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MERGING AI INNOVATION WITH COMPASSIONATE CARE FOR TRANSFORMATIVE PATIENT OUTCOMES. A MINI REVIEW OF NEXT-GEN PHYSICAL THERAPY

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Abstract*:* *The integration of artificial intelligence (AI) into physical therapy is not merely a technological advancement. It represents a paradigm shift in how clinicians assess, treat, and empower patients. As global demographics skew older and the demand for rehabilitation grows, AI offers unprecedented opportunities to enhance precision, accessibility, and efficiency in care delivery. This editorial explores the evolving synergy between AI and human expertise, emphasizing how this collaboration can address current limitations while preserving the irreplaceable value of true patient relationships.*

Keyword*s: Artificial intelligence, physiotherapy, rehabilitation, allied health sciences*

Introduction

AI-driven innovations in physiotherapy are significantly improving patient care across various domains. Platforms like SWORD Health use inertial sensors and computer vision to quantify joint kinematics during functional movements, providing real-time corrective feedback by benchmarking patient performance against biomechanical norms. For instance, a 2023 review reported that AI-guided tele-rehabilitation for knee osteoarthritis led to faster functional recovery compared to traditional methods [1].

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Wearable biosensors, such as inertial measurement units [2] and pressure-sensitive insoles [3], continuously capture data on gait symmetry, postural sway, and activity levels. In stroke rehabilitation, AI models analyzing these data have predicted motor recovery trajectories with excellent accuracy, facilitating early intervention for high-risk patients [4]. These technologies are particularly beneficial for rural or underserved populations, where remote therapeutic monitoring (RTM) bridges geographic gaps in care [5].

Additionally, ambient AI tools, including voice-to-text systems, streamline clinical workflow by auto-populating electronic health records and reducing administrative burdens [6]. Predictive algorithms also identify patients at risk of no adherence or relapse based on factors like exercise consistency and pain progression. A study found that clinics using AI saw a reduction in missed appointments due to proactive patient engagement [7].

Finally, deep learning models are now able to match radiologists in detecting musculoskeletal pathologies on MRI [8, 9]. These models help stratify patients into subtypes, such as "rapid progressors" or "slow responders" in osteoarthritis, enabling therapists to tailor interventions using biomarker-driven insights. These advancements collectively enhance the precision, efficiency, and accessibility of physiotherapy care.

Challenges at the Human-AI Interface

Despite its potential, the adoption of AI in physiotherapy faces several challenges related to ethics, evidence, and implementation. A systematic review found that only 28% of AI-assisted rehabilitation tools were validated through randomized controlled trials, with significant variation in outcomes for pain and function [10].

Moreover, there are concerns about data privacy and algorithmic bias, as AI models trained on non-representative datasets can exacerbate health disparities, such as misdiagnosing age-related gait changes in older populations when trained on younger cohorts [11].

Ensuring HIPAA-compliant data governance frameworks is essential to protect patient trust. Additionally, the therapeutic relationship between clinicians and patients is at risk, as AI cannot replicate the contextual judgment and empathy crucial for understanding why an error occurs for example, whether due to fatigue, fear, or environmental factors—necessitating human insight [12].

Finally, the high upfront costs of AI tools and varying levels of digital literacy among healthcare providers hinder their scalability, particularly in low-resource settings, limiting their widespread adoption [13].

Toward a Collaborative Future: Principles for Progress

Maximizing the potential of AI in physiotherapy requires a balanced, ethically grounded approach. First, prioritizing robust clinical validation is essential, with large-scale trials, such as the ongoing

evaluation of Kaia Health's AI-powered chronic pain app [14], being critical to confirm efficacy across diverse populations.

Secondly, embedding ethical guardrails like federated learning, training AI on decentralized data, and ensuring transparency in algorithmic decision-making can help mitigate biases [15]. The FSBPT's guidelines for AI integration into licensure exams provide a model for accountability in this process [16]. Additionally, upskilling clinicians is vital, with curricula in physical therapy programs incorporating AI literacy, allowing trainees to critically interpret algorithmic outputs while maintaining a focus on patient-centered care.

Finally, AI should be designed to augment, not replace, clinical expertise. For example, while large language models (LLMs) like GPT-4 can assist in drafting patient education materials, a final review by therapists ensures that the content remains accurate and contextually relevant [17]. This approach will foster a thoughtful and responsible integration of AI in the field of physiotherapy.

Conclusion

The fusion of AI and physical therapy heralds an era of precision rehabilitation, where data-driven insights refine diagnostic accuracy and personalize interventions. Yet, as scholar Michael Rowe argues, the field's future hinges on strengthening the "human-centered pillars" of care trust, adaptability, and empathy that no algorithm can replicate [11]. By fostering collaboration among clinicians, engineers, and policymakers, we can ensure AI catalyzes equitable, evidence-based, and compassionate care.

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