

Using ChatGPT to Predict the Future of Personalized Medicine

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Abstract

Personalized medicine is a novel frontier in health care that is based on each person's unique genetic makeup. It represents an exciting opportunity to improve the future of individualized health care for all individuals. Pharmacogenomics, as the main part of personalized medicine, aims to optimize and create a more targeted treatment approach based on genetic variations in drug response. It is predicted that future treatments will be algorithm-based instead of evidence-based that will consider a patient's genetic, transcriptomic, proteomic, epigenetic, and lifestyle factors resulting in individualized medication. A generative pretrained transformer (GPT) is an artificial intelligence (AI) tool that generates language resembling human-like writing enabling users to engage in a manner that is practically identical to speaking with a human being. GPT's predictive algorithms can respond to questions that have never been addressed. Chat Generative Pretrained Transformer (ChatGPT) is an AI chatbot's advanced with conversational capabilities. In the present study, Questions were asked from ChatGPT about the future of personalized medicine and pharmacogenomics. ChatGPT predicted both to be a promising approach with a bright future that holds great promises in improving patient outcomes and transforming the field of medicine.

Introduction

Personalized medicine is a promising field in the practice of medicine that uses an individual's genetic makeup to tailor medical decisions in regard to prediction, prevention, and personalized treatment (1).

According to the National Academy of Sciences (NAS), Precision medicine is defined as "the use of genomic, epigenomic, exposure and other data to define individual patterns of disease, potentially leading to better individual treatment (2)". Thereby, treatment is tailored to the unique characteristics of each patient to correct the disease's dysfunctional molecular pathways. Terms like "personalized medicine", "precision medicine", "individualized medicine", "p4 medicine", and "stratified medicine" describe the efforts being made to tailor therapeutic strategies to individual requirements.

The goal of personalized medicine is to individualize healthcare by using knowledge of patients' omics, and health history. Genetic studies have provided more data that can be used to more accurately predict the risk of developing certain diseases and prevent the onset of disease. Nowadays, There has been a significant decrease in the cost of sequencing, due to the current novel sequencing technology, which means it is now possible to consider the technology as part of routine healthcare. Personalized medicine is overcoming the limitations of evidence-based medicine (3).

One of the most important components of personalized medicine is pharmacogenomics (pharmacogenetics). It can be used to detect different variants of genes that an individual carries and the drug responses to drugs they are given (4). The Pharmacogenomics approach can reduce the cost of care, increasing the chance of selecting more effective treatments and decreasing adverse drug reactions.

A generative pretrained transformer (GPT) is an artificial intelligence (AI) tool that creates text that seems like humanwriting, allowing customers to communicate with AI as if they were speaking with another person. Written instructions in the form of questions or commands are input into GPT which has the capacity to give out data regarding healthcare research, education, and clinical practice. This technology can assist researchers in developing study protocols, developing research questions, and summarizing results (5).

For years, scientists have speculated about how AI will change the way health care is delivered. Chat Generative Pretrained Transformer (ChatGPT), an AI-based chatbot, is a conversational language model which has been developed by OpenAI. It has gained widespread popularity on the internet (6).

The goal of ChatGPT is to use artificial intelligence and machine learning to teach computers to automatically understand human language (6, 7).

Although OpenAI has not disclosed the source of the dataset that is used to coach ChatGPT, it has been presumed that the model was trained using text databases on the internet such as books, articles, Wikipedia, and the WebText dataset (7).

Methods And Results

There was no discussion of the use or relevance of ChatGPT for pharmacogenomics and personalized or precision medicine in any article. As a result, we asked ChatGPT (<https://openai.com/>) some questions about the corresponding subjects (6).

" ChatGPT provided the following response:

1. What is the difference between precision medicine and personalized medicine?

Precision medicine and personalized medicine are often used interchangeably, but there is a subtle difference. Precision medicine refers to the use of genetic and other molecular information to tailor treatment plans to specific subgroups of patients, while personalized medicine takes into account a broader range of factors, such as lifestyle and environmental factors, in addition to genomic information, to tailor treatment plans to each individual.

2. What is the future of personalized medicine?

The future of personalized medicine is very promising. With advancements in technology, we are able to analyze large amounts of genomic data and personalize treatment plans based on an individual's unique genetic makeup, lifestyle, and environmental factors. This allows for more targeted and effective treatments, leading to better outcomes and reduced healthcare costs.

3. What is the future of precision/personalized medicine?

Precision/personalized medicine is an approach to healthcare that seeks to tailor medical treatment to individual patients based on their unique characteristics, including genetics, environment, lifestyle, and other factors. The future of precision/personalized medicine is promising, as it has the potential to transform healthcare by improving treatment outcomes, reducing adverse effects, and lowering healthcare costs.

Here are some of the potential developments and advancements in precision/personalized medicine that we may see in the future:

1. Increased use of genomic and another biomarker testing: As the cost of genetic testing continues to decrease and other biomarker testing becomes more widely available, more patients may undergo testing to help determine which treatments are most suitable for them.
2. Integration of data from multiple sources: By integrating data from different sources such as electronic health records, wearable devices, and social determinants of health, healthcare providers can obtain a more comprehensive understanding of individual patients' health and develop more targeted treatment plans.
3. Advancements in AI and machine learning: AI and machine learning technologies can analyze vast amounts of data to identify patterns and predict outcomes, making it easier for healthcare providers to develop personalized treatment plans.
4. Personalized prevention: By identifying individuals at high risk of developing certain diseases or conditions, healthcare providers can develop personalized prevention strategies, such as lifestyle modifications and targeted screening programs, to help prevent or delay the onset of disease.
5. Patient engagement: Patients can play an active role in their healthcare by providing information about their health, lifestyle, and preferences, and by participating in shared decision-making with their healthcare providers.

Overall, the future of precision/personalized medicine is bright and holds great promise for improving patient outcomes and transforming the field of medicine. As technology continues to advance, and our understanding of genetics and other factors that influence health improves, precision/personalized medicine will likely become more integrated into routine clinical care.

4. What is the economic effect of precision medicine?

The economic effect of precision medicine can be significant, as it has the potential to improve patient outcomes, reduce healthcare costs, and increase the efficiency of healthcare delivery. Here are some of the ways that precision medicine can impact the economy:

1. Improved patient outcomes: By providing targeted and personalized treatment options, precision medicine can improve patient outcomes and reduce the length of hospital stays. This can lead to increased productivity and a reduction in the economic burden of illness on patients and their families.

2. **Reduced healthcare costs:** Precision medicine can help identify patients who are at high risk of adverse health outcomes or who may not respond to standard treatments. By avoiding ineffective treatments and adverse health outcomes, healthcare costs can be reduced, and resources can be allocated more efficiently.
3. **Increased use of generic drugs:** Precision medicine can help identify patients who are likely to respond better to generic drugs, which can be significantly cheaper than brand-name drugs. This can help reduce overall healthcare costs and improve access to affordable treatments.
4. **Improved drug development:** Precision medicine can help identify drug targets more precisely, resulting in the development of more effective and targeted drugs. This can increase the efficiency of drug development and reduce the cost of bringing new drugs to market.
5. **Increased revenue for diagnostic companies:** As precision medicine becomes more widely adopted in clinical practice, there will likely be an increased demand for diagnostic testing companies that provide genetic testing services. This can lead to increased revenue for these companies and drive innovation in the field.

Overall, the economic impact of precision medicine is complex and multifaceted. While there may be upfront costs associated with implementing precision medicine into clinical practice, the potential benefits, including improved patient outcomes, reduced healthcare costs, and increased efficiency in drug development and healthcare delivery, make it a promising area for investment and innovation.

5. What is the future of pharmacogenomics?

Pharmacogenomics is a field of study that investigates the relationship between a person's genes and their response to medication. The future of pharmacogenomics is promising as it has the potential to transform medicine by improving drug safety, efficacy, and personalized treatment.

Here are some of the potential developments and advancements in pharmacogenomics that we may see in the future:

1. **Increased use of pharmacogenomic testing:** As the cost of genetic testing continues to decrease and testing becomes more widely available, more patients may undergo genetic testing to help determine which drugs are most suitable for them.
2. **Improved drug development:** Pharmacogenomic research may lead to the development of new drugs that are more effective and have fewer side effects. By identifying specific genetic mutations that are linked to particular diseases or conditions, researchers can develop drugs that target those mutations more precisely.
3. **Personalized medicine:** By using pharmacogenomic testing, doctors may be able to tailor treatment plans to individual patients based on their genetic makeup. This could lead to more effective treatments with fewer side effects.
4. **Integration with electronic health records:** The use of electronic health records could make it easier for doctors to access and use pharmacogenomic data when making treatment decisions.

5. Collaboration among researchers: As more researchers investigate pharmacogenomics, collaborations and data sharing could lead to the discovery of new insights and a better understanding of the relationship between genes and drug response.

Overall, the future of pharmacogenomics is bright and holds great promise for improving patient outcomes and transforming the field of medicine.

6. How long takes for the implementation of pharmacogenomics into clinical practice?

The implementation of pharmacogenomics into clinical practice depends on various factors such as regulatory approval, cost-effectiveness, and integration with existing healthcare systems. Here are some factors that can affect the timeline for the implementation of pharmacogenomics into clinical practice:

1. Regulatory approval: Regulatory agencies such as the US Food and Drug Administration (FDA) play a crucial role in the approval of drugs and diagnostic tests that incorporate pharmacogenomic information. The approval process can take several years, depending on the complexity of the product and the amount of data required to demonstrate safety and efficacy.
2. Cost-effectiveness: The cost-effectiveness of pharmacogenomic testing can affect its adoption in clinical practice. Insurance companies and healthcare systems need to evaluate the costs and benefits of incorporating pharmacogenomics into routine care.
3. Education and training: Healthcare providers need to be educated and trained in the use of pharmacogenomic testing to ensure that they can effectively interpret test results and make treatment decisions based on the results.
4. Integration with existing healthcare systems: The integration of pharmacogenomics into existing healthcare systems and electronic health records can be a significant challenge. It requires collaboration between healthcare providers, laboratory professionals, and information technology experts to ensure that test results are easily accessible and integrated into the clinical workflow.

Given these factors, the implementation of pharmacogenomics into clinical practice can take several years or more. However, with continued research and development, increased regulatory approval, and improved education and training, the integration of pharmacogenomics into routine clinical care will likely accelerate in the coming years.

7. What is the economic effect of pharmacogenomics?

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5. **Increased revenue for diagnostic companies:** As pharmacogenomics becomes more widely adopted in clinical practice, there will likely be an increased demand for diagnostic testing companies that provide genetic testing services. This can lead to increased revenue for these companies and drive innovation in the field.

Overall, the economic impact of pharmacogenomics is complex and multifaceted. While there may be upfront costs associated with implementing pharmacogenomic testing into clinical practice, the potential benefits, including improved patient outcomes, reduced healthcare costs, and increased efficiency in drug development, make it a promising area for investment and innovation.

8. How long takes for transition from evidence-based medicine to precision-based medicine?

The transition from evidence-based medicine to precision-based medicine is an ongoing process and can take many years, if not decades. The adoption of precision-based medicine requires significant advances in technology, as well as changes in clinical practice and healthcare policies.

Here are some of the factors that can impact the speed of the transition from evidence-based medicine to precision-based medicine:

1. **Availability of data and technology:** The adoption of precision-based medicine relies on the availability of large amounts of high-quality data, as well as advanced technology for analyzing and interpreting that data. As these technologies continue to develop and become more widely available, the adoption of precision-based medicine is likely to accelerate.
2. **Regulatory approval and reimbursement:** Precision-based medicine requires regulatory approval and reimbursement policies that are tailored to the specific needs of individual patients. As regulatory agencies and payers develop policies to support the use of precision-based medicine, its adoption is likely to increase.
3. **Education and training:** The adoption of precision-based medicine requires education and training of healthcare providers and patients. As healthcare providers become more familiar with the benefits of

precision-based medicine and the technology required to implement it, they are more likely to adopt it into their clinical practice.

4. Patient acceptance: The adoption of precision-based medicine requires patient acceptance and engagement. As patients become more familiar with the benefits of precision-based medicine and the technology required to implement it, they are more likely to request it from their healthcare providers.

Overall, the transition from evidence-based medicine to precision-based medicine is a complex and ongoing process that depends on a wide range of factors, including advances in technology, regulatory policies, education and training, and patient acceptance. While the transition may take many years, the potential benefits of precision-based medicine make it a promising area for investment and innovation.

9. What is the most powerful impact of personalized medicine?

The most powerful impact of personalized medicine is the ability to tailor treatment plans to each individual's unique needs. This can lead to more effective treatments with fewer side effects, as well as improved patient outcomes and quality of life.

10. What is the most powerful impact of precision medicine?

The most powerful impact of precision medicine is its potential to improve patient outcomes by providing personalized and targeted treatments based on an individual's genetic makeup, environment, and lifestyle. By identifying the most effective treatments for individual patients, precision medicine can reduce adverse events, improve treatment response rates, and ultimately lead to better health outcomes.

Precision medicine has the potential to transform the way healthcare is delivered, by moving away from a one-size-fits-all approach and towards a more personalized and patient-centered model of care. By leveraging the latest advances in genomics, proteomics, and other technologies, precision medicine can provide clinicians with the tools they need to make more informed treatment decisions and improve patient outcomes.

Precision medicine can also have a significant impact on the cost-effectiveness of healthcare. By avoiding unnecessary treatments and adverse events, precision medicine can reduce healthcare costs and increase the efficiency of healthcare delivery.

Overall, the most powerful impact of precision medicine is its potential to improve patient outcomes and transform the way healthcare is delivered. As precision medicine continues to evolve and become more widely adopted, its impact on healthcare is likely to continue to grow.

Conclusion

The future of personalized medicine seems very promising and depends on our knowledge of genetics to influence its integration of into routine clinical care. We can expect to implement personalized medicine in

the coming years that will help patients to better manage their condition and improve the quality of their lives. The implementation requires training, education, and regulatory approval. The discovery of new genes need more research and development in the field of pharmacogenetics. The prediction of ChatGPT about the economic impact of precision medicine and pharmacogenomics was similar and it depends on the potential benefits of precision medicine. In conclusion, the implementation of precision medicine is very critical for popularizing genomics into clinical practice and pharmacogenomics is just one element of the drive toward personalized (precision) medicine. AI will never fully replace manual review. Altogether, this is a process that affects patients' lives, therefore accuracy is very vital. However, ignoring AI entirely isn't the answer either. We need to find a way to integrate AI into processes that improve upon but do not replace, the knowledge and abilities of experts in the literature review. For ChatGPT to be incorporated into research and education, it will need to undergo extensive assessment, data variability, and quality validation by human experts of the training dataset. Therefore, the ChatGPT model's key limitations are the lack of transparency in the source of data and the accuracy of the information utilized to train the model.

Declarations

Author Contributions

GP participated in the supervision of the study design and validation. NS participated in the visualization and investigation. BS participated in the writing and reviewed and edited the manuscript. BL provided insightful comments. MH conceptualized and wrote the first draft of the manuscript.

Competing Interests

The authors declare no competing interests.

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