Integrative approaches of AI in personalized disease management: From diagnosis to drug delivery

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Abstract
Artificial Intelligence (AI) is transforming healthcare in remarkable ways, enabling more precise, data-driven, and personalised approaches to managing diseases. In the realm of personalised medicine, AI is reshaping the entire journey of patient care, from early diagnosis and risk assessment to creating customised treatment plans and developing targeted drug delivery systems. These advancements have become possible due to the merging of vast medical data, computational modelling, and cutting-edge machine learning algorithms. This paper explores how AI enhances personalised disease management by integrating various technologies across multiple fields, including medical imaging, genomic data analysis, predictive analytics, and clinical decision support systems. AI's capability to analyse medical images and decode genetic information enables early and accurate disease detection, along with tailored therapeutic strategies for patients. Moreover, AI-driven tools help optimise treatment pathways, adjust drug regimens, and support integrative medicine by blending conventional and complementary therapies. Beyond its clinical applications, AI also streamlines administrative tasks, making healthcare workflows more efficient. However, as we integrate AI into healthcare, we must also consider critical ethical issues, including data privacy, algorithmic bias, transparency, and the need for explainable decision-making in clinical environments. The paper concludes with a forward-looking perspective on future innovations, such as AI-enabled gene editing, virtual health assistants, and quantum computing for drug discovery. As we move forward, ensuring that AI's implementation is equitable, secure, and ethically sound will be crucial for unlocking its full potential in delivering genuinely personalised healthcare solutions.

Significance | AI enhances healthcare efficiency by automating tasks, optimising workflows, and enabling timely, patient-centred care with reduced administrative burden.

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1. Introduction

Personalised medicine is truly transforming healthcare by moving away from the traditional "one-size-fits-all" approach and instead focusing on tailoring medical treatment to fit the unique characteristics of each individual. Unlike conventional models, which often rely on standardised protocols and treatments based on general population data, personalised medicine considers a broad spectrum of patient-specific factors, including genetic and genomic profiles, proteomic and metabolomic signatures, environmental exposures, lifestyle choices, and even psychosocial factors (Abdelhalim et al.,2022). The goal is to enhance the effectiveness of therapies, minimise adverse side effects, and ultimately improve patient health outcomes. This significant shift is primarily fueled by

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in biomedical science, particularly in genomics and molecular biology. The completion of the Human Genome Project and subsequent innovations in next-generation sequencing technologies have enabled researchers and healthcare providers to explore the molecular foundations of many diseases. With this wealth of knowledge has come an explosion of biomedical data—complex, high-dimensional, and often varied—that traditional analytical tools find challenging to manage. This is where Artificial Intelligence (AI) steps in as a crucial ally, providing powerful tools to process and extract valuable insights from these vast and intricate datasets (Ali et al.,2022). AI encompasses the design of computer systems that can perform tasks typically requiring human intelligence, such as learning from data (machine learning), recognising patterns (deep learning), understanding natural language, reasoning, and making decisions. In the realm of healthcare, AI algorithms can analyse diverse data sources—including electronic health records (EHRs), medical imaging, genomic sequences, outputs from wearable devices, and laboratory results—to help clinicians make more accurate, timely, and personalised decisions (Figure 1). The application of AI in personalised medicine extends beyond mere technological advancements; it signifies a new clinical and operational model for delivering healthcare (Amboree et al.,2022). For instance, AI can enhance early diagnosis by detecting disease markers in medical images or genomic data that might go unnoticed by human observers. In oncology, AI can pinpoint actionable mutations in a patient's tumour genome and align them with targeted therapies, providing more precise treatment options. Furthermore, AI-powered risk stratification tools can forecast the likelihood of disease onset or recurrence, enabling preventive measures to be taken long before symptoms manifest. Beyond simply diagnosing and predicting, AI plays a pivotal role in fine-tuning treatment strategies. Crafting a personalised treatment plan involves selecting the most effective therapy and dosing regimen for an individual, based on a combination of real-time clinical data and historical outcomes from similar patient populations. AI algorithms are capable of continuously updating and refining this treatment pathways based on new data, ensuring that care remains responsive to the patient's evolving condition. In certain instances, AI can facilitate remote monitoring and telemedicine, broadening the scope of personalised care to reach underserved communities (Batarseh et al.,2020).

Another prominent application of AI in personalised disease management is focused on drug discovery and delivery. The traditional drug development process is notoriously lengthy and expensive, often accompanied by high rates of failure. AI-driven platforms can accelerate this journey by predicting drug-target interactions, identifying potential repurposing opportunities, and modelling the pharmacokinetics of novel compounds. Additionally, personalised drug delivery systems—such as AI-guided infusion pumps or smart inhalers—can adjust dosages in real-time according to patient feedback or physiological parameters, maximising therapeutic benefits while mitigating risks. The integrative nature of AI in personalised medicine ensures that these technologies do not function in isolation. Instead, they interact synergistically across various facets of healthcare, establishing a cohesive system that connects diagnostics, treatment planning, patient monitoring, and drug delivery (Blasiak et al.,2020). For example, data collected from wearable biosensors can be integrated into AI algorithms to track the progression of chronic diseases, anticipate exacerbations, and automatically adjust treatment protocols. This level of real-time, data-driven management signifies a significant evolution from reactive care to proactive and preventive healthcare models. However, despite the tremendous promise that AI holds for personalised medicine, its integration also brings forth several challenges. One paramount concern is the issue of data privacy and security. Given the sensitive nature of health data, it is essential to have robust protections in place to prevent the misuse or unauthorised disclosure of confidential information. Additionally, AI systems heavily rely on the data they are trained on, and any biases present in training datasets can lead to unequal outcomes, particularly for marginalised populations. Furthermore, many AI models operate as "black boxes," making it difficult to understand or explain their internal workings and the decisions they make (Brady et al.,2020). This lack of transparency can erode trust among both clinicians and patients, highlighting the need for ongoing attention and improvement in how these technologies are developed and implemented.

2. AI in Personalised Diagnostics

Artificial Intelligence (AI) is becoming a vital part of how we approach personalised healthcare, reshaping the way we detect, monitor, and manage diseases. One of the most exciting areas of AI application is in medical imaging. AI systems, particularly those employing deep learning techniques such as convolutional neural networks (CNNs), can analyse X-rays, CT scans, and MRIs with remarkable accuracy (Mondal et al.,2024). These tools can spot early signs of severe conditions such as cancer, heart disease, and neurodegenerative disorders, often matching or even outdoing the skills of seasoned radiologists. In the realm of personalised medicine, these imaging technologies play a crucial role in diagnosing diseases early by identifying subtle indicators of disease progression. They can also monitor how a disease progresses over time and even predict how well a treatment might work based on initial imaging results. For instance, in cancer treatment, AI can assess the diversity of tumours, enabling doctors to choose the most effective targeted therapies. Similarly, tools for analysing wounds can assist healthcare providers in understanding healing processes

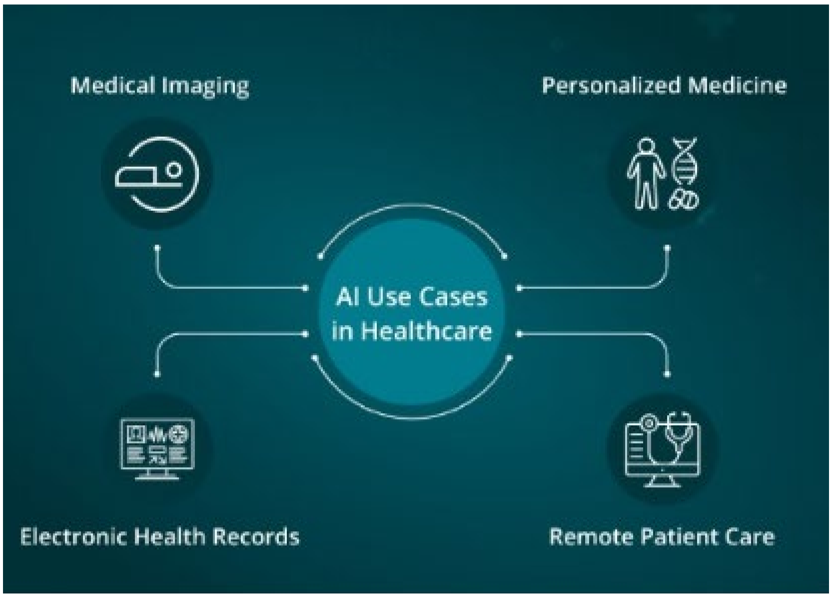

Figure 1. AI systems can assist clinicians by providing evidence-based recommendations (Courtesy images from Niazi et al.,2019)

in patients with diabetes or those undergoing surgery and foresee possible complications. It isn't limited to imaging; it's also making waves in the interpretation of genetic data (Cesario et al., 2021). By analysing large volumes of genetic information, AI can identify mutations and patterns that influence how individuals respond to diseases and treatments. When combined with data from other biological fields, such as proteins and metabolites, AI enables a tailored approach to healthcare. This is particularly transformative in oncology, where understanding a tumour's genetic makeup can inform decisions about immunotherapy. Moreover, AI excels in predictive analytics by sifting through various data sources, such as electronic health records and information from wearable devices, to estimate risks associated with diseases. These predictive models can identify individuals at risk for chronic conditions, such as diabetes or heart disease, and suggest lifestyle modifications that may be beneficial for them (Figure 2). AI systems have also shown promise in anticipating hospital readmissions and detecting early signs of severe conditions, such as sepsis, long before symptoms appear, allowing healthcare providers to intervene quickly and improve patient outcomes (Chavarriaga et al., 2020). Overall, by offering these multifaceted diagnostic capabilities, AI significantly boosts the accuracy and personalisation of modern healthcare.

3. Personalised Treatment Planning with AI

Artificial Intelligence (AI) is revolutionising the way we approach personalised treatment in healthcare, making it more tailored to each patient's unique needs. By continuously analysing various data, such as lab results, medical images, and patient-reported health information, AI can create and adjust personalised care plans in real-time. These AI systems often operate within Clinical Decision Support Systems (CDSS), which help healthcare providers select the most suitable treatment options based on the latest research and individual patient information. By learning from past cases of patients with similar profiles, AI can predict how an individual might respond to different therapies, thereby guiding doctors in their decision-making (Saha et al.,2025). For instance, in oncology, AI combines data from tumour genetics, pathology reports, and treatment histories to suggest personalised chemotherapy or immunotherapy combinations that are more likely to be successful. But AI's role doesn't stop at planning treatments. It also helps determine the correct drug dosages and checks for interactions between medications. By considering factors such as a patient's age, weight, organ function, and genetic makeup, AI can recommend dosages that enhance effectiveness while minimising side effects. This is particularly important for patients taking multiple medications, where managing interactions can be complex. Platforms like IBM Watson for Oncology demonstrate how this technology can align treatment recommendations with the latest clinical guidelines, ensuring that every patient receives care that is not only highly personalised but also safe and effective (Davenport et al., 2019).

4. AI-Enabled Integrative Medicine

Artificial Intelligence is making a real difference in integrative medicine by helping create a holistic approach to healthcare. This means blending traditional treatments with evidence-based complementary therapies, all while keeping the patient at the centre. With its ability to analyse vast amounts of data, AI can offer insights into how effective and suitable different complementary treatments are, such as acupuncture, yoga, herbal medicine, and

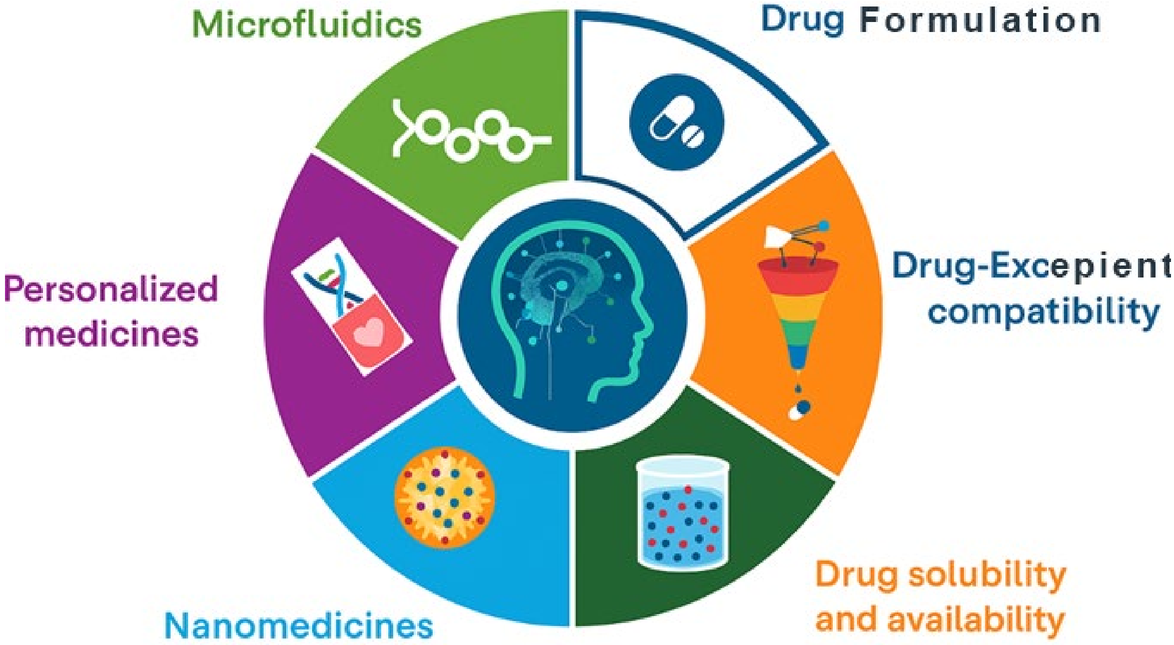

Figure 2. AI predictive modelling in personalised medicines, drug formulation, drug–excipient compatibility, drug solubility, bioavailability, nanomedicines, and microfluidics (Courtesy images from Serrano et al.,2024).

dietary changes. One of the key benefits of AI is its ability to identify potential interactions between herbal supplements and prescription medications, which is crucial for ensuring patient safety in integrative care. Beyond that, AI can suggest personalised wellness strategies that resonate with a person's unique health needs, preferences, and cultural background (Mondal et al.,2025). For example, it might recommend mindfulness therapies for a cancer patient dealing with anxiety or tailored dietary changes for someone with autoimmune issues based on their gut health. AI also excels in supporting behavioural and lifestyle changes, which are crucial for managing chronic conditions. Think of AI-powered apps and virtual health coaches that track everything from your physical activity and sleep patterns to your diet and mood. These tools provide personalised strategies for achieving goals such as weight loss, quitting smoking, or managing stress. They often make the process more engaging by using motivational techniques and gamification, helping you stick to your health goals in a fun way. By combining both medical and lifestyle aspects of care, AI enhances the effectiveness of integrative medicine, enabling patients to actively participate in their health journeys.

5. Artificial Intelligence in Drug Discovery and Delivery: Shaping the Future of Personalised Medicine

Artificial Intelligence (AI) is reshaping the future of modern healthcare in remarkable ways, particularly in the areas of drug discovery and delivery, making the entire process faster, more accurate, and cost-effective. In the past, bringing a new drug to market could take over a decade and cost billions of dollars, involving painstaking phases of molecular research, animal testing, and extensive clinical trials that seemed to stretch on indefinitely. However, the introduction of machine learning algorithms, deep learning frameworks, and big data analytics has begun to revolutionise this landscape (Fritsch et al.,2022). AI is now expediting the journey from laboratory discovery to clinical application, ushering in a pioneering era of precise, predictive, and personalised medicine. In the initial stages of drug development, AI plays a crucial role through a technique known as in silico modelling. This approach involves computer-based simulations that analyse how different molecules interact with biological targets (Table 1). Instead of a painstaking trial-and-error method that requires screening thousands of compounds, AI algorithms can quickly predict factors like binding affinities, pharmacokinetics, and potential side effects by identifying patterns in massive chemical and biological databases. A standout achievement in this area is DeepMind's AlphaFold, which can predict protein structures with impressive accuracy. This capability is vital for designing drugs aimed at serious conditions, such as Alzheimer's and cancer, areas where protein modelling once represented a significant hurdle. Beyond merely targeting molecules, AI also serves a pivotal function in predicting the pharmacological properties of

Table 1. Integrative Approaches of AI in Personalised Disease Management

AI Applications	Benefits	References
- Medical imaging analysis (X-ray, MRI, CT)- Genetic data interpretation- Predictive analytics from EHRs and wearables	- Early and accurate disease detection- Tailored diagnostics- Risk prediction	Caparrós et al., 2022; Cesario et al., 2021; Chavarriaga et al., 2020
- Clinical Decision Support Systems (CDSS)- Therapy and dose optimisation- Drug interaction monitoring	- Real-time, evidence-based personalised therapy- Safer medication plans	Davenport et al., 2019
- AI-assisted complementary therapy suggestions (herbal, yoga)- Behavioural and lifestyle recommendation engines- Interaction checks	- Holistic care models- Enhanced patient adherence- Culturally sensitive therapies	Mondal et al.,2025
- In silico modelling- Deep learning for molecular targeting- Predictive ADMET screening- Virtual screening and de novo design	- Faster, cheaper, and more accurate drug development- Identification of novel therapies	Fritsch et al., 2022; Gokdeniz et al., 2022
- Smart nanocarriers- AI-powered wearable delivery devices (e.g., insulin pumps)- Implantable microchips- CRISPR editing guides	- Targeted delivery- Adaptive and remote-controlled therapy- Enhanced treatment precision	Hassan et al., 2022; Hosny et al., 2018
- Medical transcription & documentation via NLP- AI in billing, scheduling, insurance- Predictive workflow and resource optimisation	- Reduced clinician workload- Cost-efficient operations- Better patient throughput	Iqbal et al., 2021; Jackson et al., 2021
- Bias in training data- Consent and data privacy issues- Lack of explainability in AI decisions	- Awareness needed for fair, transparent, and trustworthy AI integration	Jin et al., 2020
- Quantum computing in drug discovery- AI-enhanced gene editing (CRISPR)- AR/VR in surgical navigation and mental health support	- Improved accuracy and speed in therapies- Immersive care and training experiences	Kim et al., 2023; Kumar et al., 2023
- Wearables for glucose, HR, O_2, sleep monitoring- Predictive analytics for readmission risk and deterioration	- Preventive care- Early intervention- Reduced hospital visits	Tufael et al., 2023; Siddique et al., 2018

prospective drugs. It assesses factors such as absorption, distribution, metabolism, and excretion (ADME), as well as toxicity (Gokdeniz et al.,2022). Supervised learning models, trained on historical drug data, can identify molecules that are likely to cause adverse effects or fail during clinical trials, effectively preventing costly late-stage failures and reducing development expenses. Alongside this, AI-enhanced virtual screening tools are capable of evaluating millions of compounds and simulating their biological effects. Additionally, generative algorithms, including Generative Adversarial Networks (GANs) and reinforcement learning models, are paving the way for the creation of entirely new drug candidates through de novo design, which significantly expands the therapeutic options available. When it comes to drug repurposing, AI proves to be an invaluable asset by pinpointing new uses for existing medications through thorough analyses of genomics, transcriptomics, electronic health records, and clinical trial data. This method has expedited the identification of potential treatments during urgent public health crises, such as the COVID-19 pandemic, and presents promising opportunities for addressing rare and complex diseases (Mondal et al.,2025). Innovative companies like IBM Watson and BenevolentAI are at the forefront, developing platforms that connect gene-disease-drug relationships, often uncovering novel therapeutic possibilities at a fraction of the usual costs. AI's impact doesn't stop at discovery; it also plays a transformative role in drug delivery systems. Through the development of smart nanocarriers, AI enables the delivery of drugs directly to affected tissues, significantly reducing harm to healthy cells and minimising side effects. These advanced nanocarriers can respond to internal stimuli, such as changes in pH, temperature, or enzymatic activity, ensuring that the medication is released precisely where it is needed. AI models contribute to the design of these carriers by optimising their characteristics based on the unique physiological data of individual patients. Moreover, wearable devices powered by AI are transforming the management of chronic diseases (Hassan et al.,2022). Devices like AI-driven insulin pumps or smart inhalers utilise real-time biosensor data to dynamically adjust drug dosing, thereby providing more personalised and adaptive treatment options. These systems offer closed-loop feedback mechanisms, which diminish the need for manual intervention while simultaneously improving therapeutic outcomes. Looking ahead, the merging of AI and robotics is poised to redefine how drugs are administered. Cutting-edge research is underway to develop implantable microchips capable of storing and delivering medications in pre-programmed doses, activated by biometric signals or remote commands. For those suffering from chronic illnesses like epilepsy or rheumatoid arthritis, these implants could help automate long-term therapy, enhance patient adherence, and reduce the necessity for hospital visits. AI also contributes to the precision of gene editing by designing CRISPR guide RNAs, which minimise off-target effects and enhance editing accuracy. When combined with gene therapy, AI-driven strategies can facilitate highly personalised treatments tailored to an individual's unique genetic makeup, offering hope to those affected by previously untreatable genetic conditions (Hosny et al.,2018). However, even with these exceptional capabilities, the integration of AI in drug discovery and delivery does come with its share of challenges. Issues concerning data quality and algorithmic bias are significant concerns, especially when models are trained on datasets that are not representative of the diverse patient population. This could lead to inequitable healthcare outcomes and erode trust in AI systems. The transparency and explainability of AI decisions become critical, particularly in life-sensitive areas such as medicine. Regulatory challenges also persist, as entities such as the FDA and EMA continue to develop comprehensive guidelines for evaluating

AI-generated therapies. Additionally, ethical considerations surrounding data privacy, patient consent, and equitable access to AI-driven treatments must be actively addressed to prevent the further entrenchment of existing healthcare disparities (Saha et al.,2024). While AI holds the potential to revolutionise medical practice by making it more personalised, affordable, and efficient, navigating these complexities will be crucial to realising the full promise of AI in healthcare.

6. Operational and Administrative Applications

Artificial Intelligence (AI) is revolutionising the way healthcare systems operate, ushering in a new era where efficiency, accuracy, and responsiveness are paramount. One of AI's most significant contributions lies in its ability to automate repetitive and time-consuming administrative tasks that have long burdened healthcare professionals. With the aid of advanced natural language processing (NLP), AI can now transcribe medical notes, summarise patient records, and manage clinical documentation with remarkable speed and precision. This not only lightens the documentation workload for clinicians but also reduces the likelihood of human error in record-keeping, a crucial factor in ensuring patient safety and continuity of care. By handling these essential yet mundane tasks, AI enables doctors, nurses, and administrative staff to devote more time and energy to what truly matters: direct interaction with patients and making informed medical decisions—areas where the human touch remains irreplaceable (Iqbal et al.,2021). Moreover, AI is revolutionising healthcare administration by simplifying complex processes, such as appointment scheduling, billing, insurance claims processing, and prior authorisations. Intelligent algorithms can effectively optimise appointment slots based on clinician availability and patient urgency, resulting in fewer no-shows and improved scheduling efficiency. AI-driven billing systems can automatically identify billing codes, verify their compliance, and submit claims with minimal human oversight, thereby enhancing revenue cycle management while reducing administrative burdens. When it comes to insurance processing, AI can verify patient coverage, flag inconsistencies, and even pre-authorise necessary treatments using historical data and payer policies, significantly accelerating the approval process for essential treatments and interventions.

Beyond these routine tasks, AI is also being woven into the very fabric of clinical workflow optimisation. Predictive analytics tools powered by AI can scrutinise a patient's electronic health record (EHR), lab results, imaging data, and real-time monitoring inputs to assess their risk level for specific conditions. This enables proactive care interventions, such as early detection of sepsis or timely referrals for specialist care. AI algorithms can prioritise radiology images, highlighting those with potentially urgent findings, which enables radiologists to respond to critical cases more efficiently (Jackson et al., 2021). In addition, AI aids in forecasting resource needs—such as predicting ICU bed demand during flu season or a pandemic and optimising staff scheduling to meet expected patient volumes. These capabilities not only minimise delays in care but also enable healthcare institutions to allocate resources more cost-effectively. In essence, AI is not merely a tool for automation; it is a strategic asset that drives systemic improvements in healthcare delivery. It enhances operational efficiency, ensures better resource utilisation, minimises human errors, and contributes to a more seamless patient journey from registration to discharge. Most importantly, by alleviating administrative burdens and enhancing workflow efficiency, AI empowers healthcare professionals to focus on what they do best: delivering compassionate, timely, and high-quality care to every patient. As AI continues to evolve, its role in healthcare administration will become increasingly crucial, shaping a more innovative and more patient-centred healthcare system for the future.

7. Ethical, Legal, and Social Considerations

The use of AI in personalised disease management raises important ethical, legal, and social issues that we must address to ensure healthcare is both safe and equitable. A significant concern is data privacy and informed consent. AI relies on vast amounts of patient data, which raises concerns about unauthorised access, data breaches, and whether patients understand how their information is being used. Patients often face consent fatigue, feeling overwhelmed by repeated requests for permission to use their data without fully grasping the consequences. Another issue is the potential for bias in AI systems, particularly when they are trained on datasets that do not accurately represent everyone. For example, facial recognition technology can struggle with identifying people of colour accurately, and health algorithms might not serve minority groups well, leading to skewed health outcomes (Jin et al.,2020). To help prevent these problems, AI developers should utilise diverse datasets and regularly assess fairness in their algorithms. Additionally, we need to consider the explainability and accountability of AI systems. Clinicians must trust and understand the recommendations generated by AI. Still, many models often feel like "black boxes," making it hard to explain their decisions or pinpoint responsibility when things go wrong. That's where the field of Explainable AI (XAI) comes in, which aims to make these technologies more transparent and comprehensible. Ultimately, addressing these ethical, legal, and social challenges is crucial for the responsible integration of AI into personalised medicine.

8. Discussion

The integration of Artificial Intelligence (AI) into healthcare, particularly in personalised disease management, represents a significant shift away from traditional one-size-fits-all methods toward a more tailored, patient-focused approach to care. The integration of extensive biomedical data, significant advancements in computing power, and the development of sophisticated machine learning algorithms drive this evolution. AI's influence extends across the entire spectrum of disease management, from the initial stages of diagnosis to personalised treatment plans, drug delivery, and continuous patient monitoring, heralding a transformative era known as precision medicine (Mondal et al., 2025). One of the standout roles of AI is its ability to enhance the accuracy of diagnoses. While traditional diagnostic techniques can be effective, they often require considerable time and are susceptible to human error. In contrast, AI and deep learning algorithms have proven to be exceptionally skilled at interpreting intricate diagnostic information, including medical imaging, pathology slides, and genomic data (Kumar et al., 2023). For example, AI-powered image analysis programs have demonstrated superior performance compared to radiologists in detecting breast cancer through mammograms and identifying diabetic retinopathy in retinal images. Additionally, natural language processing (NLP) tools can sift through unstructured electronic health records (EHRs) to identify potential diagnoses or uncover clinical patterns that may signal the need for early interventions (Rabi Sankar Mondal et al.,2024). These abilities are critical for diseases such as cancer, cardiovascular disorders, and neurodegenerative conditions, where timely detection can markedly improve prognosis and treatment outcomes. Aligned closely with improved diagnostics, AI also plays a pivotal role in genomics and personalised medicine. AI algorithms adeptly analyse genomic and proteomic data to identify disease-related variants and forecast disease risk. Such genomic insights enable healthcare professionals to categorise patients based on their genetic risk profiles, allowing them to devise tailored preventive measures (Tufael et al.,2023). Moreover, AI facilitates pharmacogenomics, the examination of how genetic factors influence an individual's response to medications by predicting how people metabolise certain drugs. This insight is crucial for avoiding adverse drug reactions and enhancing treatment effectiveness. For instance, AI models have successfully matched cancer patients with targeted therapies based on the genetic characteristics of their tumours, thereby significantly improving treatment outcomes. In the era of real-time monitoring and remote patient management, AI-driven wearable devices and mobile health applications have emerged as key players. These innovative tools continuously monitor parameters such as heart rate, oxygen levels, glucose measurements, and sleep patterns. By analysing this data, AI can detect deviations from established health baselines, often even before physical symptoms appear, allowing for prompt medical action. Additionally, AI-powered predictive analytics can alert healthcare providers to potential complications or declines in health, which helps to lower hospital readmission rates and fosters proactive care. This capability is especially valuable for managing chronic conditions such as diabetes, hypertension, and chronic obstructive pulmonary disease (COPD) (Bhuiyan et al., 2025). Another frontier where AI is making a profound impact is in drug discovery and development, as well as in the development of drug delivery systems. The traditional drug development process is notoriously lengthy and expensive, often taking over a decade and is plagued by high failure rates. AI accelerates this timeline by utilising molecular docking simulations, quantitative structure-activity relationship (QSAR) modelling, and compound screening to identify promising drug candidates more rapidly. Furthermore, AI can predict issues concerning the toxicity, solubility, and bioavailability of compounds at early stages, which helps mitigate the risks of failures in later phases of development. Platforms like DeepMind's AlphaFold have made groundbreaking contributions to structural biology by accurately predicting protein structures, which are crucial for identifying new drug targets for diseases such as Alzheimer's and various types of cancer (Tufael et al., 2023). Not only does AI aid in the discovery of new drugs, but it also transforms personalised drug delivery methods. State-of-the-art AI-integrated drug delivery systems are being developed to ensure that medications are administered at the precise dose, exactly when needed, and at the correct location within the body. Smart nanocarriers, guided by AI algorithms, can accurately target specific tissues or cellular receptors, thereby reducing systemic side effects and enhancing the effectiveness of treatments. Furthermore, wearable drug delivery devices, such as insulin pumps, are being increasingly enhanced with AI algorithms that create feedback systems to automatically adjust dosages based on real-time glucose levels. These technological advancements represent a significant step toward achieving fully autonomous and adaptive treatment systems. AI is also making waves in the operational and administrative facets of healthcare. While these aspects may not involve direct patient care, they have a substantial impact on personalised disease management (Mondal et al.,2024). By automating routine tasks such as medical transcription, billing, appointment scheduling, and insurance processing, the administrative burden on healthcare professionals is significantly reduced, allowing them to dedicate more time to patient interactions. Moreover, AI-driven clinical workflow management tools provide substantial assistance in triaging patients and prioritising imaging, enabling healthcare providers to function more efficiently while maintaining a focus on delivering high-quality care. Looking ahead, the future of AI in personalised disease management holds exciting opportunities. We are witnessing remarkable advancements as emerging technologies, such as virtual reality (VR) and augmented reality (AR), collaborate with AI to enhance patient care and medical training. For example, VR is becoming a valuable tool in pain distraction therapy, helping people manage chronic pain more effectively. On the surgical side, AR is proving to be invaluable, assisting surgeons with real-time guidance and navigation during intricate procedures, which can significantly improve patient outcomes. Additionally, the collaboration between AI and gene editing technologies, particularly CRISPR, presents groundbreaking possibilities for addressing genetic disorders (Tufael et al., 2022). AI can refine the design of guide RNAs, allowing for more precise gene targeting. This refinement minimises off-target effects, thereby enhancing the safety and effectiveness of gene therapies for conditions such as cystic fibrosis and sickle cell anaemia, which have long required innovative solutions. The realm of mental health care is also witnessing exciting developments through the use of AI. AI-powered chatbots and sophisticated sentiment analysis tools are being employed to track patients' language and behaviour patterns, enabling the early detection of signs of depression, anxiety, or even suicidal thoughts (Mondal et al.,2025). These tools can provide immediate support to individuals and alert healthcare providers when intervention is needed, particularly in areas that may lack adequate mental health resources. Moreover, the integration of quantum computing with AI, a field known as quantum AI, holds remarkable potential for revolutionising drug discovery and design (Siddique et al.,2018). By dramatically accelerating molecular simulations and compound screenings, quantum AI could significantly reduce the time it takes to bring new therapies to market, ensuring that patients have access to the latest treatments more quickly than ever before. Importantly, AI is more than just a technological advancement; it serves as a strategic ally in the realm of personalised medicine, which has the power to analyse extensive datasets, recognise patterns, and make high-accuracy predictions, opening the door to breakthroughs in how we manage diseases (Akter et al.,2025). Yet, for these potentials to be fully realised, we must prioritise responsible development, foster interdisciplinary collaboration, and adhere to ethical standards. By embracing these principles, AI has the potential to become the backbone of a healthcare system that is more precise, equitable, and efficient, transforming it into one that is not only deeply personalised but also profoundly impactful in the lives of patients.

9. Future Perspectives

The future of AI in personalised disease management is inspiring and has the potential to transform lives in numerous innovative ways. One up-and-coming area is the combination of AI with virtual reality (VR) and augmented reality (AR). These technologies are being used more and more to help manage pain and reduce stress for people with chronic illnesses. They're also providing immersive training experiences for medical professionals and enhancing precision in surgeries through real-time navigation. Another fascinating development is the role of AI in gene editing, particularly in enhancing CRISPR technology (Bhuiyan et al.,2023). With the help of AI, researchers can design guide RNAs that are highly targeted, allowing for more accurate corrections of genetic disorders such as cystic fibrosis and muscular dystrophy, which is a significant step forward for those affected by these conditions. In the field of mental health, AI chatbots and tools that analyse emotions are making it easier to spot early signs of issues like depression, anxiety, and even suicidal thoughts by examining patterns in how people express themselves through speech and text. Moreover, an exciting crossover is occurring with quantum computing, often referred to as Quantum AI, which is poised to transform the field of drug discovery dramatically. Quantum algorithms can perform incredibly complex simulations of molecules and screen compounds at lightning speed, which could significantly reduce the time required to develop new medications (Kim et al., 2023). All these advancements underscore how AI is not just a tool, but a key player in shaping a more personalised, precise, and proactive approach to healthcare. It's an era filled with hope for achieving better health outcomes for individuals.

10.Conclusion

Integrative AI is revolutionising personalised healthcare by offering more accurate diagnoses and customised treatments based on our unique genetic makeup. It allows for better drug delivery and ongoing monitoring, paving the way for truly individualised patient care. Yet, to fully realise AI's benefits, we must tackle ethical issues and ensure data security while upgrading our healthcare infrastructure. By prioritising a human-centred approach, we can implement these technologies responsibly. With thoughtful integration, AI has the potential to improve health outcomes, enhance patient satisfaction, and make our healthcare systems more efficient.

Author contributions

M.S.A. and A.R. contributed to the conception, literature review, writing, and revision of the manuscript. All authors read and approved the final version of the manuscript.

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