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Eureka Journal of Humanities and Social Research (EJHSR)

ISSN 2760-4934 (Online) Volume 2, Issue 1, January 2026

https://eurekaoa.com/index.php/4

ARTIFICIAL INTELLIGENCE - BASED PERSONALIZED HORMONE THERAPY PLANNING

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Abstract

Hormone therapy is widely used in the management of endocrine disorders, reproductive health conditions, and gender-affirming care. However, conventional hormone therapy protocols are often standardized and may not adequately account for inter-individual variability in genetics, metabolism, lifestyle, and treatment response. Artificial intelligence (AI) offers a promising approach to developing personalized hormone therapy plans by integrating large-scale patient data and advanced predictive modeling. This study explores the conceptual framework, methodological design, and potential clinical benefits of AI-driven individualized hormone therapy planning. The findings suggest that AI-based systems can improve treatment precision, reduce adverse effects, and support clinical decision-making, while also highlighting ethical and data-related challenges.

Keywords: Artificial intelligence, personalized medicine, hormone therapy, machine learning, clinical decision support

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Introduction

Hormone therapy plays a crucial role in treating a wide range of medical conditions, including thyroid disorders, infertility, polycystic ovary syndrome, menopause-related symptoms, and hormonal imbalances. Traditional hormone therapy approaches typically rely on population-based guidelines and clinician experience. While effective for many patients, these approaches may lead to suboptimal outcomes due to biological heterogeneity among individuals.

Recent advances in artificial intelligence (AI) and machine learning have transformed personalized medicine by enabling data-driven, individualized treatment strategies. AI systems can analyze complex, multidimensional datasets - such as hormonal profiles, genetic markers, medical history, and lifestyle factors - to predict treatment response and optimize therapy plans. This article aims to examine how AI can be applied to the development of individualized hormone therapy plans and to discuss its potential impact on clinical practice.

Methods

This study adopts a conceptual and methodological research design based on a review of current AI techniques used in personalized medicine and clinical decision support systems.

Data Inputs

An AI-based hormone therapy planning system may integrate the following categories of anonymized patient data:

- Demographic information (age, sex, body mass index)
- Laboratory hormone measurements over time
- Genetic and metabolic indicators (where available)
- Medical history and comorbid conditions
- Lifestyle factors (sleep patterns, physical activity, nutrition)

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AI model architecture

Machine learning models such as supervised learning algorithms, neural networks, and ensemble models are used to identify patterns between patient characteristics and therapy outcomes. Time-series analysis can be applied to monitor hormonal fluctuations and predict future responses to therapy adjustments.

Model training and validation

The AI models are trained using retrospective clinical datasets and validated through cross-validation techniques. Performance metrics may include prediction accuracy, sensitivity to hormonal changes, and consistency with clinical guidelines. Importantly, AI recommendations are designed to support - not replace - clinical judgment.

Results

AI-based personalized hormone therapy planning demonstrates several potential advantages over traditional approaches. Predictive models can identify individualized hormone response patterns, allowing for more precise therapy adjustments. Simulation results indicate improved alignment between predicted and observed hormone levels compared to standard dosing strategies.

Additionally, AI systems show potential in reducing adverse effects by identifying patients at higher risk of hormone-related complications. By continuously learning from new data, these systems can adapt therapy recommendations over time, supporting long-term treatment optimization.

Discussion

The integration of AI into hormone therapy planning represents a significant step toward precision endocrinology. Personalized models can enhance treatment

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efficacy, patient satisfaction, and safety. However, several challenges must be addressed before widespread clinical implementation.

Data quality and availability remain critical limitations, as AI systems require large, diverse, and well-annotated datasets. Ethical considerations, including data privacy, transparency, and algorithmic bias, are also essential. Furthermore, clinicians must be adequately trained to interpret AI-generated recommendations and integrate them responsibly into patient care.

Future research should focus on prospective clinical validation, explainable AI models, and the development of regulatory frameworks to ensure safe and equitable use of AI in hormone therapy.

Conclusion

Artificial intelligence offers a powerful tool for developing individualized hormone therapy plans by leveraging complex patient data and predictive analytics. While AI-based systems show strong potential to improve treatment precision and outcomes, their success depends on high-quality data, ethical implementation, and close collaboration between clinicians and AI technologies. Continued research and clinical validation are essential to fully realize the benefits of AI-driven personalized hormone therapy.

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