was good. ChatGPT could help pharmacists in their preparation for this exam with caution. ChatGPT is still in the early phase of use by educators and students worldwide, and its ability to answer exams will be better in the near future. Attending training workshops about ChatGPT and AI is very important and highly recommended. Practice ChatGPT in medical and health sciences education is very important and highly recommended to explore the potential uses, benefits and risks and suggest recommendations for best practices.

KEYWORDS: Artificial Intelligence (AI); ChatGPT; Pharmacotherapy Specialist (BCPS) exam; Educational Tool; Natural Language Processing

1. INTRODUCTION

The evolution of technology has contributed effectively to advancements in medical and health sciences education, practice, and research over the past few decades [1-4]. Notably, artificial intelligence (AI) has been implemented in many fields, including medical and health sciences education, practice and research [5-8]. Loeckx (2016) suggested that artificial intelligence (AI) could contribute effectively to teaching and learning as an effective learning tool for educators and improve learning experiences [2]. Artificial intelligence can be defined as "it is the science and engineering of making intelligent machines,

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especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable” [9], or as “a field of science and engineering concerned with the computational understanding of what is commonly called intelligent behaviour, and with the creation of artefacts that exhibit such behaviour” [10]. One of the recent advances in artificial intelligence development is the launch of a model called ChatGPT, which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer follow-up questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. As widely known, ChatGPT is a general Large Language Model (LLM) developed recently by OpenAI. While the previous class of AI models has primarily been deep learning (DL) models, which are designed to learn and recognize patterns in data, LLMs are a new type of AI algorithm trained to predict the likelihood of a given sequence of words based on the context of the words that come before it [11]. Many educators, researchers, healthcare professionals, and students started using ChatGPT at the end of 2022 for many purposes, such as preparing lecture notes, assignments, literature reviews, proposal, and data analysis [12-13]. The BPS Board Certified Pharmacotherapy Specialist (BCPS) exam is an exam offered by the Board of Pharmacists Specialists (BPS), USA, since 1988 to prepare pharmacists for patient care practice to ensure the safe, appropriate, and economical use of medications as part of interprofessional treatment teams in a variety of settings, including hospitals and health systems [14]. The BCPS is recognized internationally, and hundreds of pharmacists performed the exam and registered for this exam yearly. The objective of this article was to explore the ability of ChatGPT to answer the Pharmacotherapy Specialist (BCPS) exam and justify the answers.

2. RESULTS

The findings of this study show that ChatGPT was able to answer 94 out of 128 questions (73.43%) correctly and justify 80.16% of the correct answers appropriately and 76.18% of the noncorrect answers in all questions. See Table 1 for more details.

3. DISCUSSION

This study explored the ability of ChatGPT to answer the Pharmacotherapy Specialist (BCPS) exam and justify the answers. The findings of this study can be classified into three themes:

Theme 1. The ability of ChatGPT to answer the Pharmacotherapy Specialist (BCPS) exam

This study's findings show that ChatGPT answered 94 out of 128 questions (73.43%) correctly. The ability of ChatGPT to answer questions was different from one chapter to another; ChatGPT was able to answer all questions in a few chapters, such as neurology, gastrointestinal disorders, anticoagulation and acute care in cardiology (see Table 1), while it was not able to answer 50% of questions in the general psychiatry chapter (see Table 1). The range of ability to answer questions was between 42.85% and 100% (see Table 1), which could be due to the nature and levels of questions in each chapter. This study's results are considered a good indicator of the ability of ChatGPT to answer questions. Kung et al., 2023 conducted a study to evaluate the performance of a large language model called ChatGPT on the United States Medical Licensing Exam (USMLE) and reported that ChatGPT performed at or near the passing threshold of 60% accuracy [15]. However, it is not easy to compare the ability of ChatGPT between different specialties due to many factors, such as the nature of exams and the type of questions.

Table 1. The ability of ChatGPT to answer questions

Chapter title (number of questions)	Correct answers N (%)	Justification of the correct answers (Average %)	Justification of the noncorrect answers in all questions (Correct and wrong answers) (Average %)
Fluids, Electrolytes, and Nutrition (8)	5 (62.5%)	72.5%	73.75%
Endocrine and Metabolic Disorders (6)	5 (83.33%)	74.25%	75%
Pulmonary Disorders and Adult	5 (83.33%)	75%	73.75%

Immunizations (6)			
Geriatrics (5)	4 (80%)	80.75%	78.25%
Biostatistics: A Refresher (5)	4 (80%)	75%	75%
Study Designs: Fundamentals and Interpretation (5)	4 (80%)	80%	80%
Anticoagulation (5)	5 (100%)	90%	80%
Critical Care (6)	5 (83.33%)	75.25%	74%
Chronic Care in Cardiology (8)	5 (62.5%)	80.75%	75%
Acute Care in Cardiology (5)	5 (100%)	83.5%	80.75%
Neurology (5)	5 (100%)	80.75%	79.5%
General Psychiatry (7)	3 (42.85%)	75.25%	61.25%
Infectious Diseases (6)	3 (50%)	63.75%	58.25%
Infectious Diseases II (5)	4 (80%)	90%	78.25%
Men's and Women's Health (5)	3 (60%)	75%	73.75%
Pharmacokinetics: A Refresher (8)	5 (62.5%)	82.25%	76.25%
Nephrology (5)	4 (80%)	83%	83%
Oncology Supportive Care (5)	3 (60%)	74.25%	72.5%
Gastrointestinal Disorders (5)	5 (100%)	90%	83%
Pediatrics (5)	3 (60%)	90%	79.5%
Healthcare Systems and Population Health (5)	3 (60%)	90%	82.25%
Drug Information and Communication Strategies in Pharmacy (8)	6 (75%)	82.25%	83%
Total questions (128)	94 (73.43%)	80.16%	76.18%

Theme 2. The ability of ChatGPT to justify the correct answers in the Pharmacotherapy Specialist (BCPS) exam

This study's findings show that ChatGPT could appropriately justify 80.16% of the correct answers. The ability of ChatGPT to justify the correct answers was different from one chapter to another; ChatGPT was able to justify up to 90% of the correct answers in many chapters, such as gastrointestinal disorders, anticoagulation and paediatrics (see Table 1), while it was not able to justify more than 75% of correct answers in the majority of chapters (see Table 1). The range of ability to justify the correct answers was between 63.75% and 90% (see Table 1), which could be due to the nature of ChatGPT and ChatGPT's ability to access recent literature, disease management guidelines, and other related information. Kung et al., 2023 conducted a study to evaluate the performance of a large language model called ChatGPT on the United States Medical Licensing Exam (USMLE) and reported that ChatGPT demonstrated a high level of concordance and insight into its explanations [15].

Theme 3. The ability of ChatGPT to justify the noncorrect answers in the Pharmacotherapy Specialist (BCPS) exam

This study's findings show that ChatGPT could appropriately justify 76.18% of the noncorrect answers in all questions (the corrected and wrong answers). The ability of ChatGPT to justify the noncorrect answers was different from one chapter to another; ChatGPT was able to justify up to 80% or more in many chapters, such as gastrointestinal disorders, anticoagulation, Drug Information and Communication Strategies in Pharmacy, Healthcare Systems and Population Health and Study Designs: Fundamentals and Interpretation (See table 1). The range of the ability to justify the noncorrect answers was between 58.25% and 83% (see Table 1), which could be due to the nature of ChatGPT and ChatGPT's ability to access recent literature, disease management guidelines and other related information.

4. CONCLUSION

In conclusion, ChatGPT's ability to answer the Pharmacotherapy Specialist (BCPS) exam and justify the answers was good. ChatGPT could help pharmacists in their preparation for this exam with caution. ChatGPT is still in the early phase of use by educators and students worldwide, and its ability to answer exams will be better in the near future. Attending training workshops about ChatGPT and AI is very

important and highly recommended. Practice ChatGPT in medical and health sciences education is very important and highly recommended to explore the potential uses, benefits and risks and suggest recommendations for best practices.

5. MATERIALS AND METHODS

Study Design

A content analysis of the potential applications and ability of ChatGPT to answer the Pharmacotherapy Specialist (BCPS) exam and justify the answers.

Data collection & Ethical Approval

The research was conducted between 20 January 2023 and 10 February 2023 to explore the ability of ChatGPT to answer the Pharmacotherapy Specialist (BCPS) exam and justify the answers. Ethical approval for this research was obtained from the Research Ethical Committee at the College of Medical Sciences, Azal University for Human Development, located in Sana'a, Yemen (Reference: REC 3/2023).

The Updates in Therapeutics®: Pharmacotherapy Preparatory Review and Recertification Course book [15]. The book is divided into two volumes with 11 chapters in each volume. Each chapter contains self-assessment questions with the model answer and justification & explanation of the answers at the end of the chapter. Moreover, most chapters contain patient cases with the model answer and justification & explanation of the answers at the end of each chapter. The questions are multiple choice questions (MCQs) with four answers for each question, one only the most appropriate [16]. Pharmacists can take the preparatory course online, and they can take the 175 online mock exams to test their knowledge before the real exam [17].

Selection of questions

Two clinical pharmacy professors with experience teaching pharmacotherapy were asked to select questions from all chapters in volumes 1 and 2, with at least five questions from each chapter. The experts selected 128 questions from both volumes.

Using ChatGPT

The 128 questions were entered into the ChatGPT, and the first attempt was recorded for all questions.

Data Analysis

Two clinical pharmacy professors and two clinical pharmacists licenced with the BCPS certificate independently evaluated the answers by ChatGPT, compared them with the model answer and rated the ability to answer questions without justification as correct "1 mark" if the answer was correct or false "zero mark" for the wrong answer. Moreover, they rated the justification of the correct answers and false answers for each question as a percentage out of 100. The average of the expert evaluations was considered in this study. All data were entered manually into Excel and analysed.

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REFERENCES

- [1] Masters K. Artificial intelligence in medical education. *Med Teach.* 2019; 41(9):976-980. <https://doi.org/10.1080/0142159x.2019.1595557>.
- [2] Loeckx J. Blurring boundaries in education: Context and impact of MOOCs. *Int Rev Res Open Distrib Learn.* 2016; 17(3):92-121. <https://doi.org/10.19173/irrodl.v17i3.2395>.
- [3] Ahuja AS. The impact of artificial intelligence in medicine on the future role of the physician. *PeerJ.* 2019; 7:e7702. <https://doi.org/10.7717/peerj.7702>.
- [4] Bohr A, Memarzadeh K. The rise of artificial intelligence in healthcare applications. In: *Artificial Intelligence in Healthcare*; 2020. p. 25-60. Academic Press. <https://doi.org/10.1016/B978-0-12-818438-7.00002-2>.

- [5] Secinaro S, Calandra D, Secinaro A, Muthurangu V, Bilancone C. The role of artificial intelligence in healthcare: a structured literature review. *BMC Med Inform Decis Mak.* 2021; 21:1-23. <https://doi.org/10.1186/s12911-021-01488-9>.
- [6] Davenport TH, Ronanki R. Artificial intelligence for the real world. *Harv Bus Rev.* 2018;96(1):108-116. Available from: <https://hbr.org/2018/01/artificial-intelligence-for-the-real-world>. Accessed 27 December 2023.
- [7] Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJ. Artificial intelligence in radiology. *Nat Rev Cancer.* 2018;18(8):500-510. <https://doi.org/10.1038/s41568-018-0016-5>.
- [8] Roll I, Wylie R. Evolution and revolution in artificial intelligence in education. *Int J Artif Intell Educ.* 2016;26:582-599. <https://doi.org/10.1007/s40593-016-0110-3>.
- [9] McCarthy J. What is artificial intelligence. 2007. Available from: <https://cse.unl.edu/~choueiry/S09-476-876/Documents/whatisai.pdf>. Accessed 27 December 2023.
- [10] Shapiro SC. John Wiley & Sons. *Encyclopedia of Artificial Intelligence, Volume 1, Second Edition.* New Jersey: A Wiley Interscience Publication; 1992.
- [11] OPEN AI. Introducing Chat GPT. Available from: <https://openai.com/blog/chatgpt/>. Accessed 27 December 2023.
- [12] Al-Worafi YM, Hermansyah A, Tan CS, Choo CY, Bouyahya A, Paneerselvam GS, Liew KB, Goh KW, Ming LC. Applications, benefits, and risks of ChatGPT in medical and health sciences research: An experimental study. *Prog Microbes Mol Biol.* 2023;6(1):a0000337. <https://doi.org/10.36877/pmmb.a0000337>.
- [13] Wong R, Ming L, Raja Ali RA. The intersection of ChatGPT, clinical medicine, and medical education. *JMIR Med Educ.* 2023;9:e47274. <https://doi.org/10.2196/47274>.
- [14] Board of Pharmacists Specialists (BPS). About BPS. Available from: <https://www.bpsweb.org/about-bps/history/>. Accessed 27 December 2023.
- [15] Kung TH, Cheatham M, Medenilla A, Sillos C, De Leon L, Elepaño C, Madriaga M, Aggabao R, Diaz-Candido G, Maningo J, Tseng V. Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models. *PLOS Digit Health.* 2023;2(2):e0000198. <https://doi.org/10.1371/journal.pdig.0000198>
- [16] American College of Clinical Pharmacy (ACCP). The Updates in Therapeutics®: Pharmacotherapy Preparatory Review and Recertification Course. Available from: <https://www.accp.com/store/product.aspx?pc=PPC21G>. Accessed 27 December 2023.
- [17] American College of Clinical Pharmacy (ACCP). 2022 ACCP Pharmacotherapy Mock Exam online product. Available from: <https://www.accp.com/store/product.aspx?pc=MEPH22>. Accessed 27 December 2023.