

Review

The Impact of Artificial Intelligence on Personalized Medicine

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Khansari N. The impact of artificial intelligence on personalized medicine. *Vaccin Res Open J.* 2024; 7(1) 1-12. doi: [10.17140/VROJ-7-119](https://doi.org/10.17140/VROJ-7-119)**ABSTRACT**

Artificial intelligence (AI) has the potential to revolutionize personalized medicine by enabling more accurate and efficient diagnoses, treatment selection, and disease prediction, for instance, cancer, diabetes, and many genetic defects. AI algorithms can analyze large amounts of patient data, including genomic data, medical history, and lifestyle factors, to identify patterns and predict disease risk, treatment effectiveness, and potential adverse reactions. AI can also support the development of personalized treatment plans based on the unique characteristics of each patient, such as their genetic makeup, disease stage, and health history. This approach, known as precision medicine, can significantly improve patient outcomes and reduce healthcare costs by focusing on the most effective treatments for each individual. Moreover, AI-powered tools can help clinicians identify patients at high risk of developing a particular disease and intervene early to prevent or delay its onset. This can be particularly crucial for chronic diseases like diabetes and heart disease, which can be managed more effectively with early intervention. Furthermore, AI can significantly improve research efficiency and outcomes in personalized medicine by enhancing patient stratification during clinical trials. By leveraging AI-driven algorithms, researchers can identify and group patients based on various factors, such as genetic profiles, disease characteristics, and treatment responsiveness. It should be noted that the impact of AI on personalized medicine is still being explored, and there are many opportunities for this technology to transform healthcare in the coming years. However, it is crucial to ensure that AI is used ethically and responsibly to respect patient privacy and guarantee the accuracy and reliability of the data being analyzed. This review article explores the various ways AI can impact personalized medicine.

Keywords

Artificial intelligence (AI); Personalized medicine; Diagnosis; Cancer; Genetic defects.

INTRODUCTION

Artificial intelligence (AI) algorithms with remarkable accuracy are increasingly used to analyze medical data, such as medical images, genomic information, and electronic health records. These AI-driven tools have demonstrated their potential to outperform human experts in several diagnostic tasks. Machine learning algorithms and intense learning approaches have successfully interpreted medical images like X-rays, computed tomography (CT) scans, and magnetic resonance imagings (MRIs). AI can quickly analyze large volumes of imaging data, identifying patterns and abnormalities that human eyes may find difficult to detect. For example, AI systems have been shown to reduce false positives and negatives in lung cancer diagnosis, leading to more accurate detection of cancerous nodules in the early stages.¹

Similarly, AI-powered tools have demonstrated exceptional performance in diagnosing diabetic retinopathy, skin cancer, and breast cancer, among other conditions. AI has also played a significant role in genomic analysis, contributing to a better understanding of the genetic basis of various diseases. By analyzing large datasets of gene information, machine-learning algorithms can identify patterns and associations that human experts might miss. This enhanced understanding of the genetic underpinnings of diseases can lead to more accurate diagnoses and personalized treatment plans.²

In addition to improving diagnostic accuracy, AI can significantly enhance the efficiency of the diagnostic process. The ability of AI-powered tools to rapidly analyze vast amounts of data allows healthcare professionals to reach a diagnosis much faster than traditional methods. Diagnostic delays can have serious

consequences, particularly for patients with life-threatening conditions. AI-driven diagnostic tools can help eliminate these delays by automating medical data analysis and promptly providing healthcare professionals with accurate, actionable insights. As a result, patients can receive appropriate treatment earlier, potentially improving their prognosis and quality of life.³

THE IMPACT OF AI IN ENHANCING CLINICAL LABORATORY TESTING

AI has revolutionized various industries, and healthcare is no exception. Clinical laboratory testing is one of the most significant areas of AI application in healthcare. By leveraging advanced algorithms and machine learning techniques, AI can enhance the accuracy, efficiency, and quality of laboratory testing. In recent years, clinical laboratories have experienced a growing demand for rapid and accurate diagnostic testing. This increased workload has led to more efficient methods of processing and analyzing vast amounts of data generated by these tests. Integrating AI into laboratory workflows can address this challenge, as it allows the automation of repetitive tasks and enhances decision-making processes through data-driven insights.^{4,5}

Furthermore, genomics, proteomics, and metabolomics advancements have contributed to an exponential rise in complex biological data. The sheer volume of information generated requires sophisticated tools capable of extracting meaningful patterns to aid disease diagnosis and treatment planning. AI's ability to process and analyze large datasets makes it an invaluable asset in this context.⁶

AI in Mental Health Diagnosis

The potential of AI extends beyond physical health conditions, as it can also play a transformative role in diagnosing and treating mental health disorders. By leveraging AI-driven tools, healthcare professionals can gain deeper insights into patients' mental health conditions and provide more personalized treatment plans. AI algorithms can analyze large datasets of behavioral information, such as social media activity, speech patterns, and facial expressions, to identify subtle signs of mental health issues. This early detection can lead to timely interventions and prevent the escalation of symptoms in at-risk individuals. In addition, AI-powered tools can complement traditional diagnostic methods used by mental health professionals, such as clinical interviews and self-report questionnaires. Integrating AI-driven analysis with human expertise allows a more comprehensive understanding of a patient's condition, leading to more accurate diagnoses and targeted treatments.^{7,8}

Cost-Effectiveness of AI-Driven Diagnostic Tools

Implementing AI-driven diagnostic tools in healthcare systems benefits patients and healthcare providers. The efficiency and accuracy offered by these tools can lead to significant cost savings in various aspects of healthcare delivery.

Reduced Hospital Admissions and Length of Stay

By enabling faster and more accurate diagnoses, AI-driven tools can help reduce unnecessary hospital admissions and shorten the length of stay for patients who require inpatient care. This results in decreased costs associated with hospitalization, including bed occupancy, medical staff time, and resource utilization.⁹

Prevention of Misdiagnosis

Misdiagnoses can lead to costly treatments that may not be effective or even harmful to patients. By improving diagnostic accuracy, AI-powered tools can minimize misdiagnoses and ensure patients receive appropriate care while reducing expenditures on ineffective treatments.¹⁰

Enhanced Resource Allocation

AI-driven diagnostic tools enable healthcare providers to use their resources better by automating repetitive tasks and streamlining workflows. This increased efficiency allows medical professionals to focus on higher-value activities and provide better care for more patients without compromising quality. Consequently, this improved resource allocation leads to cost savings for healthcare systems.

Long-Term Savings Through Early Detection

Early detection and intervention are crucial for managing many health conditions effectively. AI-powered diagnostics can identify diseases at earlier stages when treatment is generally less expensive and more successful. As a result, healthcare systems can achieve long-term cost savings by preventing more extensive interventions or ongoing management of chronic conditions.

However, it is essential to consider the initial investments required for implementing AI-driven diagnostic tools within healthcare systems. These costs may include purchasing necessary hardware, software development or licensing fees, system integration efforts, staff training, and ongoing maintenance expenses. While these upfront costs may be substantial, the potential long-term benefits achieved through improved patient outcomes and cost savings can outweigh the initial investment, making AI-driven diagnostics a worthwhile and cost-effective addition to healthcare systems.

ADVANCEMENTS IN PERSONALIZED THERAPY REGIMENS

Artificial intelligence has revolutionized various industries, and healthcare is no exception. In recent years, AI has played a significant role in developing personalized therapy regimens, leading to more effective and tailored treatments for patients. By analyzing vast amounts of data, AI algorithms can identify patterns and correlations previously unattainable by human analysis alone. This has led to several critical advancements in personalized therapy¹¹:

It is improving diagnostics and patient stratification. AI algorithms can analyze complex medical data, such as genetic infor-

mation and medical imaging, to accurately diagnose diseases and categorize patients into specific subgroups. This enables healthcare professionals to develop targeted treatment plans for each patient, increasing the likelihood of success.

Prediction of treatment response. AI can analyze data from past clinical trials and patient records to predict how a patient will respond to a particular treatment. This information can be used to identify the most effective therapy for each patient, minimizing side effects and improving overall outcomes.

Drug discovery and development. AI can expedite the drug discovery process by identifying potential drug candidates and predicting their effectiveness in targeting specific diseases. This accelerates the development of personalized therapies and reduces the time and cost associated with traditional drug discovery methods.¹²

Real-time Monitoring and Adjustment

AI-powered devices and wearables have emerged as valuable tools for tracking patient progress and making real-time adjustments to treatment plans. These devices provide healthcare professionals with a comprehensive understanding of a patient's condition by continuously collecting data on vital signs, physical activity, and other relevant health metrics. This enables them to make informed decisions about necessary modifications to therapy regimens, ensuring that treatments remain effective and responsive to the patient's needs. Moreover, AI algorithms can automatically analyze the collected data to detect patterns or trends that may indicate the need for intervention. This proactive approach allows healthcare providers to address potential issues before they escalate, ultimately improving patient outcomes and satisfaction with their personalized therapy experience.¹³

Enhanced Patient Engagement

AI-driven platforms can significantly improve patient engagement by providing personalized recommendations and support tailored to each individual's needs. These platforms can analyze patient data, such as health history and treatment plans, to deliver targeted advice on lifestyle changes, medication adherence, and self-monitoring techniques. By fostering better communication between patients and healthcare providers, AI-powered tools empower patients to take a more active role in managing their health. Additionally, these AI-driven platforms can be integrated with mobile applications and wearable devices, enabling real-time monitoring of patient progress and seamless access to relevant information. This facilitates increased transparency in the treatment process and encourages patients to stay informed about their care. As a result, patients become more invested in their therapy regimens, leading to improved adherence and, ultimately, better outcomes.

Optimization of Treatment Combinations

AI algorithms can analyze vast amounts of data from various sources, such as clinical trials, patient records, and genomic information. This enables them to identify optimal combinations of therapies tailored to individual patients. AI can determine the

most effective and safest treatment regimens by considering drug interactions, potential side effects, and patient-specific characteristics. Furthermore, AI's capacity for continuous learning allows it to refine its recommendations as new data becomes available or a patient's condition evolves. This iterative approach ensures that personalized therapy plans remain up-to-date and responsive to each patient's unique needs, ultimately increasing the chances of successful outcomes and improving healthcare quality.¹⁴

Identification of Novel Biomarkers

AI's ability to process and analyze large-scale datasets has opened up new possibilities in identifying novel biomarkers. These biomarkers, which can include genes, proteins, or other molecular indicators, play a critical role in early disease detection, prognosis prediction, and personalization of treatments. AI algorithms can uncover previously unrecognized patterns and correlations between specific biomarkers and various diseases or treatment responses by sifting through vast data from sources like genomic sequencing and proteomics. The discovery of new biomarkers enhances our understanding of disease mechanisms and provides valuable targets for developing personalized therapies. As more targeted treatments become available, healthcare professionals can use these novel biomarkers to stratify patients more accurately and select the most appropriate treatment for each individual. AI-driven identification of novel biomarkers can significantly improve patient outcomes by enabling earlier interventions and tailoring treatments based on each patient's unique biological characteristics.

Reducing Healthcare Disparities

AI's ability to analyze large and diverse datasets enables it to identify patterns and trends across various populations, shedding light on healthcare disparities that may have gone unnoticed. By uncovering these differences, AI can drive the development of more inclusive personalized therapies that cater to the specific needs of underrepresented groups. Furthermore, AI can help address healthcare inequalities by optimizing resource allocation and guiding targeted interventions in areas with higher disease prevalence or limited access to care. Healthcare providers can proactively develop tailored prevention strategies and allocate resources effectively by identifying communities at a higher risk for certain conditions. Ultimately, AI's potential to reduce healthcare disparities lies in its ability to promote equity in personalized therapy regimens. By ensuring that all patients receive care tailored to their unique needs, regardless of their background or socioeconomic status, AI can improve health outcomes across diverse populations significantly.

Cost-Effectiveness Analysis in Personalized Therapy

AI-powered algorithms can evaluate the cost-effectiveness of various treatment options, considering factors such as drug pricing, duration of therapy, and potential side effects. By comparing the costs and benefits of different treatments, AI can help healthcare providers make informed decisions regarding resource allocation while maximizing patient outcomes. In addition to informing treatment selection, AI-driven cost-effectiveness analysis can

identify potential savings areas within personalized therapy regimens. This may include optimizing dosage schedules or identifying more affordable alternatives to expensive medications without compromising treatment efficacy. Ultimately, this approach improves patient care and reduces financial burdens on patients and healthcare systems, making personalized therapy more accessible and sustainable in the long-term.¹⁵

Treatment Selection and Optimization

AI algorithms can analyze a vast array of patient data, including medical history, genetic information, and lifestyle factors, to recommend the most appropriate treatment options for each patient. For example, AI can help oncologists determine the best course of treatment for cancer patients by analyzing the tumor's genetic profile and identifying the most effective therapies. Additionally, AI can monitor patient responses to treatment in real time, which can help healthcare professionals adjust treatment plans as needed to optimize patient outcomes.

Remote Monitoring and Telemedicine

AI can improve personalized medicine by enabling remote monitoring of patients and delivering healthcare services through telemedicine. Wearable devices and mobile apps can collect and analyze patient data, such as heart rate, blood pressure, and glucose levels. AI algorithms can then use this data to detect potential health issues, provide personalized health recommendations, and alert healthcare professionals if intervention is needed. AI-powered telemedicine platforms can also improve access to personalized care by connecting patients with healthcare professionals regardless of their geographic location. This can be beneficial for individuals living in rural or underserved areas with limited access to healthcare services.

PREDICTIVE ANALYTICS: PERSONALIZED PREVENTION STRATEGIES

Artificial intelligence can play a significant role in early identification of disease risk factors by utilizing predictive analytics. These advanced algorithms can analyze vast amounts of data from diverse sources to detect patterns and correlations indicating an individual's susceptibility to specific health conditions. By identifying these risk factors early, AI-driven solutions can support the development of personalized prevention strategies tailored to each person's unique needs.¹⁶

Comprehensive Risk Profiling

AI-powered predictive analytics can generate complete risk profiles for individuals by considering various factors, such as genetics, lifestyle habits, environmental exposures, and social determinants of health. By integrating this information into a holistic assessment, healthcare providers can gain valuable insights into potential vulnerabilities that warrant attention or intervention.^{17,18}

Targeted Preventive Measures

With a better understanding of individual risk factors, healthcare

professionals can design preventive measures to mitigate disease risks before they manifest into more severe conditions. These personalized strategies may include lifestyle modifications, such as dietary changes or increased physical activity; pharmacological interventions, like prescribing medications or supplements; and behavioral supports, such as stress management techniques or smoking cessation programs.¹⁹

AI IN PREDICTION AND PREVENTING ADVERSE DRUG REACTIONS

Artificial intelligence can play a crucial role in predicting and preventing potential adverse drug reactions (ADRs), which are unintended and harmful effects due to medication use. ADRs are a significant concern in healthcare, as they can lead to increased morbidity, hospitalization, and even mortality.²⁰

Identifying Drug-Drug Interaction

AI can help minimize ADRs by identifying potential drug-drug interactions (DDIs); as patients may simultaneously be on multiple medications, the risk of DDIs increases, potentially leading to ADRs. AI algorithms can analyze large datasets of drug information and patient and patient data to predict possible DDIs before they occur. This allows healthcare professionals to adjust medication regimens proactively, minimizing the risk of harmful interactions and associated ADRs.²¹

Personalized Dosing Recommendations

AI can also contribute to preventing ADRs by providing dosing recommendations based on individual patient factors, such as age, weight, renal function, liver function, and genetic makeup. By considering these variables, AI algorithms can help healthcare professionals determine the most appropriate dosage for each patient while reducing the likelihood of overdosing or suboptimal treatment.

Pharmacogenomics and Tailored Therapy

Pharmacogenomics is an emerging field that studies how an individual's genetic makeup influences drug response. AI can analyze genomic data to identify specific gene variants associated with increased susceptibility to ADRs or altered drug metabolism. With this information, healthcare professionals can tailor therapy by choosing alternative medications or adjusting dosages according to each patient's genetic profile. This personalized approach helps prevent potential ADRs and ensures optimal outcomes.

Real-time Monitoring for Early Detection

AI-powered wearable devices and mobile apps can monitor a patient's physiological parameters during medication use. These tools can detect early signs of ADRs, such as abnormal heart rate or blood pressure changes, and alert healthcare professionals or patients to take appropriate action. Early detection and intervention can prevent the escalation of ADRs and help maintain patient safety.

In conclusion, AI's ability to predict and prevent adverse drug reactions has significant potential for enhancing personalized medicine. By identifying drug-drug interactions, providing personalized dosing recommendations, incorporating pharmacogenomic data into treatment decisions, and enabling real-time monitoring for early detection of ADRs, AI can improve patient outcomes while reducing the burden of medication-related complications in healthcare.

INTEGRATION WITH ELECTRONIC HEALTH RECORDS

AI can streamline access and analysis of patient data from electronic health records (EHRs), significantly enhancing the efficiency of developing personalized therapies. By seamlessly integrating with EHR systems, AI algorithms can quickly gather relevant patient information, such as medical history, demographics, and genetic data. This comprehensive view of a patient's health enables healthcare professionals to understand individual needs better and make informed decisions regarding treatment plans. Furthermore, AI-powered EHR analysis can identify potential gaps in care or opportunities for intervention, ensuring that each patient receives optimal care tailored to their unique circumstances.²²

Streamlined Patient Data Management

Integrating AI with electronic health records (EHRs) can significantly improve patient data management, leading to more personalized and efficient healthcare. By analyzing and extracting valuable insights from the vast amounts of structured and unstructured data within EHRs, AI algorithms can identify trends, patterns, and correlations that may be difficult for healthcare professionals to discern manually.

Predictive Analytics for Early Intervention

AI-powered analysis of EHRs can also enable predictive analytics, allowing healthcare providers to identify at-risk patients before the onset of severe symptoms or complications. By proactively detecting potential health issues based on a patient's medical history, genetic information, and lifestyle factors, healthcare professionals can intervene early and implement personalized preventive measures tailored to each individual's needs.²³

Enhanced Decision Support Systems

Incorporating AI into EHR systems can lead to the development of more advanced clinical decision-support tools. These tools help healthcare providers make informed decisions regarding diagnosis, treatment options, and care management by providing real-time recommendations based on comprehensive patient data analysis. This results in a more accurate and personalized approach to patient care while reducing the likelihood of medical errors.

Improved Care Coordination

AI-driven EHR systems can facilitate better care coordination among healthcare professionals involved in a patient's care journey. By automatically sharing relevant information across different

specialties and care settings, AI-enabled EHRs ensure that all care team members can access up-to-date patient information. This promotes seamless communication between providers and enables them to collaborate effectively in devising personalized treatment plans that consider all aspects of a patient's health.

In summary, integrating AI with electronic health records holds significant promise for enhancing personalized medicine by streamlining patient data management, enabling predictive analytics for early intervention, improving clinical decision support systems, and facilitating better care coordination among healthcare professionals. Adopting such technology will ultimately contribute to more efficient and tailored healthcare delivery while ensuring that each patient's needs are adequately addressed.

AI-DRIVEN VIRTUAL HEALTH ASSISTANTS FOR PATIENT ENGAGEMENT AND ADHERENCE

AI-driven virtual health assistants (VHAs) can play a pivotal role in enhancing patient engagement and promoting adherence to treatment plans. These intelligent conversational agents can communicate with patients through text or voice, providing personalized support, education, and guidance throughout their healthcare journey.

Personalized Health Coaching

Virtual health assistants can offer tailored health coaching based on individual patient needs and preferences. By analyzing patient data, such as medical history, lifestyle habits, and treatment plans, VHAs can provide customized advice on nutrition, exercise, stress management, medication adherence, and more. This personalized approach empowers patients to actively manage their health while fostering a better understanding of their condition and treatment.²⁴

Medication Reminders and Monitoring

One of the critical challenges in healthcare is ensuring that patients adhere to prescribed medication regimens. AI-driven VHAs can provide timely reminders for medication intake, helping patients maintain consistent dosing schedules. Additionally, they can monitor side effects or potential adverse drug reactions by asking relevant questions and recording patient feedback. This real-time monitoring enables early detection of issues that may require intervention from healthcare professionals.

Emotional Support and Empathy

AI-powered virtual health assistants can offer emotional support by engaging in empathetic conversations with patients experiencing anxiety or stress related to their medical condition. While not a substitute for professional mental health care services, these interactions can provide reassurance and comfort during challenging times.²⁵

Seamless Integration with Healthcare Teams

Virtual health assistants can integrate with existing healthcare teams

by sharing relevant patient information with providers as needed. This ensures that healthcare professionals stay informed about their patient's progress outside clinical settings while allowing them to intervene when necessary.

AI-DRIVEN RESOURCE ALLOCATION FOR COST REDUCTION

Artificial intelligence can significantly impact healthcare costs by optimizing resource allocation, leading to more efficient and cost-effective care delivery. By analyzing large datasets and identifying patterns, AI algorithms can help healthcare organizations make informed resource distribution and utilization decisions.

Predictive Analytics for Resource Planning

AI-powered predictive analytics can help healthcare providers forecast patient demand, enabling them to allocate resources more effectively. Hospitals and clinics can optimize staffing levels, bed availability, and equipment usage by predicting patient influx based on historical data, seasonal trends, and other relevant factors. This proactive approach minimizes wasted resources and reduces operational costs associated with underutilized or overburdened facilities.²⁶

Optimizing Treatment Strategies

AI algorithms can analyze treatment outcomes across diverse patient populations to identify cost-effective care strategies. By comparing the effectiveness, side effects, and costs of various treatment options, AI can help healthcare professionals select the most appropriate therapies that deliver optimal results at lower expenses. This leads to better patient outcomes and reduces healthcare spending.²⁷

Streamlining Administrative Processes

Inefficient administrative processes often contribute significantly to rising healthcare costs. AI-driven automation of appointment scheduling, billing, insurance claims processing, and medical coding can result in substantial time savings for healthcare professionals. This allows them to focus on direct patient care while reducing overhead expenses associated with manual administrative work.

Identifying High-Risk Patients for Early Intervention

AI's ability to analyze vast amounts of data enables identifying high-risk patients who may require costly interventions if left untreated. By targeting these individuals for early intervention through personalized preventive measures or tailored treatment plans, healthcare providers can avoid expensive hospitalizations or complications down the line.²⁸

In summary, artificial intelligence can reduce healthcare costs through more efficient resource allocation. By leveraging predictive analytics for resource planning, optimizing treatment strategies based on cost-effectiveness analysis, streamlining administrative processes, and identifying high-risk patients for

early intervention, AI can contribute to a more sustainable and affordable healthcare system.

FOSTERING COLLABORATION FOR SAFE AND EFFECTIVE AI IMPLEMENTATION

To ensure the safe and effective use of AI technology in personalized medicine, it is essential to foster collaboration between AI developers, healthcare professionals, and regulatory bodies. This collaborative approach can help address potential challenges associated with the integration of AI in healthcare while maximizing its benefits.

Establishing Standards and Guidelines

Working together, AI developers, healthcare professionals, and regulatory bodies can set standards and guidelines that govern the development, testing, validation, and deployment of AI systems in personalized medicine. These guidelines should emphasize transparency, explainability, fairness, and accountability to ensure that AI algorithms are designed ethically and responsibly.

Sharing Knowledge and Expertise

Collaboration between these stakeholders allows sharing of knowledge and expertise from diverse perspectives. Healthcare professionals can provide valuable insights into patient needs, clinical workflows, and real-world challenges providers face when implementing new technologies. AI developers can bring their technical expertise to design solutions that effectively address these issues while adhering to established ethical principles.

Continuous Evaluation and Improvement

By working closely with healthcare professionals who use AI-driven tools in clinical settings, AI developers can receive regular feedback on system performance. This enables them to continuously iterate on their designs, improving accuracy and functionality based on real-world experiences. Regulatory bodies play a crucial role in overseeing this process by setting benchmarks for performance evaluation while ensuring compliance with relevant laws and regulations.

Training Healthcare Professionals

Collaboration between AI developers and healthcare professionals is vital during the development phase and in training providers on using these new tools effectively. Joint efforts should be made to create comprehensive training programs that equip healthcare professionals with the necessary skills to leverage AI-powered solutions confidently while understanding their limitations.²⁹

Explainable AI Models for Enhanced Transparency and Trust

Developing solvable AI models is essential for increasing transparency and trust in the decision-making process within personalized medicine. While AI algorithms can make accurate

predictions and recommendations, their complex nature often makes it difficult for healthcare professionals to understand the reasoning behind these decisions. This lack of transparency can lead to skepticism and reluctance among providers to adopt AI-driven tools in clinical practice.³⁰

Continuous Education and Training for Healthcare Professionals

To fully harness the potential of AI in personalized medicine, it is essential to prioritize continuous education and training for healthcare professionals on the latest advancements in AI technology and its applications. This ensures that providers stay up-to-date with current innovations and can effectively integrate AI-driven tools into their clinical practice.³¹

Regular Workshops and Seminars

One approach to facilitating continuous learning is to organize regular workshops and seminars focusing on emerging AI-powered personalized medicine trends. These events can provide healthcare professionals with opportunities to learn from experts in the field, engage in hands-on training sessions, and discuss real-world case studies that illustrate the practical implementation of AI-driven solutions.

Online Learning Platforms

Leveraging online learning platforms is another effective way to support ongoing education for healthcare professionals. By offering various courses, webinars, and interactive modules tailored to different skill levels, these platforms allow providers to expand their knowledge at their own pace while accommodating busy schedules.

Interdisciplinary Collaboration

Promoting interdisciplinary collaboration between healthcare professionals, AI developers, data scientists, and other relevant stakeholders can foster shared learning experiences. Through collaborative projects or research initiatives, participants can exchange ideas, insights, and expertise across disciplines while understanding how AI can be applied effectively within personalized medicine.

Institutional Support for Professional Development

Healthcare organizations are crucial in encouraging continuous education and training by providing institutional support for professional development. This includes allocating resources, such as time off or financial assistance, for attending conferences or enrolling in courses focused on AI-driven personalized medicine. By fostering a culture of lifelong learning within their institutions, healthcare organizations can ensure that their staff remains well-equipped to adopt new technologies as they emerge.

INTRODUCTION TO PHYSICIAN-MACHINE COLLABORATION

Physician-machine collaboration has the potential to revolutionize

the healthcare industry by combining the expertise of medical professionals with the analytical capabilities of AI and machine learning (ML) technologies. This synergy can lead to more accurate diagnoses, personalized treatment plans, and improved patient outcomes. As AI and ML continue to advance, physicians must stay informed about these emerging technologies and understand how to integrate them into their practice effectively.³²

Interpretable Machine Learning Algorithms: One approach to enhancing explainability is to design interpretable machine learning algorithms that allow healthcare professionals to examine the factors contributing to a specific prediction or recommendation. These algorithms provide insights into the relationships between input features, such as patient demographics, medical history, and genetic information, and the output generated by the AI system. Healthcare providers can better assess its reliability and relevance in a clinical context by understanding how various factors influence AI decision-making. Incorporating human feedback into AI models' decision-making processes helps ensure they align with expert knowledge and ethical considerations. By allowing healthcare professionals to contribute their expertise and actively override AI-generated recommendations when necessary, a collaborative human-AI decision-making framework promotes trust in technology while maintaining the essential role of providers in patient care.³³

ADDRESSING THE DIGITAL DIVIDE FOR EQUITABLE ACCESS TO AI-POWERED PERSONALIZED MEDICINE

Addressing the digital divide across different socioeconomic groups is essential to harness the potential of AI-powered personalized medicine. The digital divide refers to unequal access to technology, internet connectivity, and digital literacy, which can hinder specific populations from fully benefiting from AI-driven healthcare advancements.³⁴

Expanding Infrastructure and Connectivity

One of the primary steps in bridging the digital divide is increasing infrastructure and connectivity in underserved areas. By investing in high-speed internet access and affordable devices, governments and private organizations can ensure that individuals from diverse backgrounds have equal opportunities to benefit from AI-enabled healthcare services, such as telemedicine consultations, remote monitoring, and virtual health coaching.

Promoting Digital Literacy

Enhancing digital literacy among various population segments is crucial to enabling equitable access to AI-powered personalized medicine. Educational initiatives should be implemented at community levels to teach essential digital skills, such as navigating online resources, understanding privacy settings, and effectively using healthcare applications. These efforts can empower individuals with the necessary knowledge and confidence to make informed decisions about their health while leveraging AI-driven tools.³⁵

Culturally Sensitive AI Systems

Enhancing digital literacy among various population segments is crucial to enabling equitable access to AI-powered personalized medicine. Educational initiatives should be implemented at community levels to teach essential digital skills, such as navigating online resources, understanding privacy settings, and effectively using healthcare applications. These efforts can empower individuals with the necessary knowledge and confidence to make informed decisions about their health while leveraging AI-driven tools. Enhancing digital literacy among various population segments is crucial to enabling equitable access to AI-powered personalized medicine. Educational initiatives should be implemented at community levels to teach essential digital skills, such as navigating online resources, understanding privacy settings, and effectively using healthcare applications. These efforts can empower individuals with the necessary knowledge and confidence to make informed decisions about their health while leveraging AI-driven tools.³⁶

Affordable Access to Advanced Care Technologies

Addressing economic barriers is vital for promoting equitable access to AI-driven personalized medicine. Governments should work closely with insurance providers and healthcare organizations to create affordable pricing structures for advanced care technologies, making them accessible regardless of a patient's financial status. Additionally, public-private partnerships can help subsidize costs associated with AI-driven care delivery, ensuring personalized medicine benefits all segments of society.

ASSESSING THE LONG-TERM IMPACT OF AI ON DOCTOR-PATIENT RELATIONSHIP AND COMMUNICATION DYNAMICS IN PERSONALIZED MEDICINE

Strengthening Trust and Empathy

Integrating artificial intelligence into personalized medicine can strengthen trust and empathy between doctors and patients. By providing evidence-based insights and recommendations, AI-driven tools can help healthcare professionals make more informed decisions, leading to better patient outcomes. Patients may, therefore, develop greater confidence in their providers' abilities, fostering trust and enhancing the overall doctor-patient relationship.³⁷

Balancing Technological Reliance with Human Interaction

While AI-powered solutions can significantly support clinical decision-making processes, it is crucial for healthcare professionals not to overly rely on these tools at the expense of human interaction. Maintaining open communication channels, actively listening to patient's concerns, and involving them in shared decision-making are essential to preserving the human touch in personalized medicine. Striking a balance between technological reliance and interpersonal connection is critical to optimal patient care.³⁸

Encouraging Patient Engagement through AI-Enhanced Education

Artificial intelligence can also improve patient education by offering tailored resources that address individual needs and preferences. By facilitating personalized information about their health conditions or treatment options, AI-enhanced educational materials can empower patients to manage their well-being actively. This increased engagement may lead to more productive conversations with healthcare providers as patients become better equipped to ask informed questions or express their concerns.³⁹

Navigating Privacy Concerns and Ethical Considerations

As AI-driven solutions advance within personalized medicine, privacy concerns and ethical considerations surrounding data sharing must be addressed. Open dialogue between doctors and patients regarding how AI algorithms use personal health information is vital for maintaining trust within the doctor-patient relationship. Healthcare professionals should ensure transparency about potential risks associated with data sharing while emphasizing the benefits of using such technology for improving patient outcomes.³¹

Decisions

As personalized medicine continues to gain momentum, it is essential to address the ethical concerns arising from using genetic information in treatment decisions. While this approach holds great promise for improving patient outcomes, it also raises questions about privacy, confidentiality, and potential discrimination based on genetic predispositions.⁴⁰

Privacy and Confidentiality

The collection and storage of genetic data pose significant challenges in ensuring the privacy and confidentiality of sensitive information. As healthcare providers increasingly rely on genomic testing to inform treatment decisions, there is a growing need for robust safeguards to protect individuals' genetic data from unauthorized access or misuse. Moreover, given the familial nature of genetic information, privacy concerns extend beyond individual patients to their relatives who may share similar genetic traits. Various legislative measures have been implemented globally to protect patient privacy in response to these concerns. For example, the Genetic Information Non-discrimination Act (GINA) in the United States prohibits health insurers and employers from discriminating against individuals based on their genetic information. However, continued vigilance is necessary as technology advances and new privacy threats emerge.⁴¹

Informed Consent

Informed consent plays a crucial role in addressing ethical issues related to personalized medicine. Patients must fully understand the implications of genomic testing before consenting to participate. This includes potential risks associated with revealing predispositions for specific diseases or conditions and possible

psychological impacts resulting from such knowledge. Healthcare providers are responsible for ensuring that patients are adequately informed about the benefits and limitations of personalized medicine before making treatment decisions based on their genetic profile. This includes discussing potential alternatives and addressing misconceptions during decision-making.⁴²

Genetic Discrimination

Genetic information in treatment decisions raises concerns about potential discrimination based on an individual's predisposition for certain diseases or conditions. For instance, insurance companies might charge higher premiums or deny coverage altogether based on a person's genetic risk for a particular condition. Employers might also discriminate against job applicants or employees with specific genetic traits, fearing higher healthcare costs or perceived limitations in work performance. To mitigate these concerns, it is crucial to implement comprehensive anti-discrimination policies that protect individuals from being unfairly targeted based on their genetic information. Public awareness campaigns can also help educate society about the potential misuse of genetic data and promote the responsible use of such information in healthcare settings.

REAL-WORLD EXAMPLES AND CASE STUDIES OF AI IN PERSONALIZED THERAPY REGIMENS

Example 1: Oncology and Precision Medicine

A notable example of AI's successful implementation in personalized therapy is using IBM Watson for Genomics. This AI-driven platform helps oncologists identify cancer-causing mutations and select the most appropriate targeted therapies for individual patients. By analyzing vast amounts of genomic data, Watson for Genomics has helped healthcare providers make more informed treatment decisions, ultimately improving patient outcomes.⁴³

Example 2: Diabetes Management

Another real-world example can be found in diabetes management, where AI-powered platforms like Glooko and Diabnext have revolutionized personalized care. These applications use machine learning algorithms to analyze data from continuous glucose monitors (CGMs), insulin pumps, and other connected devices. Based on this analysis, they provide personalized recommendations for blood sugar control, lifestyle modifications, and medication adjustments that cater to each patient's unique needs.⁴⁴

Example 3: Mental Health Treatment

AI has also made significant strides in mental health treatment personalization through platforms like Woebot, an AI-driven chatbot designed to provide cognitive-behavioral therapy (CBT) interventions. Woebot assesses users' emotional states through natural language processing (NLP) techniques and delivers tailored therapeutic content based on their responses. By offering personalized support at scale, Woebot has demonstrated promising results in reducing symptoms of anxiety and depression among its

users.⁴⁵

Case Study: Parkinson's Disease Research Collaboration

In a groundbreaking collaboration between Intel Corporation and the Michael J. Fox Foundation for Parkinson's Research (MJFF), researchers used AI technology to analyze wearable device data from Parkinson's patients. The goal was to identify patterns that could lead to more effective treatment personalization. The team successfully identified specific motor symptoms related to disease progression through machine learning algorithms, enabling them to develop tailored therapeutic strategies for individual patients.^{46,47}

CONCLUSION

These real-world examples and case studies demonstrate the potential of AI-driven personalized therapy regimens to transform patient care across various medical domains. By leveraging AI technology, healthcare providers can offer more precise and tailored treatment options that improve patient outcomes and quality of life. In conclusion, integrating AI in personalized therapy regimens has immense potential for revolutionizing healthcare across various medical domains. AI-driven personalized therapies can significantly improve patient outcomes and healthcare efficiency by enabling patient stratification, predicting responses to novel treatments, facilitating remote monitoring and telemedicine, optimizing cost-effectiveness, and fostering interdisciplinary collaboration. However, to fully realize the benefits of AI in personalized therapy, it is essential to address ethical considerations and potential biases and ensure responsible implementation. Ultimately, the successful adoption of AI-based personalized therapies will depend on the collaborative efforts of healthcare providers, data scientists, ethicists, and policymakers to create an equitable, transparent, and patient-centered healthcare ecosystem. As the adoption of AI-driven personalized therapies grows, it is essential to periodically evaluate and assess their real-world impact on patient care and healthcare systems. This can be achieved by establishing robust monitoring and evaluation frameworks that track key performance indicators, such as treatment efficacy, patient satisfaction, cost savings, and overall healthcare efficiency. By systematically collecting and analyzing data on the performance of AI-driven personalized therapies, healthcare providers can identify areas for improvement, refine existing algorithms, and develop new AI-driven solutions that further enhance patient care.

Additionally, the continuous evaluation of AI-driven personalized therapies will contribute to developing best practices and guidelines, ensuring that the benefits of these transformative technologies are maximized for all stakeholders involved. The future of AI-driven personalized therapies will depend on the ability to adapt to emerging trends and challenges in healthcare, such as the rise of multi-morbidity, aging populations, and increasing healthcare costs. By staying abreast of these trends and proactively addressing the associated challenges, AI-driven personalized therapy regimens can continue to evolve and advance, ensuring their long-term sustainability and effectiveness. Furthermore, as AI technology progresses, healthcare providers and other stakeholders

must remain open to new possibilities and embrace the potential of AI-driven personalized therapies in transforming how we diagnose, treat, and manage a wide range of medical conditions. Through a collective commitment to innovation, collaboration, and responsible implementation, AI-driven personalized therapies can unlock a new era of precision medicine that delivers better health outcomes and improved quality of life for patients worldwide.

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AI Grammarly has been used for editorial assistance in this article. The author prefers CC-BY for this article..

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