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ARTIFICIAL INTELLIGENCE: IN PRECISION MEDICINE

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ABSTRACT

Precision medicine is being transformed by artificial intelligence, which now allows for predictive diagnostics and personalized therapies. Machine learning (ML) has made tremendous strides in the medical field of genetics, creating classification models for the identification of autoimmune liver diseases (AiLDs), psoriasis, lesions, and skin cancer. AI is emerging as a crucial tactic in digital pathology to get over the limitations of black-box AI models, especially when it comes to rare pediatric endocrine illnesses. AI has the potential to improve diagnostics, identify susceptible genes, and customize treatment for autoimmune hepatitis. Artificial intelligence has potential for revolutionizing the diagnosis, treatment, and management of thyroid, pituitary, adrenal, and pancreatic cancers in endocrinology. This review discusses the use of artificial intelligence in screening, diagnosis, risk assessment, translational research, and preventative medicine.

Keywords: Precision Medicine, Artificial Intelligence (AI), Machine Learning (ML), Predictive Diagnostics, AI in Medicine, Autoimmune Liver Diseases (AiLDs)

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1. INTRODUCTION

Precision medicine aims to discover subpopulations with varied disease risk, therapeutic responsiveness, and treatment results as a result of biological distinctions. Genomic sequencing is used to develop biomarkers, and AI can assist in the analysis of this data. Precision medicine has been transformed by AI thanks to its predictive diagnostics and customised treatments. It facilitates early illness detection, accurate diagnosis, and the discovery of new treatment targets. By navigating chemical structures and anticipating interactions, AI also speeds up the drug discovery process. To fully realise AI's potential in precision medicine, more study is necessary.

By customising therapies for each patient according to their covariate history, demographics, genetic composition, and the results of diagnostic tests, precision medicine, a data-driven approach to healthcare, seeks to improve clinical outcomes. This understanding enables clinicians to determine the appropriate treatment strategy for each patient, resulting in more successful disease targeting. AI, which was initially recognised in the 1960s, has evolved into machine learning (ML), a branch of AI that use numerical approaches to train programs for data processing. Medical advances employing machine learning (ML) include the development of classification models for psoriasis, skin cancer, and lesions based on clinical imaging data.

Through the analysis of enormous volumes of intricate biological and clinical data, artificial intelligence (AI) is transforming precision medicine by offering predictive diagnostics and individualised treatments [1].

The use of AI in healthcare is revolutionising precision medicine by enhancing medication responsiveness, illness risk assessment, and treatment results[2]. Accurate diagnosis, early illness detection, and the discovery of new therapeutic targets are all made possible by machine learning algorithms[1]. By traversing chemical structures and forecasting drug-target interactions, artificial intelligence speeds up the drug discovery process[1]. The technology is essential for converting high-dimensional data from electronic health records and biobanks into precision medicine tools that can be used in clinical settings[3]. By placing patients at the point of care and facilitating sophisticated analytics of enormous volumes of data, AI is propelling a change in medicine towards prevention, personalisation, and precision[4].

In endocrinology, artificial intelligence (AI) has promise for transforming the identification, management, and therapy of endocrine problems. Applications of AI in screening, diagnosis, risk assessment, translational research, and preventative medicine are examined in this review. AI has demonstrated significant advancements in comprehending the complex mechanisms behind endocrine diseases and improving healthcare outcomes. AI-driven methods make it easier to create precision medicine plans, which allow for patient-specific interventions based on their unique needs and features. A future in which medical practitioners and AI systems work together in a synergistic manner to improve the lives of people with endocrine illnesses might be imagined by integrating AI in endocrinology. With the use of clinical imaging data, machine learning (ML) has advanced significantly in the medical field, developing classification models for the diagnosis of psoriasis, lesions, and skin cancer.

2. LITERATURE REVIEW

Artificial intelligence is transforming precision medicine by enabling predictive diagnostics and customised treatments. The medical discipline of genetics has seen enormous advancements thanks to machine learning (ML), which has produced classification models for the identification of skin cancer, psoriasis, lesions, and autoimmune liver disorders (AiLDs).

Artificial intelligence (AI) has advanced from the experimental stage to the implementation stage in various domains, including medicine. Machine learning (ML) is a branch of AI that identifies patterns in complex datasets, enhancing the functionality of ART. This combination of AI and reproductive medicine is crucial for future medical advancement[5].

With applications in cancer diagnosis, molecular characterisation, drug development, and patient treatment prediction made possible by deep learning architectures, high-dimensionality datasets, and high-performance computers, artificial intelligence is transforming personalised clinical care and cancer research. AI could have a big influence on oncology by improving diagnostics and finding novel medications. [7].

Vascular medicine is being revolutionised by artificial intelligence, a potent collection of computer-based statistical techniques that are also improving operational efficiency and massive data banks. Pathophysiological discoveries, patient care decision support, and logistical process optimisation are some examples of applications. The leading field is machine learning, especially deep learning, which has had success in imaging processing, risk prediction, early warning systems, and disease pheno-mapping [12].

By enabling early disease prediction and the customisation of successful treatments, precision medicine and genomic medicine are transforming healthcare. These devices can detect changes in health by looking at general factors and patient data. By enabling predictive models educated on cell attributes, genomic medicine and artificial intelligence are enhancing physician decision-making. A new era of genetic medicine can be ushered in by researchers using machine learning and more accessible datasets. [24].

Artificial intelligence (AI) mimics human intelligence using computing methods, particularly in medical fields like cardiovascular medicine. AI aids in noninvasive imaging processes, including acquisition, reconstruction, segmentation, measurement, and interpretation. Scalable AI programs can analyze large volumes of data, enhancing productivity and producing objective quantitative findings. Lin et al. (2020) and Badano et al. (2020) underlined that AI may be integrated into clinical reporting and cardiac imaging analysis software in the future.

The need for predictive assays for patient therapy has grown as a result of precision oncology. However, intricate signalling networks make it difficult to create biomarkers based on individual genes. By analysing subvisual morphometric features, artificial intelligence and machine learning technologies in digital pathology can enhance patient care. This viewpoint assesses computational methods for digital pathology that rely on artificial intelligence. Bera et al., (2019) showed some of the difficulties associated with using AI, such as the requirement for carefully selected validation datasets, regulatory clearance, and equitable reimbursement practices and the prospective directions for precision oncology in the future.

Effective data collection, processing, and characterisation are required due to the growing volume of data in biomedicine. Deep learning-capable artificial intelligence (AI) can support fundamental research, diagnostics, medication discovery, and clinical trials, especially for rare diseases (RDs). AI technology can overcome obstacles like geographical dispersion and low diagnosis rates, combine data from several sources, and greatly accelerate the creation of new therapies. Brasil et al., (2019) in their article cover congenital glycosylation diseases and provide an overview of AI techniques in RDs.

- **An overview of precision medicine and AI and its application to reproductive medicine**

Genomic sequencing is used to detect individual tumours in precision medicine, a technology-driven personalised approach to treating diseases caused by genetic events. This method uses artificial intelligence and machine learning to integrate data from imaging, metabolomics, epigenomics, and genomics. Reproductive medicine is currently being influenced by this strategy, which has been used in fields like cancer. However there are still obstacles and restrictions in this emerging industry. Thanks to developments in learning algorithms, massive datasets, and processing capacity, artificial intelligence has expanded quickly across several industries, including medicine. The use of machine learning (ML) in healthcare is growing, as it enhances the effectiveness of assisted reproductive technology (ART). Notwithstanding obstacles, it is anticipated that the combination of AI and reproductive medicine will result in significant advancements in medicine down the road.

In the field of reproductive medicine, artificial intelligence (AI) is developing quickly and has potential uses in assisted reproductive technologies (ART) and infertility treatment [5]. In order to predict sperm quality, improve embryo selection, and improve semen analysis for improved pregnancy outcomes, artificial intelligence and machine learning approaches are being used. Additionally, these technologies have the potential to improve testicular sperm retrieval processes and diagnose and treat female infertility. It is anticipated that the application of AI in reproductive medicine would result in faster, more accurate, and objective methods, which will increase the field's precision and standardisation [6]. Despite obstacles, as precision medicine advances and big datasets become more accessible, AI's significance in reproductive care is probably going to grow [5]. The future of ART and reproductive medicine could be greatly impacted by this integration [5][6].

2.1 AI in Precision Medicine and Cancer Research

With the use of deep learning architectures, high-dimensionality datasets, and high-performance computing, artificial intelligence (AI) is transforming precision medicine, personalised clinical care, and cancer research. These applications include cancer detection, molecular characterisation, drug discovery, and patient treatment prediction. Oncology could be greatly impacted by AI, which could improve diagnosis and lead to the development of new medications [7].

Personalised clinical treatment and cancer research are aided by artificial intelligence (AI). AI is revolutionising cancer detection, classification, molecular characterisation, drug development, and treatment prediction through the use of deep learning architectures, high-dimensionality datasets, and high-performance computers. AI can change the way cancer is treated by improving diagnosis, tailoring treatment, and finding novel anticancer medications. Applications of AI include drug discovery, molecular tumour characterisation, cancer detection and classification, and treatment outcome prediction [8].

Precision oncology can be advanced by machine learning, especially deep learning, which is excellent at identifying patterns in big, complicated datasets [9]. Significant advancements in personalised cancer care have resulted from the use of AI with medical imaging and high-throughput omics technologies[7] [9]. There are still issues, though, such as possible biases in the implementation and design of algorithms, which could make already-existing health inequities worse [10] . To fully realise the potential of AI in oncology and provide fair AI-driven cancer care, it is imperative that these issues be addressed through open and inclusive methods [10] .

2.2 AI in Precision Cardiovascular Medicine

Because it offers advanced statistical tools for massive data repositories and operational efficiency, artificial intelligence is revolutionising cardiovascular medicine. With applications in automated imaging processing, risk prediction, early warning systems, disease phenomapping, and operational efficiency, machine learning—both supervised and unsupervised—is widely used. AI has proven to be more effective than humans at creating predictive models, early warning systems, and disease phenomapping. Large-scale deployment in cardiovascular practice requires widespread adoption. By improving diagnosis, prognosis, and treatment approaches, artificial intelligence is transforming precision cardiovascular medicine. AI methods, especially machine learning algorithms, are being used to lower mortality rates, enhance patient care quality, and investigate novel genotypes and phenotypes [11]. These powerful computer-based technologies employ vast data repositories to find complex associations and construct predictive models [12].

From automated image interpretation and disease phenomapping to early warning systems and operational efficiency enhancements, artificial intelligence has a wide range of applications in cardiovascular care (Ranka et al., 2020). Cardiovascular services are seeing an increase in value generation and personalised care due to the integration of AI with laboratory medicine [13]. Using a variety of machine learning models and data sources, including imaging and electronic health records, recent research has concentrated on AI-based techniques for risk stratification, diagnosis, phenotyping, and prediction [14]. Even though AI has the potential to improve cardiovascular care, more study is required to completely assess its clinical usefulness and efficacy.

The application of artificial intelligence (AI) in cardiology is transforming the field, and cardiovascular disease (CVD) is a significant worldwide health concern. Through wearable technology, AI techniques are being utilised to detect malignant arrhythmias, diagnose CAD non-invasively, and accurately forecast the consequences of CVD. AI, the Internet of Things, and precision medicine will play a major role in cardiology in the future, yet there are still unresolved ethical issues [15].

2.3 Digital pathology using artificial intelligence: new diagnostic and precision oncology tools

In digital pathology, artificial intelligence (AI) is becoming a potent instrument for precision oncology and cancer diagnosis. Whole-slide photos can be analysed by AI algorithms, especially those based on deep learning, to help in tumour detection, classification, grading, and prognostic prediction[16] [17]. Digital pathology (DP) is using computer-aided methods, AI algorithms, and digital imagery to revolutionise cancer diagnosis. Imaging may now be included into every facet of pathology reporting because to developments in precision treatment for cancer. Future developments in anatomical and clinical pathology workflows will be made possible by the FDA’s recent approvals of WSI scanners and prostate AI algorithms, which open the door for the use of AI technologies in primary diagnosis. These tools could increase the precision of diagnoses, lessen the workload of pathologists, and facilitate advanced decision-making[18]. Additionally, AI can support personalised medicine by assisting in the identification of genetic alterations, biomarkers, and pathological traits [17]. According to preliminary research, diagnosing cancer micrometastases with AI assistance may improve sensitivity and efficiency [19]. But there are still obstacles to overcome, such as the requirement for carefully selected validation datasets, obtaining regulatory approval, and resolving patient and healthcare professional concerns [16] [17]. Randomised prospective trials are required as AI in pathology develops further in order to validate its advantages and enable broad use [19].

2.4 Implications for managing chronic diseases of precision medicine in the age of artificial intelligence

A dysregulated metabolism lowers life expectancy and causes major health problems. This results in inflammatory pathways, which are set off by environmental elements such as lifestyle and nutrition. Numerous illnesses, including diabetes, obesity, and cardiovascular ailments, are associated with chronic inflammation. Through the use of extensive datasets that incorporate individual gene, function, and environmental differences, precision medicine seeks to enhance diagnosis, treatment, and prognosis. Artificial intelligence and high-performance computing are better at predicting dangers, which enables clinicians to customise early therapies for each patient. Artificial intelligence (AI)-enhanced precision medicine is transforming the management of chronic diseases by combining clinical data, environmental factors, and multi-omics data to deliver individualised therapy [20] [21]. For a number of chronic ailments, such as diabetes, respiratory problems, and cardiovascular diseases, AI-powered precision medicine allows for earlier diagnosis, more precise risk prediction, and customised therapies [20][22] . Patient-specific results and better illness prevention and prediction are achieved by the combination of AI, healthcare, clinical genomics, and pharmacogenomics [23]. But to apply precision medicine in clinical practice, healthcare infrastructure must be redesigned to include the instruments needed for data collection, processing, and interpretation [21]. The doctor-patient interaction is still essential to provide efficient, individualised treatment, even when AI-based solutions help physicians with daily tasks and improve patient monitoring [22].

2.5 Precision and genetic medicine using artificial intelligence and machine learning

Precision medicine requires new methods for processing and comprehending massive information since it leverages multimodal data to understand and treat diseases. Techniques for storing, manipulating, and analysing these intricate datasets have been developed by computer science. One area of artificial intelligence called machine learning assists in spotting intricate patterns in data so that classifications or predictions can be made. The use of machine learning for precision medicine’s “big data” in genomics, genetics, and other fields is the main topic of this paper.

With the use of GPUs and deep learning algorithms, artificial intelligence (AI) is transforming medical diagnosis. Deep learning algorithms are utilised in clinical genomics to analyse massive datasets, while AI-based computer vision techniques are transforming image-based diagnostics. Clinical diagnostic tasks are ideally suited for AI systems, and variant calling, annotation, and classification are new techniques in clinical genomics. There is discussion of upcoming AI uses in risk assessment, personalised treatment, and problem solving.

By facilitating the study of sizable, intricate datasets to enhance patient care, artificial intelligence (AI) and machine learning (ML) are transforming precision and genomic medicine [24][25]. Personalised medicines, improved diagnostic capabilities, and early disease prediction are made possible by these technologies [24]. To develop prediction models for illness risk, prognosis, and treatment response, machine learning algorithms can find patterns

in genomic data, electronic health records, and physiological readouts [25][26]. A deeper comprehension of human health and illness as well as patient-tailored decisions are made possible by the integration of multi-omics data [27].
In addition to resolving ethical issues, new analytical techniques beyond data correlation are required as AI develops [25]. A new era of efficient, personalised medicine might be ushered in by the integration of AI, ML, and genomic medicine, which could also greatly enhance healthcare outcomes [24] [27].

2.6 Personalised treatment with artificial intelligence and machine learning techniques that use gene expression and variant data

By facilitating early disease prediction and individualised treatment plans, artificial intelligence is transforming precision medicine in healthcare. AI can enhance patient care by evaluating patient data and distinguishing between healthy and sick people. By monitoring cell properties like gene up-regulation and protein binding, AI combined with precision and genomic medicine can improve physician decision-making. Researchers can usher in a new era of successful genetic medicine with enhanced datasets and machine learning methods. A clinical research technique called precision medicine creates individualised medicines by utilising multimodal data. Computer science has created methods for processing and analysing the vast and intricate datasets that are produced. A subfield of artificial intelligence called machine learning aids in finding patterns in data, generating classifications or predictions, and improving our comprehension of human health.

With the use of gene expression and variation data for individualised diagnosis and treatment, artificial intelligence (AI) and machine learning (ML) techniques are being used more and more in precision medicine [28]. By examining patient data in conjunction with more general characteristics, these methods allow for early illness risk prediction, enhanced diagnostics, and tailored treatments [24] . AI techniques with high accuracy, sensitivity, and specificity have demonstrated efficacy in treating a variety of neoplasms. These techniques include rule-based systems, deep learning, and linear and nonlinear models [29]. However, there are difficulties in integrating disparate datasets, including processing various data formats, controlling genetic predisposition and environmental factor heterogeneity, and resolving confidentiality issues [30]. Notwithstanding these challenges, genomics and precision medicine using AI and ML techniques present exciting opportunities to further individualised treatment for a range of patients and illnesses[28][24].

2.7 Using artificial intelligence in autoimmune liver disease precision medicine.

Patient-specific precision medicine has become more prevalent in hepatology as a result of the usage of investigative tools and electronic health records (HER). More accurate illness prediction is made possible by models for supervised and unsupervised algorithms that are provided by artificial intelligence (AI), machine learning, and deep learning. NAFLD, cirrhosis, liver fibrosis, and benign tumour differentiation can all be predicted by AI. Data preparation, collection, quality, labelling, and sampling biases are obstacles, nevertheless. AI ushers in a new era of hepatology precision medicine in spite of these obstacles.

In the treatment of autoimmune liver diseases (AiLDs) and other hepatological disorders, artificial intelligence (AI) is becoming a potent precision medicine tool. AI can enhance diagnosis, prognosis, and treatment choices by analysing complex data from several sources, such as imaging, pathology, and electronic health records [31].

AI can be used to pinpoint vulnerable genes, improve diagnosis, and tailor treatment for autoimmune hepatitis. From radiological imaging, machine learning and deep learning algorithms have demonstrated potential in the prediction of cirrhosis, hepatocellular cancer, and liver fibrosis. For more precise diagnosis and treatment suggestions, doctors may find AI-based decision support tools useful in integrating a variety of clinical data [32] . Nonetheless, there are still issues with data quality, algorithm verification, and regulatory clearance [32] . Notwithstanding these challenges, AI has promise for transforming hepatology precision medicine and enhancing patient outcomes.

2.8 Using artificial intelligence to diagnose and cure uncommon diseases

By enhancing the diagnosis and treatment of rare diseases, artificial intelligence (AI) is transforming the healthcare industry. Large datasets can be analysed effectively using machine learning techniques, which also help to uncover patterns and produce important insights. This can decrease drug research expenses, optimise randomised control studies, and get beyond traditional restrictions. Recent developments in AI can make diagnosis and treatment more efficient.

Large datasets can be analysed by AI technologies, especially machine learning, to find trends and produce insights for personalised treatment suggestions and medical diagnosis [33].

AI is utilised in rare illness research to improve analytical processes, conduct clinical investigations, and find new drugs. One popular algorithm in this field is random forest [34].

AI’s capacity to combine data from diverse sources can solve problems associated with uncommon diseases, such as low diagnosis rates and tiny patient populations [35]. AI technologies such as PredictSNP, Face2Gene and REVEL, are increasing the speed and accuracy of diagnosis for Congenital Disorders of Glycosylation (CDG). Additionally, AI is helping to characterise illness symptoms, identify important Golgi proteins, and forecast glycosylation sites [36]. Notwithstanding its promise, there are still issues with data quality, model interpretability, and ethics.

Due to small cohort sizes, interindividual symptom heterogeneity, and a lack of knowledge about disease mechanisms, rare diseases—which impact 300 million people globally—need innovative treatments. Although medication repurposing presents a promising therapeutic option, it might be difficult to connect pharmacological activity to disease processes. To support more than 500 families of rare diseases, the Hugh Kaul Precision Medicine Institute created mediKanren, an artificial intelligence application that connects pertinent resources and literature [37].

2.9 Artificial intelligence in radiomics for radiation therapy precision medicine

Clinical procedures are being transformed by artificial intelligence (AI) and machine learning, especially in the planning of radiotherapy. AI helps in lesion detection and segmentation, which boosts output and quality and may lead to better patient outcomes. Additionally, AI can predict the response to radiotherapy by extracting quantitative imaging features from structural or functional data.

Radiomics and artificial intelligence (AI) together are becoming a potent precision medicine strategy for cancer treatment and radiation therapy. Radiomics can give non-invasive biomarkers for tumour characterisation, prognosis classification, and treatment response prediction by extracting a large number of quantitative features from medical pictures [38] [39] . Because it may capture phenotypic features that are invisible to the human eye, this method holds significant promise for the treatment of lung cancer [39] . The prediction ability of radiomics for a range of clinical outcomes, such as adverse events and survival time, is improved by AI and machine learning algorithms [38] . Clinical translation is hampered by ongoing issues with validation and standardisation across datasets. Notwithstanding these challenges, there is a lot of promise for improving patient care and increasing precision medicine in radiation therapy through the combination of radiomics, AI, and clinical data [38].

In order to better characterise tissue characteristics and generate individualised diagnoses, the radiological reading room is moving towards a symbiosis of computer science and radiology by combining radiomics with artificial intelligence, machine learning, and deep learning. The promise of deep learning and radiomics techniques in precision medicine in radiology to transform clinical decision support is highlighted in this study, which covers both historical and contemporary approaches[40].

2.10 Precision medicine and its strategies to revolutionise medical care

Over the course of the next ten years, precision medicine—which enables healthcare interventions to be customised for patient groups based on factors like illness susceptibility, diagnostic data, or treatment response—is anticipated to become more prevalent in clinical practice. It is anticipated that three forms of precision medicine will develop: omics-based testing, digital health applications, and sophisticated algorithms. From scoping and modelling to decision-making and review, these will have an effect on the HTA process. Precision medicine innovation will alter how health services are delivered and assessed, thereby reducing the shelf life of guidelines and raising structural uncertainty. By 2030, precision medicine could completely transform healthcare by providing individualised treatments based on a patient's genetic, environmental, and lifestyle characteristics [41].

The incorporation of routine clinical genomics, phenomics, artificial intelligence, and big cohorts are important advancements [41]. It is anticipated that the use of precision medicine would increase patient control over health data, healthcare equity, and efficiency [42]. There are still obstacles to overcome, though, such as a lack of proof, problems with data sharing, a sluggish adoption of genetic data, and financial concerns. Digital health applications, 'omics'-based diagnostics, and intricate algorithms are the three primary forms of precision medicine that are expected to emerge. From scoping to decision-making, these developments will affect several phases of health technology assessment, requiring modifications to review techniques to account for intricate treatment pathways and quick technological advancement.

2.11 Precision Pathology with Explainable Artificial Intelligence

In digital pathology, explainable artificial intelligence (AI) is becoming a key strategy to overcome the drawbacks of black-box AI models. To promote trust and understanding among pathologists, AI seeks to make machine learning conclusions accessible, interpretable, and explicable [43][44].

By exposing the root reasons of AI judgements, the incorporation of AI into computational pathology systems can improve pathologists' precision and productivity [45] . Analytical Pathology with Explainable AI. By fusing the advantages of artificial and human intelligence, this method makes it possible to analyse complex data from a variety of sources, such as molecular profiling and histology pictures [46]. Applications such as HistoMapr-Breast show how AI can be used to improve diagnostic procedures and automate operations [45] . As the discipline develops, AI is anticipated to be essential to improving pathologists' capacity to evaluate and comprehend intricate medical data and developing precision medicine [43].

In the treatment of cancer, pathology is essential, and precise histopathologic diagnosis is becoming more and more important. Analysing digital images has the potential to enhance histomorphological assessment. Rapid advancements in computational pathology have been made possible by machine learning, especially deep learning. With applications in histopathology that enhance metastasis identification, Ki67 scoring, Gleason grading, and tumor-infiltrating lymphocyte score, this integration will mark a significant advancement in healthcare during the next ten years. Molecular marker status and survival outcomes in a variety of diseases can be predicted using deep learning algorithms[47].

2.12 A thorough analysis of artificial intelligence in endocrinology

The variety and volume of digital data in endocrinology are growing quickly. The recent growth in the use of well-liked generative artificial intelligence (AI) applications is another example of how computing capabilities are evolving at an astounding rate. Numerous AI-powered diagnostic and treatment tools have already been incorporated into standard endocrine procedures, and advancements in this area are anticipated to continue to pick up speed. In order to manage AI applications, endocrinologists will want assistance. In addition to technical expertise, interdisciplinary thinking is required to handle the significant effects of AI on patient-provider interactions, address the ethical and regulatory implications of AI, and preserve the best possible balance between human input and AI in endocrinology. By improving the diagnosis, management, and therapy of endocrine problems, artificial intelligence (AI) is transforming endocrinology [48].

Natural language processing, artificial neural networks, and machine learning are some of the AI applications in endocrinology [49]

AI has been widely used in diabetes care, especially to improve glycaemic control and forecast complications [49]. Additionally, AI is being used to diagnose thyroid cancer, identify osteoporosis, and determine bone age [49]. AI is used in paediatric endocrinology to diagnose premature puberty, identify growth problems, and use facial recognition for a variety of ailments. Addressing algorithmic bias, data privacy, and ethical issues is essential as AI develops, particularly in the case of uncommon paediatric endocrine disorders. Even though AI has many advantages, clinical expertise and the doctor-patient connection should be enhanced rather than replaced.

Healthcare is undergoing a change because to artificial intelligence (AI), which offers improved computational power and precision. Adrenal, pancreatic, pituitary, and thyroid tumours can now be characterised thanks to machine intelligence in image-based endocrine cancer diagnosis. AI is being incorporated into systems through automated pipelines and developing computing platforms, and it can solve issues with data availability and model interpretability[50].

Certain algorithms are used by virtual AI, like electronic medical records, to identify subjects and gather health-related data. In contrast, machine learning (ML) creates complex networks and models that help computer systems perform better on particular tasks. AI/ML technology has the potential to significantly improve patient treatment modalities, workflow, and diagnosis accuracy in medicine [51].

2.13 Artificial intelligence: enhancing cardiovascular imaging effectiveness

Cardiovascular imaging is being revolutionised by artificial intelligence (AI), which enhances clinical decision-making, efficiency, and accuracy. From acquisition and reconstruction to interpretation and risk assessment, artificial intelligence is used throughout the whole imaging process [52] [53].

Tasks like heart structure segmentation can be automated by machine learning algorithms, which lowers human error and saves time [52]. AI lowers healthcare expenses while improving diagnostic performance, enabling personalised reporting, and improving patient safety [53] . AI supports intravascular imaging and intraprocedural guidance in interventional cardiology [54].Future applications may include expanding the informational value of images, facilitating disease detection, and improving prognosis [52]. While AI shows great promise, challenges such as lack of interpretability and explainability must be addressed [53] As AI continues to evolve, it is poised to work alongside clinicians, augmenting their capabilities and improving patient care in cardiovascular imaging.

3. CONCLUSION

Conclusively, precision medicine has been greatly impacted by artificial intelligence (AI) and machine learning (ML), which have revolutionised healthcare by facilitating personalised medicines and predictive diagnoses for a variety of medical disorders. AI and ML have been essential in developing precision medicine for a variety of conditions, including autoimmune liver diseases (AiLDs), psoriasis, lesions, skin cancer, autoimmune hepatitis, and endocrine disorders like thyroid cancer. In addition to facilitating early illness detection and precise diagnosis, artificial intelligence's capacity to interpret genomic sequencing data and navigate complex chemical structures has also produced new treatment targets, greatly improving medication responsiveness, illness risk assessment, and treatment results.In the end, this has improved the standard of care for patients with these complicated medical diseases by opening the door for more efficient and customised interventions. Furthermore, overcoming the drawbacks of black-box AI models—particularly in the diagnosis of uncommon paediatric endocrine disorders—has been made possible by the incorporation of AI into digital pathology. This has improved our knowledge of the intricate processes that underlie endocrine disorders and created opportunities for the creation of precision medicine strategies that may take into account each patient's particular requirements and characteristics. Improved healthcare outcomes for people with endocrine diseases have been demonstrated by the use of AI in endocrinology in a number of domains, including screening, diagnosis, risk assessment, translational research, and preventative medicine.

Precision medicine and genomic medicine in particular are being transformed by artificial intelligence (AI) and machine learning (ML). Significant improvements in healthcare are being made possible by the application of AI and ML in medicine. Precision medicine and genomic medicine are revolutionising healthcare by making it possible to predict diseases early and customise effective therapies. By examining patient data and general circumstances, these technologies are able to identify changes in health. Reproductive medicine and artificial intelligence (AI) are proving to be essential for future medical development because they improve physician decision-making by using prediction models that are informed by cell characteristics. AI is revolutionising personalised clinical care and cancer research with applications in molecular characterisation, drug development, cancer detection, and patient therapy prediction.By enhancing operational effectiveness, pathophysiology discoveries, patient care decision assistance, and logistical process optimisation, it is revolutionising vascular medicine. Furthermore, by analysing subvisual morphometric data and resolving issues related to developing biomarkers based on individual genes, artificial intelligence (AI) and machine learning technologies in digital pathology are improving patient care. Furthermore, particularly for rare diseases (RDs), AI technology is being important in assisting with basic research, diagnostics, drug discovery, and clinical trials. AI technology can significantly speed up the development of novel treatments by overcoming challenges like low diagnosis rates and regional dispersion. All things considered, the use of AI and ML to medicine has enormous potential for the field's future.

Medicine is undergoing a transformation thanks to the application of artificial intelligence (AI) and machine learning in precision medicine, reproductive medicine, oncology, and cardiovascular care. By enhancing sperm quality prediction, embryo selection, semen analysis, and infertility therapy, artificial intelligence (AI) has great promise for transforming assisted reproductive technologies (ART) in the future. The use of AI in precision medicine is revolutionising drug discovery, treatment prediction, molecular characterisation, and cancer diagnosis, resulting in important breakthroughs in individualised cancer therapy and the creation of new drugs. To guarantee equitable AI-driven cancer care and to fully realise the potential of AI in oncology, it is crucial to address concerns such potential biases in algorithm design and implementation.AI's contributions to cardiovascular medicine are also clear from its use in automated imaging processing, risk prediction, disease phenomapping, and operational efficiency improvements, which provide better methods for diagnosis, prognosis, and therapy. Even though AI has a lot to offer, unsolved ethical concerns must be addressed to guarantee equitable and inclusive AI-driven healthcare. As AI develops, more study is required to completely evaluate its clinical use and effectiveness in order to achieve broad application in medical practice. Unquestionably, the ongoing advancement and integration of AI and machine learning will play a significant role in the future of medicine, offering better patient outcomes, more individualised treatment, and increased precision.

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