

Future of Precision Medicine with AI

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Abstract

The emergence of Artificial Intelligence (AI) has been a catalytic force towards a revolutionary transformation in the scenario of precision medicine, indicating a potential for individualised healthcare. The study explores the diverse integration of AI technologies across all the fields of medical practice, such as diagnostics, pharmacotherapeutics, surgical procedures, rehabilitation, and maternal care. Using secondary data from peer-reviewed journals and academic databases, the study details how AI algorithms process complex data sets spanning genomics to electronic health records to enable personalised therapeutic decisions and enhance patient outcomes. Focus areas covered include AI-guided deep brain stimulation for Parkinson's disease, machine learning-based drug discovery, smart bionic prosthetics, and adaptive pregnancy care systems. The article highlights the capability of AI to improve clinical precision, business efficiency, and personalised care delivery while recognising the significance of ethical factors and long-term clinical effects. This research adds to current academic and professional discourse by placing AI as a central agent in determining the future direction of equitable and responsive healthcare.

Keywords: 'Artificial Intelligence', 'Precision Medicine', 'Personalised Healthcare', 'Medical Technology'

Introduction

The healthcare system faces a transformation through precision medicine approaches that customise diagnostic approaches together with treatment protocols, while patient monitoring is based on genetic, behavioural and environmental factors. This is to achieve enhanced patient care and operational efficiency in the healthcare sector (refer to Figure 1) (Seyhan & Carini, 2019). Artificial Intelligence (AI) represents the core foundation of the revolution, which employs algorithms together with machine learning strategies for the analysis of sophisticated data in large quantities (Sahu, et al., 2022). Medical professionals obtain precise healthcare results through AI because it combines genomic analysis with biomarker identification, along with real-time decision support systems.

Precision medicine has solved the fundamental issue of conventional medicine through its AI-powered integration process (Oyeniyi & Oluwaseyi, 2024). Traditional medical treatments that ignore personalised healthcare characteristics produce limited success while causing unwanted effects on patients and leading to elevated healthcare expenses (Esteve, et al., 2019). AI achieves these improvements through individual treatment plans and analytical calculations which create superior patient results and minimise healthcare resource waste.

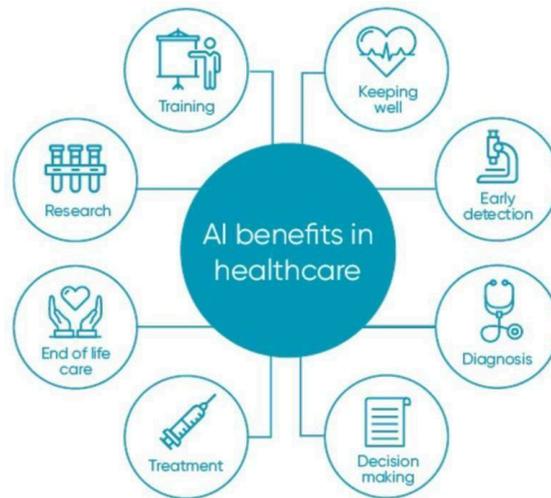


Figure 1: AI Contributions in Healthcare (Source: Balasubramanian, et al., 2023)

This study examines how AI and precision medicine technologies transform healthcare sectors starting from diagnosis and continuing through pharmacotherapeutics rehabilitation and surgical care and entering the space of pregnancy care. This is to assess increasing therapeutic specificity and safety through AI-facilitated advances in medical treatment. Analysis of theme-based segments in AI diagnostics software and AI drug discovery and prescription as well as accurate surgery by AI and intelligent prosthetics and AI-governed pregnancy management forms the basis of this research. In this study, a detailed discussion of the paradigmatic revolution driven by AI has been achieved with the help of various secondary sources, such as journals, available research papers, and articles from genuine platforms like Google Scholar and PubMed. By highlighting the benefits and applications of AI, this research signifies its role in shaping the future of targeted medicine. It adds value to present-day academic and clinical discourse, idealising increasingly equitable and customised healthcare systems.

AI in the Management of Pregnancy to Choose Precise Therapy The application of Artificial Intelligence tools increases obstetrical practice for delivering customised therapeutic decisions about pregnancy management (Delanerolle, et al., 2021). Extensive maternal and fetal data shared with AI systems which includes genetic information along with blood biomarkers, medical backgrounds and pictures enables the systems to detect patterns (refer to Figure 2). It also allows to prediction of pregnancy risks that affect gestational diabetes preeclampsia and fetal growth restrictions (Davidson & Boland, 2021).

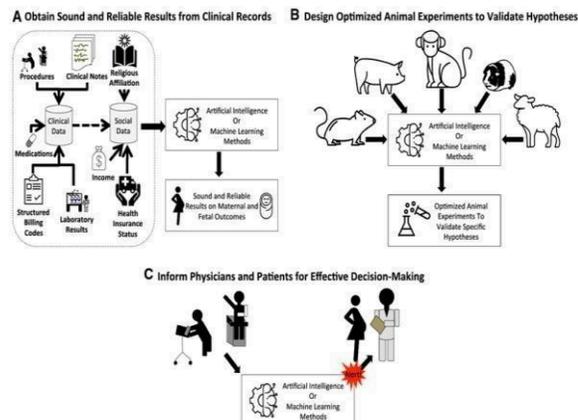


Figure 2: AI in Pregnancy- Leading Informed Decisions (Source: Davidson & Boland, 2021)

The integration of artificial intelligence into maternal healthcare platforms enables the creation of adaptive care protocols which adjust to maternal physiological changes during pregnancy (Mehta, et al., n.d.). Numerical analysis systems combine maternal body measurements obtained from physical activity parameters and weight changes and glycaemic indicators for accurate insulin dose determination in gestational diabetes treatment. Computer algorithms work in sustained loops to readjust treatments which results in better clinical responses and enhanced patient safety achievements.

The current generation of AI applications shows better analytical performance in foetal ultrasonography interpretation because this helps clinicians detect developmental problems during earlier pregnancy stages (Sriram, et al., 2024). Early and advanced diagnostic processes make it possible to initiate medical treatments promptly which leads to better results for newborns. AI systems examine complete pharmaceutical plans for risky pregnancies and recommend new drugs which minimise harmful maternal and foetal consequences (Shedge, et al., 2024).

Healthcare professionals utilise advanced AI methodologies to analyse genomic and clinical datasets thus improving NIPT procedures for better chromosomal abnormality detection. The combined benefits of this method include better safety characteristics and longer periods for planners to make therapeutic or palliative care decisions.

Precision medicine in obstetrics relies on creating unique treatment approaches that match individual patient healthcare needs (Jameson & Longo, 2015). AI has become an essential core component for maternal-foetal healthcare through sectoral transformation that advances patient care delivery strategies and healthcare results with ongoing technological developments (World Health Organization, 2023).

AI Software and Machines: The Digital Support of Precision Medicine

Modern precision medicine leverages AI technology and intelligent machines to revolutionise patient-centred healthcare. The driving force behind this transformation is AI systems' ability to understand complex data from various domains, including genomics, proteomics, medical imaging, and electronic health records (EHRs) (Bajwa, et al., 2021). Medical professionals utilise different information sources to develop individualised treatment approaches that link biomedical data with treatment-specific

requirements unique to each patient. The combined approach enables healthcare providers to create customised care plans because it transcends rigid standardised procedures.

Recent medical systems including Deep Patient and DeepMind Health validate the important clinical applications of machine learning technology in healthcare practice (Kim, 2018). Advanced healthcare technology uses sophisticated algorithms to identify diseases along with forecasting their development process before standard clinical indicators emerge. The technology analyses previous encounters and finds complex relations that medical specialists cannot easily detect (Junaid, et al., 2022).

The IBM Watson for Oncology system uses AI to process clinical patient data to generate precise treatment recommendations based on present medical literature and cancer research findings (Aikemu, et al., 2021). The diagnostic precision improves significantly through AI-driven systems because they accelerate the process of clinical decision-making. AI-based radiomics technology enables the extraction of numerous medical image features to assist physicians with early disease detection, particularly for cancer diagnosis (Pinto-Coelho, 2023). Using artificial intelligence enables better diagnosis of invisible biomarkers which early diagnosis can be more accurate. Modern diagnostic practice benefits highly from AI analytical capabilities due to the complexity of medical data (refer to Figure 3). The established future of precision medicine is secure because the system delivers swift standardised patient-specific insights.

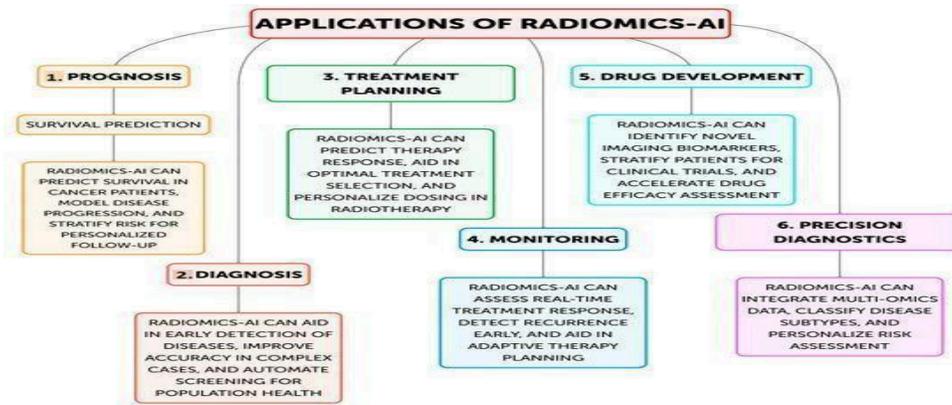


Figure 3: Current and Future Applications of Radiomic-AI (Source: Maniaci, et al., 2024)

AI in Pharmacotherapeutics: Personalised Drug Discovery and Prescribing

Pharmacotherapeutics experience a revolutionary change through artificial intelligence systems that develop individual drug therapies to revolutionise precision medicine (Chen, et al., 2018). Through its usage of advanced algorithms and machine learning, AI systems generate patient-tailored drug regimens that operate according to genomic physiological and metabolic information (Johnson, et al., 2021). The right drug treatment delivered at the appropriate dose achieves two-fold benefits: it reduces adverse effects and improves treatment effectiveness.

Two drug discovery tools namely 'Atomwise' and 'BenevolentAI' lead the innovation in pharmaceutical development (Chen, 2023). Advancements in medical science enable these programs to conduct predictions about which chemical molecules will be most effective against diseases based on patient- specific genetic markers (Lu, et al., 2023). The process is completed within a few hours. The existing long years of drug testing get shortened because of this technique which allows pharmaceutical companies to launch more secure treatments at a faster rate.

Artificial intelligence algorithms streamline the development of optimal dosing programs after drug discovery stages (refer to Figure 4) (Mak, et al., 2024). Computers-enabled decision systems utilise patient-specific details about metabolism together with weight age and genetic markers to determine proper medication dosages which help prevent medication toxicity and improper medication levels (Fu & Chen, 2025).

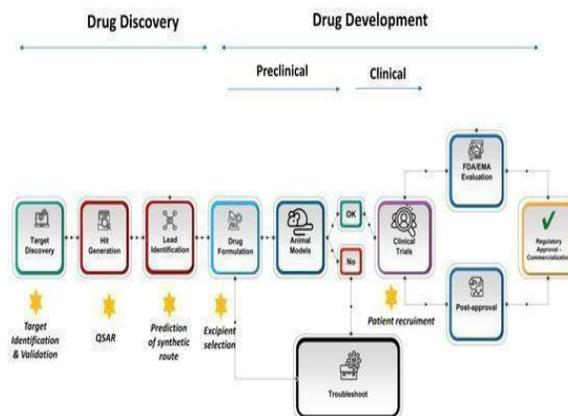


Figure 4: Drug Discovery: Main Stages (The Star represents the Stages where AI has a Vital Role in pharmaceuticals)(Source: Serrano, et al., 2024)

AI software gains access to complete health records for patients to forecast drug-drug interactions and adverse drug reactions which healthcare providers can utilise prior to writing prescriptions (Choudhury & Asan, 2020). The active method leads to better patient safety as well as improved clinical result achievements.

Pharmacotherapeutic use of artificial intelligence results in better efficiency and personalised effectiveness and administration of drugs (Vora, et al., 2023). The precision of targeted treatments together with shorter care periods and reduced healthcare expenses guarantees that each patient receives optimal treatment plans based on their distinct biological makeup (Karalis, 2024). AI continues to prove its role in constructing a new foundation for precise medical practices going forward.

AI-Assisted Surgical Precision: Deep Brain Stimulation in Parkinson's Disease

Surgical interventions are entering the precision medicine era because AI integration has become possible. 'Deep Brain stimulation' remains the most famous AI used for managing Parkinson's disease symptoms as one of its applications (Malek, 2019). Professionals perform DBS as a surgical operation that requires placing electrodes into specific brain areas to manage uncontrolled neuron activity (Sui, et al., 2021). Surgery benefits from AI by getting more precise and safer as well as more effective.

The unique brain framework of each individual can be utilised by AI systems that use precise neuroimaging data to determine suitable electrode placement (Bacon, et al., 2024). The customised electrode positioning becomes possible through mapping which ensures correct placement for achieving therapeutic success. Through intraoperative AI systems surgeons receive ongoing live feedback which adds dynamic precision and reduces procedural errors during surgical procedures (Guni, et al., 2024).

The application of AI extends beyond surgical facilities during patient treatments. Adaptive AI systems enable post-surgery care function to track patient reactions and change stimulation parameters automatically based on their developing clinical requirements (Alsareii, et al., 2022). The customised treatment model leads to superior patient results because it produces fewer adverse consequences alongside superior therapeutic outcomes throughout the extended period.

The convergence of robotics, imaging modalities, and artificial intelligence not only enhances the accuracy of surgery but also provides opportunities for extremely individualised neurosurgical interventions (Kazemzadeh, et al., 2023). With the continued advancement of artificial intelligence, its role in precision surgery will become even more complex and sophisticated, delivering more accurate, goal- oriented, and adaptive therapy for complex neurological disorders. This represents a paradigm shift in planning, executing, and postoperative follow-up surgical care under precision medicine.

AI-Driven Artificial Hands: A Future of Custom Rehabilitation

Precision medicine continues past diagnostics and pharmacotherapy by creating personalised rehabilitation tools which include computer-intelligent prostheses (Javaid, et al., 2022). The field of physical rehab is experiencing an ongoing revolution because these tools deliver focused strategies which help patients recover their functional capabilities and achieve higher quality living after amputation. This case demonstrates the integration potential between AI-based bionic hand prostheses through a leading example which represents a major advancement.

Built-in artificial intelligence systems in AI- driven bionic hands enable them to adjust and learn their users' behavioural patterns along with their movements (refer to Figure 5) (Veeraiah, et al., 2024). Multiple intelligent system exchanges lead to enhanced device performance as well as machine learning algorithm applications for continuous performance enhancement and improved natural control capabilities. The connection with prosthetic movements enables users to obtain perfect coordination between thoughts and actions which improves their daily routine independence.

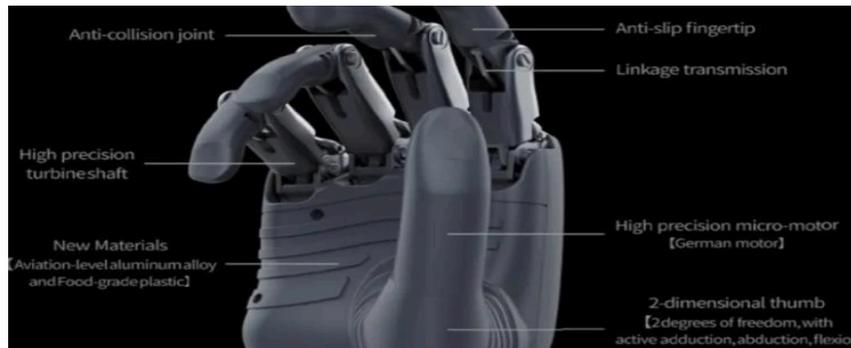


Figure 5: AI-enabled Prosthetic Hands (Source: Shacklett, 2021)

When patients transmit neural information to prosthetic hands the systems activate sophisticated sensors that handle touch control as well as extent control methods (Ciancio, et al., 2016). Users benefit from a natural and sensitive feedback system which enables them to operate in their environment through sensory signals. The devices use neural signals to adjust their settings which creates an exact fit between personal physical actions and prosthetic performance.

The chronicles of user behaviour via observation enable programming to improve functional aspects which generate significant feature enhancements. Technologies develop through regular development cycles which use practical usage patterns instead of theoretical assumptions for evolution.

The use of prosthetic devices controlled by AI has turned precision rehabilitation essential because these devices naturally adapt to user needs (Javaid, et al., 2022). Advanced dysfunctional systems reengineer their performance abilities to suit personal patient needs which static prosthetics cannot achieve.

AI in the Management of Pregnancy to Choose Precise Therapy

AI systems support obstetricians in creating specific pregnancy management solutions that enhance medical choices (Davidson & Boland, 2020). AI analyses maternity and fetal datasets that combine genetic information with blood measurement data besides medical documentation and imaging to detect patterns that help recognise pregnancy complications for gestational diabetes preeclampsia and fetal growth restriction.

These platforms utilise the technology to develop adjustable treatment plans that are modified according to the changes in pregnancy. Patient factors such as glucose measurements weight changes and physical activity levels can be analysed by machine learning algorithms to determine the right doses of insulin medications for gestational diabetes patients (Eleftheriades, et al., 2021). Such mathematical systems operate with constantly updatable real-time data streams to generate safer medical adjustments.

Fetal ultrasounds become more interpretable through AI algorithm analysis compared to human reading because AI detection provides earlier discovery of fetal anomalies (refer to Figure 6 for face anomalies) (Sriram, et al., 2024). Medical personnel receive information early for better results when dealing with neonatal care through this approach. The AI system analyses drug responses among pregnant mothers to identify potential risks which leads to alternative medication suggestions for maternal safety together with fetal protection.

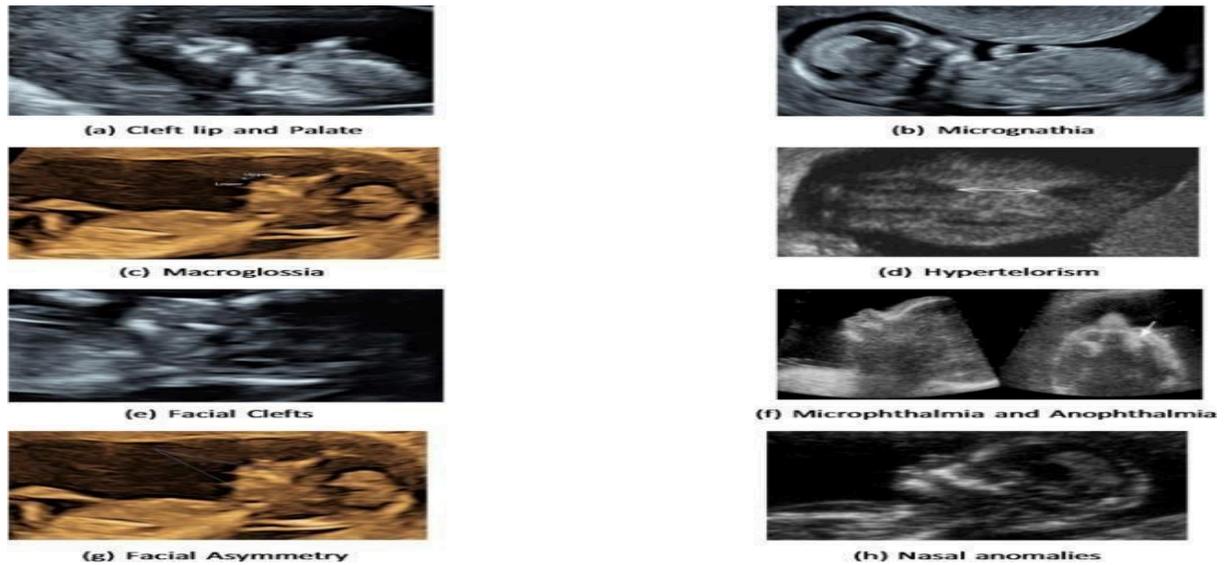


Figure 6: Types of Fetal Facial Anomalies (Source: Sriraam, et al., 2025)

Non-invasive prenatal diagnosis (NIPT) achieves higher accuracy in detecting chromosomal abnormalities through AI analysis of genomic and clinical information (Oyovwi, et al., 2024). The diagnostic approach becomes safer through this method and early therapeutic and palliative intervention planning becomes possible.

AI applications in pregnancy care serve as the key principle of precision medicine to deliver suitable treatment at precise times to exact patients. As technology evolves, AI will play a crucial role in ensuring maternal-fetal well-being through customised care

Conclusion

It can be concluded that precision medicine extends its use from diagnostics and medication to personalised rehabilitation technologies, such as AI-powered prosthetics. Such advanced devices are transforming rehabilitation by offering personalised solutions to a user's individual neural and behavioural patterns. AI-powered bionic hands, for example, utilise machine learning to acquire the user's movement and preference patterns. Through experience, these systems learn how users prefer to move, enabling them to create hand movements that closely resemble natural limbs. Sensors together with feedback systems in prosthetics simulate touch sensations and grip feedback which leads to improved user control by means of interface interaction. Studies of nerve outputs from individual patients enable feedback systems to create improved and responsive networks. The integration of AI components enables the prosthetic to continuously improve its functionality, leading to increased performance capabilities for users.

Personalised motion control together with sensory feedback emerges from AI- augmented prosthetics which provides users with physical recovery and personal independence. Assistive technology reached a critical point because the new hardware design implements precision medicine concepts. The superior therapy outcomes of these systems result in better life quality for people who have lost their limbs.

Future Implications and Research Contribution

Research shows artificial intelligence has managed to apply evidence-based decision- making processes to diverse healthcare fields thus reshaping healthcare delivery frameworks. Additional research studies need to uncover a full understanding of ethical matters along with patient safety methods and lasting medical results related to AI implementation in precision medicine practice.

The findings generated by this research study contribute to healthcare science and promote suitable artificial intelligence applications in medical practice. The proposed recommendations work toward creating efficient person-focused therapeutic approaches that will help build superior medical services for worldwide implementation.

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