

ADVANCES IN AI-BASED PERSONALIZED HEALTHCARE

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Article Received: 25 August 2026 | Article Revised: 15 September 2026 | Article Accepted: 05 October 2026

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DOI:

How to cite this Article: Gopi Jesadiya, Hemani Mistry, Maryam Meer, Satyajit Sahoo, Dhananjay B Meshram (2026) ADVANCES IN AI-BASED PERSONALIZED HEALTHCARE. World Journal of Pharmaceutical Science and Research, 5(10), 538-552.



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ABSTRACT

Artificial intelligence (AI) is increasingly changing the way healthcare is delivered by supporting a more personalized and patient-centered approach to medicine. Personalized medicine combines information such as genetics, genomics, medical history, lifestyle, laboratory results, medical images, and continuous health data to help healthcare professionals make better decisions for individual patients. Its applications include disease risk prediction, AI-assisted medical imaging, genomic data interpretation, biomarker identification, personalized drug selection, pharmacogenomics, adaptive drug dosing, treatment response prediction, and remote patient monitoring through wearable and mobile health technologies. However, successful implementation requires careful data collection, preprocessing, feature selection, model development, validation, and continuous monitoring. Despite its benefits, AI-driven personalized medicine faces important challenges, including data privacy and security, poor data quality, limited diversity in datasets, algorithmic bias, lack of transparency, high implementation costs, and regulatory and ethical concerns. Future developments such as digital twins, generative AI, precision oncology, multi-omics integration, federated learning, and real-time adaptive treatment systems may further strengthen personalized healthcare. Overall, AI should complement rather than replace healthcare professionals, providing evidence-based support while keeping patient safety, fairness, privacy, and clinical judgment at the center of care.

KEYWORDS: Artificial Intelligence (AI), Personalized Medicine, Precision Medicine, Pharmacogenomics, Biomarkers, Predictive Analytics, Clinical Decision Support, Personalized Drug Dosing.

1. INTRODUCTION

1.1 Artificial Intelligence

According to the source, Artificial Intelligence (AI) would be a technology, capable of emulating the characteristics of human learning and understanding, problem solving, decision making, creativity and autonomy. In the healthcare field, AI is being more widely utilized to handle big, intricate data, and to assist with clinical decision-making.

1.2 Personalized Medicine

Personalized medicine emphasizes medical treatment for each patient, rather than treating all patients alike. The genomic information is noted as one part of the solution. Whole genome sequencing can offer other information when conventional methods of diagnosis are not possible. The genomics has helped the development of next-generation sequencing based diagnostic tests.

Both the FDA and NIST have contributed to the creation of reference materials for assessing the accuracy and performance of WGS and genome interpretation, as mentioned in the source. Genetic testing may be referred if there is adequate information that they could benefit the patient. Healthcare information management staff can help advance clinicians and patients in understanding the available genetic tests, their potential and limitations.^[1]

1.3 Evolution from Conventional Medicine to Personalized Healthcare

Personalised healthcare is an individual approach that includes predictive and personalised treatment,” writes the source. It aligns genomics and AI to continually gathered patient information with the goal of attacking disease at the cellular level and assisting prevention.^[2]

2. FUNDAMENTALS OF PERSONALIZED MEDICINE

2.1 Principles of Personalized Medicine

Personalized medicine targets a person's genetic makeup in conjunction with environmental and lifestyle factors. Mutations that lead to disease can be identified by sequencing the human genome and can contribute to the precise diagnosis and targeted treatment. It can decrease trial and error treatments and optimize healthcare efficiency and safety, according to the source.^[3]

2.2 Role of Genetics and Genomics

Tailor-made medicine is based on genetic information. AI is playing a significant role in the personalization of medicine, and genomics is a fundamental aspect of this. AI algorithms can analyze vast amounts of DNA sequence data and detect DNA variations that might not be easily spotted by a human eye.^[4]

2.3 Biomarkers in Disease Diagnosis

Biomarkers are quantifiable, objective biological markers of either proteins, genes or metabolites. They can be employed for the diagnosis of disease processes, for assessing susceptibility and even for making treatment progress monitoring. Genomics, proteomics and AI enhance the value of the biomarkers in precision medicine to guide patient's selection of treatment based on the patient's biology.

A variety of examples are provided in the source for use of blood glucose in cases of diabetes detection, troponin in the case of a heart attack, prostate-specific antigen (PSA) for prostate cancer screening, HER2 for breast cancers, and hereditary breast and ovarian cancer BRCA1/BRCA2 mutations to evaluate.^[5]

2.4 Patient-Specific Treatment Strategies

AI has the capable ability to process these medical records, imaging, and research findings to develop individual treatment plans. It can also be used for real-time benefit/risk assessment. The source argues that AI should be leveraged by health care providers and not be a substitute to medical judgment.^[6]

3. ROLE OF AI IN PERSONALIZED MEDICINE

3.1 Analysis of Large Healthcare Datasets

Healthcare records are now digital, and issues like duplicated, incomplete and inaccurate records are significant. Manual data matching can be time-consuming and prone to inaccuracies. AI products can leverage similarity measures and predictive modeling to automate data matching capabilities and provide analysis of healthcare data.

The source details studies carried out, including those in healthcare data analysis and data linkage, such as analysis of mortalities or symptom patterns for COVID-19. The examples highlight the potential of AI in healthcare data management and personalised medical decision-making.^[7]

3.2 Predictive Analytics for Disease Risk

The talk introduces the concept of predictive modelling and how AI can be used in the early detection and prevention of diseases. AI can generate insights from genetic, clinical, lifestyle and environmental data in order to predict disease potential before symptoms can present. This can help in improving outcome, individualized treatment and early intervention.

The source also mentions imaging technologies such as CT, PET-CT and MRI. Transparency, standardization and ethical matters should also be taken into account for clinical application on the same time.^[8]

3.3 Clinical Decision Support

AI Clinical Decision Support (CDS) is a system that analyses vast amounts of health care data, structured and unstructured, to detect patterns. Data collection in intensive care, radiology and pathology are large and capable of the use of tools that support diagnosis and provide prediction for diseases. AI can simplify the medical process and assist in clinical decision-making.^[9]

4. APPLICATIONS OF AI IN PERSONALIZED MEDICINE

4.1 Personalized Treatment Recommendation

Treatment programs may not always take into consideration genetic differences and lifestyle and medical history. According to the source, AI can aid in analysing vast, complex and heterodox datasets and provide tailored health care interventions, particularly for chronic and complex diseases.^[10]

4.2 Continuous Patient Monitoring

AI has supported the field of precision medicine by improving the precision of diagnosis and early detection of disease, in addition to the prediction of disease risk and treatment outcomes. Within drug discovery, machine-learning approaches can be used to explore the structure of the chemical compound, and depict interactions with various drug targets.^[11]

4.3 Disease Risk Prediction

Treatment programs may not always take into consideration genetic differences and lifestyle and medical history. According to the source, AI can play a pivotal role in understanding vast and complex data sources to provide tailored healthcare solutions, particularly for chronic and complex conditions.

In the healthcare sector, especially in an acute-care setting and IUCs, AI can rapidly analyze patient monitoring data. Biosignal data and information from monitoring devices, as well as clinician responses and similar cases can be analysed to look for patterns that could be clinically relevant.^[12]

4.4 Lifestyle and Environmental Risk Analysis

AI in environmental health and public safety is also covered in the post. AI can be used to model changes and risks in the environment through the integration of satellite observations, data from sensor networks and other data sources. It can facilitate emission monitoring, management of renewable-energy data, monitoring forest-cover data, prediction of disaster, public-health surveillance, etc.

Genetic data may be combined with lifestyle and environmental data to provide a wider understanding of patient.^[13]

Table 1: AI applications in personalized medicine.

Application	AI-supported role	Example/data source
Precision diagnosis	Pattern recognition and early disease detection	X-ray, CT, MRI, genomics
Personalized treatment	Supports treatment selection using patient-specific data	Genetic profile, medical history
Risk prediction	Identifies disease risk and complications	Clinical, lifestyle and environmental data
Continuous monitoring	Detects trends and clinically relevant changes	Wearables, CGM, remote BP monitoring

5. PRECISION DIAGNOSIS

5.1 AI-Assisted Medical Imaging

Lots of complicated and massive datasets have been analyzed in modern times by the help of AI systems which are based on AI machine learning, deep learning and artificial neural networks to identify patterns from such datasets. One area where AI has proven helpful is within healthcare, where it has been applied to analyze the amount of blood flowing through arteries in ultrasound, X-ray, CT and MRI images. These apps are expected to facilitate faster and more informed health care decisions and be expected to reduce and eliminate human error, the source said.

Data privacy and data ethics were other topics raised as elements that will be crucial in the future for the precision medicine to be used with AI.^[14]

5.2 Genomic Data Interpretation

1. Early diagnosis of disease: AI can be used to identify genes for rare and inherited disorders.
2. Genetic and other information would also help in personalised medicine which is likely to yield treatments of lesser side effects and more effective to the individual.
3. Targeted cancer therapy and disease monitoring: mutation analysis can provide information on mutations in cancer cells that can then be used for targeted therapy and monitoring disease progression.
4. Genetic screening can help with reproductive decisions (pre- and Reproductive Care).

5. Pharmacogenomics: the information of the genome can help predict reactions to a medicine and pick the medicine and precisely the correct dosage.
6. Genomic analysis may be used to help assign infectious disease diagnosis as well as in doing outbreak monitoring.
7. Rare disease diagnosis, artificial intelligence can analyze complicated genes and make a quicker diagnosis.
8. AI can detect those who are more vulnerable to dealing with certain health issues earlier on.
9. Precision Public health: genomics data can be leveraged to guide population screening and health care planning. They introduce one of the initial strategies in gene therapy and genome editing: CRISPR, as a method to correct the defective genes.^[15]

6. BIOMARKERS, DISEASE SUBTYPES AND PERSONALIZED DRUG SELECTION

6.1 Biomarker Identification

A biomarker is a measurable biological characteristic that indicates a normal biological process, a disease process or a response to therapeutic intervention. Biomarkers can be molecules or genes in blood, urine, tissue or other body fluid, or proteins, hormones or enzymes.

According to the source, biomarkers are used in a variety of areas, including oncology, as well as in cardiovascular, neurological, infectious diseases and in diabetes. Complex data sets can be used to identify useful biological signals with the help of AI and omics technologies.^[16]

6.2 Disease Subtype Classification

The applications of AI for Disease Sub-Typing can be useful in several aspects. In neurodegenerative disorders, doctors take photos of the brain to see what cells are dying and make a diagnosis. Doctors use a picture of the brain in neurodegenerative diseases to determine which cells are dying and make a diagnosis. For infectious diseases, patient data can be used to perform real time detection of sepsis, imaging to identify the pathogen and gene-sequence of patients to monitor the evolution of pathogens.

Cancer: AI can help in the detection of tumors, genetic and mutation analysis and prediction of cancer risk. For the lifestyle disorders, continuous measurement of parameters like blood glucose, heart rate and so on can be achieved by wearable AI systems, giving early warnings.^[17]

6.3 Matching Therapies to Patient Characteristics

The genomes, clinical histories and symptoms can be scanned for appropriate therapies. Precision oncology, clinical-trial matching and pharmacogenomics and personalized approaches in mental health are all discussed thoroughly.^[18]

7. PHARMACOGENOMICS AND PERSONALIZED DRUG SELECTION

7.1 Pharmacogenomics-Guided Prescribing

Pharmacogenomics looks at the genetic makeup of individual patients to try to determine how a medicine will affect a patient and what the appropriate dose might be. According to the source, AI can be used to combine genetic data, electronic health records, and multi-omics data to predict probable toxicity, thereby helping with these dosing decisions.^[19]

7.2 AI and Real-Time Clinical Decision Support

A genetic profile can be used in conjunction with an electronic health record through AI. An example of a genetic variant alert that could be activated that could provide alternative treatment recommendations is provided as CYP2D6.^[20]

7.3 Multi-Omics Integration

AI is not limited to just analysing the behavior of individual genes. The source explains how integration of proteomics, metabolomics and epigenomics with genomic information could be used to elucidate the complex drug-gene interaction.^[21]

7.4 Polypharmacy and Adverse Reactions

There may be complex interactions between medicines that patients receiving more than one medicine may experience. The source says that AI can simulate many combinations of polypharmacy and pharmacogenomic interactions quickly, assisting in determining potential hazards.

7.5 Prediction of Drug Response

AI is defined as playing a role in the prediction of therapeutic response, molecular docking and ADMET profiling. So techniques for reducing the need for classic trial-and-error development are explored here through the use of deep generative approaches and analysis of the organoids with the aid of AI.^[22]

7.6 Reduction of Adverse Drug Reactions

AI can combine prescription histories, electronic health records, patient history, lifestyle factors, genetics and real-time monitoring to identify risk factors for adverse drug reactions. It also can help detect potential drug-drug interactions and help in proactive intervention efforts.^[23]

8. PERSONALIZED DRUG DOSAGE

8.1 Dose Optimization Based on Patient Factors

Tailored dosage is based on individual characteristics of patients and not a one-size-fits-all approach. The source thinks that certain conditions like kidney and liver function, age and weight, pregnancy, other medicines and genetic predictors must be considered.^[24]

8.2 Therapeutic Drug Monitoring

Therapeutic Drug Monitoring (TDM) and Model Informed Dose de Escalon (MIPD) are termed as techniques to optimize dosing of some drugs to attain a desired therapeutic response at the lowest possible level of toxicity. Therapeutic drug concentrations and pharmacokinetic/pharmacodynamics modeling can be used for dose adjustment. The source provides a list of "narrow-therapeutic-window" drugs such as ones used to treat bacterial infections (aminoglycosides, vancomycin) or specific therapeutic indications such as treatment for suppressed immune systems and lithium.^[25]

8.3 Adaptive Dosing Strategies

It can account for such factors as ageing, body weight, kidney and/or liver function and genetic information, and recommend the correct dosage at any given time. Sera is a system that has the ability to adapt doses based on the clinical condition and therapeutic response.

The applications mentioned are those pertaining to chronic kidney diseases, liver dysfunction and diabetes. Information from CGMs and insulin pumps can be used to give personalized insulin-dosing recommendations for people with diabetes.^[26]

8.4 Benefits of Adaptive Dosing

Helps personal/medication maintenance which could also be safer.

May reduce the use of negative drug effects, and reduce mistakes in prescriptions.

Ability to support taking medicines.

When the dosage range does not have a wide therapeutic window, may be beneficial.

Enables suggestions on treatment to address patients' evolving condition.^[27]

9. TREATMENT RESPONSE PREDICTION AND REMOTE MONITORING

9.1 Predicting Treatment Efficacy

Big and complex data, such as that from clinical trial records, genetic information, treatment outcomes, and others, can be used to make predictions of treatment effectiveness using AI. A source gives an example of recognizing a pattern between characteristics and responses of patients and treatments.

This type of prediction can be helpful when a clinician is making treatment decisions by enabling him or her to take account of the likelihood of the treatment being effective, as well as adverse effects and even treatment failure.^[28]

9.2 Monitoring Disease Progression

In chronic disease, progression can be followed through use of AI, predictive analytics and remote patient monitoring. Data can be from EHRs, wearables, continuous glucose monitoring and remote blood-pressure monitoring. AI can detect any irregularities and trends, and can make adjustments to treatment in a timely fashion.

9.3 Optimizing Treatment Plans

AI can process and decipher EHRs, medical imaging, laboratory test analyses and genetic data in order to help plan for treatment. It can help identify signs of diseases, understand disease status and make projections of potential disease issues and treatment changes.^[29]

9.4 Remote Patient Monitoring

Mobile devices like smart glasses, smart clothes, smart shoes, mobile phones, smartwatch, smart earphones, and wristbands can gather information on activity, movements and health information. It refers to applications like activity recognition, health monitoring, fall detection and predicting stress.

AI, and deep learning in particular, can help to analyze complex data from wearables, helping in health monitoring, image and audio processing.^[30]

10. MOBILE HEALTH, CONTINUOUS MONITORING AND DATA SOURCES

10.1 Mobile Health Applications

Mobile health application through AI can utilize-checking symptoms, health monitoring, medication strategies, and teleconsultation. Health data holds tremendous potential for analysis using principles of machine learning and NLP to

deliver customized health care and early detection. Concerns with privacy, security, data quality and accuracy are also cited as an issue.^[31]

10.2 Continuous Health Monitoring

The use of sensors, such as heart rate, SpO₂ and temperature sensors is noted and an IoT healthcare monitoring system is created. Continuous analysis of data can be done in the cloud platform. The monitoring process can be automated by AI algorithms, which can identify abnormal activity and notify healthcare authorities.^[32]

10.3 Early Detection of Complications

Predictive AI models can be used to detect high-risk patients, even at hospitals with limited access to such specialists, such as a high-risk baby. The source mentions that predictive modelling could be a way to help with timely referral and decision-making.

10.4 Electronic Health Records

An Electronic Health Record (EHR) is a longitudinal record, which can include clinical notes, laboratory information, imaging, medications, and more health information. These can be connected with evidence-based practice, link with continuing care, communication between healthcare providers.

Some of the barriers mentioned by the source are unstructured data, Lack of interoperability and growing documentation. Clinical data stored in EHRs can be leveraged for insights through the use of AI.^[33]

11. GENOMIC, MULTI-OMICS, IMAGING AND WEARABLE DATA

11.1 Genomic and Multi-Omics Data

Multi-omics is a composite approach involving multiple layers of biology. As per the source, genomics is the study of DNA, genes & genetic variations, transcriptomics the study of RNA expression, proteomics the study of protein structure, function & interaction and metabolomics the study of small molecules involved in cellular metabolic processes.

AI can try to discover some pattern in complex biological data and deep learning and neural networks can see a relation in data volumes that is too large.^[34]

11.2 Medical Imaging Data

AI is being used in medical imaging to rapidly and accurately interpret X-ray, computed tomography (CT) scans, magnetic resonance imaging (MRI) and ultrasound images. The information can be used to target aiding a diagnosis and treatment planning.

11.3 Laboratory Test Results

AIs can look at lab results and immediately recognize abnormalities and suggest how the biomarker information should be interpreted. This further contributes to personalized health care, as the lab plays a crucial role in the mix.^[35]

11.4 Wearable Sensor Data

Wearable sensors may measure vital signs and other measures of health in real time. AI has the potential to utilize several signals from the sensors and find patterns that can help in predicting, diagnosing and preventing diseases. The

other challenges discussed in the source include errors in sensor measurement, ability to continuously measure a biomarker, privacy concerns and security.

11.5 Patient-Reported Outcomes and Lifestyle Data

Patient-reported outcome can be revolutionized by AI to become dynamic and actionable health measures. Answers to questions about patients' lifestyle and environment are also valuable in gaining greater insight into the patient's health and enable targeted provision of care.^[36]

12. AI WORKFLOW IN PERSONALIZED MEDICINE AND ADVANTAGES

12.1 Data Collection

AI data collection involves gathering, cleaning, organizing and storing raw data for training, fine-tuning and evaluation of machine-learning models. There are several common approaches to web scraping, not only the automated ones using API integration but also the others where crowdsourced human labeling is done, as displayed in the source.

12.2 Data Preprocessing

Data preprocessing involves cleansing unstructured, dirty and noisy data for subsequent machine-learning system analyses. The usefulness of this stage is affected by the data that is put in it – the more useful the data, the more useful the model will be.^[37]

12.3 Feature Selection

The selection of the important and relevant variables, and the rejection of irrelevant, noisy and redundant variables is called feature selection. This is one of those techniques for improving machine-learning, according to the source.

12.4 AI Model Development

AI model development involves model development, machine-learning/ deep-learning model training, evaluation, and deployment for complex, data-based problems.^[38]

12.5 Prediction and Decision Support

Traditional decision-support systems can change to become proactive, predictive, and prescriptive with the help of AI. This may assist in personalized medicine in the field of risk management and clinical planning.

12.6 Personalized Treatment Planning and Model Refinement

AI can analyze genetic, medical-history and lifestyle data to provide customized treatment programs. Healthcare information is fluxional and ongoing data drift and [sustaining model relevance] of the model is the key.

12.7 Advantages

Better diagnostics and recognition of patterns.

Earlier disease detection.

Optimized treatment selection.

Prompt health care solutions at affordable cost.

Increased cost-effectiveness of the use of healthcare resources.

Faster clinical decision-making.

Using Apps and Wearing technologies to engage patients.^[39]

13. CHALLENGES AND LIMITATIONS

13.1 Data Privacy and Security

While Personal information is very important in Health care information, Privacy and Security is required. The source emphasizes the importance of security measures in order to avoid unauthorized access and data breaches. Inadequate security could decrease the trust in AI in healthcare.

13.2 Data Quality and Interoperability

Things were simple for AI models before until recently, when they became more important than ever, and they required a complete and precise set of data. Information about a healthcare organization can be provided by several hospital systems and in different formats, so integration and analysis can be hard.^[40]

13.3 Bias and Limited Dataset Diversity

It is important to note that AI models can be biased or unfair when they are trained with data that isn't representative. It is crucial that the AI system can respond in an appropriate way to a myriad of datasets to be able to make appropriate decisions in a wide range of populations, the source points out.

Implementing AI technology needs to be done in accordance with legal and ethical limits. Consent, responsibility, transparency and safe management of patient information are issues.

13.4 Model Interpretability

This can be an issue with certain AI models known as "black box" that do not explain a prediction/recommendation. Human users demand helpfully and may not know exactly why the algorithm has chosen to make a prediction/recommendation. As far as the source is concerned, there is a connection between improved interpretability and a sense of confidence and clinical judgment in the case of the graph.^[41]

13.5 High Implementation Costs

Technology, infrastructure and man power are required for the development and deployment of AI. Some of these requirements may pose difficulties for smaller hospitals and medical centers, which may affect the timelines for implementing.

13.6 Workflow Integration and Training

There are significant hurdles to the process of seeding AI into the existing healthcare processes. The importance of proper training of doctors and healthcare workers and the need to ensure AI systems are implemented in healthcare without harming the patient.^[42]

14. REAL-WORLD APPLICATIONS, CASE STUDIES AND FUTURE PERSPECTIVE

14.1 AI-Guided Cancer Therapy Selection

AI systems that analyze genetic data from patients, along with their medical history and the nature of the tumor, to inform the informed selection of therapy and immunotherapies, including targeted agents. One of Watson's examples for clinical decision support for personalized cancer treatment is Watson for Oncology, which is being touted as the partnership between Memorial Sloan Kettering and IBM.

14.2 Pharmacogenomics for Individualized Prescribing

AI can correlate and cross-reference genetic information and medical history in order to accurately forecast a person's response to a medicine and aid in medicine selection and dosage. According to the source, Mayo Clinic is an example of the use of pharmacogenomics in personalizing drug prescriptions.^[43]

14.3 AI in Diabetes Management

Continuous glucose monitoring and wearables can give AI systems the data to recognize the changes in blood glucose levels. They cite Dexcom and Medtronic as two examples of companies related to continuous glucose monitoring (CGM) that are pursuing AI-driven approaches.^[44]

14.4 Cardiovascular Risk Prediction

AI can be paired with cholesterol, blood pressure, lifestyle, health information, and genetic information to aid with cardiovascular-risk prediction. The source discusses the cardiology testing of AI-based cardiovascular risk assessment tools with the NHS.

14.5 Rare Disease Treatment Planning

AI can leverage medical records, lab details, and genomic information to facilitate the diagnosis and development of treatment strategies for rare diseases. The source quotes Fabric Genomics as an example of the use of AI in genetic sequencing analysis.

14.6 Future Perspective

Virtual patients, real-world care: virtual copies, medical and other information from scans, lab analysis could be updated when later collected and could be used to explore treatment options.

AI integration with genomics and multi-omics: Interweaving genomics, proteomics and metabolomics detailed information on diseases may be improved.

Integration of imaging data, combined with genetic information and patient record, with AI-driven precision oncology can aid the detection and prediction of how an individual will respond to cancer treatment.

Generative AI for personalised treatment design: source refers to possible integration of medical history, genomics and lifestyle data in the design of treatment and drug development.

Federated learning: Without a sharing of patient data, models learn from data held at different hospitals.

Real-time adaptive treatment: AI can track wearables and medical sensors and make recommendations if there's a change in patient status.

AI-based preventive healthcare: health records, lifestyle data and wearables data can help identify risk and make preventive recommendations.^[45]

15. REGULATORY AND ETHICAL CONSIDERATIONS + CONCLUSION

15.1 Patient Consent and Data Governance

The source highlights the importance of patient consent in adopting patient information for AI applications. Patients need to know about the collection, storage, processing and sharing of their personal and medical information. In the

healthcare sector, data governance enables secure management, accountability and conformance to compliance regulations and mandates like GDPR, HIPAA and other regulations as they apply.

15.2 Transparency and Explainability

The goal of Explainable AI (XAI) is to impart a degree of transparency to AI-driven decisions, enabling healthcare professionals and patients to comprehend the reasoning behind them. Transparency can increase the likelihood of checking the recommendation made but can help too with accountability and trust, as it eliminates the need to take the word of unexplained black box outputs from the computer.^[46]

15.3 Clinical Validation

Before integrating AI systems into clinical practice or patient care, they should undergo clinical validation. The source uses accuracy, sensitivity and specificity and predictive value as measures of performance. Testing should be done on high-quality data from varied populations and ongoing monitoring is required as performance may evolve as data and clinical practice change.

15.4 Regulatory Approval

Some medical devices and health apps built with AI might need to be evaluated by a relevant regulatory agency. The source notes that the FDA, EMA and national organizations are among those responsible for safety, effectiveness and quality assessments. Testing, clinical validation and risk assessments, as well as cybersecurity and quality may be required.

15.5 Equity and Fairness

AI should offer impartial health care recommendations to each patient groups. Bias can occur if training data is not reflective of a diverse population. A range of inclusive datasets, fairness assessments and on-going monitoring can be used to decrease the disparities between different groups.^[47]

16. CONCLUSION

Smart technology is one that is most optimization using Artificial Intelligence (AI) in the field of personalized and precision health-care. AI can be used to enhance the ability of healthcare professionals to make more personalized clinical decisions, by combining data from various sources such as genetics, genomics, medical history, lifestyle factors, biomarkers, medical imaging, laboratory results, and patient-generated data. It can be used to help diagnose the disease as early as possible, to predict the disease risk, to choose the treatment, to draw personalized treatment plan of the disease, and to evaluate the effectiveness of treatment. AI also automates much of the “back-and-forth” approach, and identifies patterns in a stream of vast, complicated health-related information.

The AI systems "promises to transform the accuracy of diagnosis and precise treatment through the use of genomics and biomarkers—a focus on personalized treatments. Combined with genomics and biomarkers, AI holds promise for targeted therapy and a clearer yield in diagnosis, which will benefit personalized therapies. Machine and Deep learning methods can utilize Multi-omics data to uncover relationships that can be hard to identify by traditional methods. Medical imaging, laboratory analysis, and patient-reported outcomes, combined with AI-powered sensors and cameras, can help with continuous monitoring, disease prevention, and early intervention. However, several challenges need to be overcome for the AI system to be applied to personalised medicine: Suboptimal data quality, lack of data

connectivity, data privacy and security, data bias, lack of data diversity, regulatory requirements, and the inability to interpret the AI models. It's also important to continuously update and refine AI models to guarantee their accuracy and reliability in response to evolving healthcare data.

In general, AI shows great promise in revolutionizing healthcare from a reactive service mode to a predictive, preventive, and personalized healthcare model. Future developments across the multi-omics, wearable, digital health and advanced AI modelling can further revolutionize the new era of personalised health care. It is not to suggest however that AI eliminates human interaction — rather complementing and combining with its help is of great importance — but that this does not mean that clinical skills and ethical considerations stop being vital to the safe and effective use of AI, nor does a patient-centered approach.

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