# Position Statement on Artificial Intelligence and Physical and Rehabilitation Medicine

UEMS PRM Section and Board

## Executive Summary: AI in Physical and Rehabilitation Medicine

The UEMS PRM Section and Board recognises the transformative potential of Artificial Intelligence (AI) in Physical and Rehabilitation Medicine (PRM). This position statement addresses the definitions, benefits, challenges, and ethical principles surrounding the use of AI in rehabilitation.

**Key Points:**

1. **Definitions**: The document defines key terms, including Artificial Intelligence, Machine Learning, Deep Learning, Large Language Models, and Physical and Rehabilitation Medicine.
2. **Potential Benefits**: AI in PRM offers opportunities for personalised treatment plans, early diagnosis and prognosis, enhanced robotics and assistive technologies, remote monitoring, and improved decision support.
3. **Challenges**: Data privacy and security, algorithmic bias, integration with existing systems, lack of explainability in AI models, and the need for appropriate regulatory frameworks.
4. **Ethical Principles**: The moral framework is guided by principles of beneficence, non-maleficence, autonomy, justice, transparency, privacy, and accountability.
5. **Recommendations**:
    - Provide ongoing education and training for PRM professionals in AI technologies.
    - Encourage interdisciplinary collaboration
    - Support further research and development in AI applications for PRM
    - Develop and regularly update ethical guidelines
    - Engage patients in the development and implementation of AI systems
    - Work with policymakers to develop appropriate regulatory frameworks
6. **Research Perspectives**: The document includes an annexe on researching AI in rehabilitation as a complex intervention, covering development, feasibility, evaluation, and implementation phases.

The UEMS PRM Section and Board are committed to the responsible integration of AI into PRM practice. They aim to improve patient outcomes and quality of life while addressing potential risks and ethical concerns. This position statement is a foundation for ongoing dialogue, research, and collaboration in AI and Physical and Rehabilitation Medicine.

## Scope of the document

This position statement addresses the application of Artificial Intelligence (AI) in Physical and Rehabilitation Medicine (PRM) across various domains.

The scope of this document includes, but is not limited to:

1. **Clinical Applications**:
    - AI-assisted diagnosis and prognosis in rehabilitation settings
    - AI-driven personalised treatment planning
    - AI-enhanced robotics and assistive technologies for therapy
    - AI-powered remote monitoring and telerehabilitation
2. **Research Applications**:
    - Use of AI in analysing rehabilitation outcomes and efficacy
    - AI-assisted literature review and evidence synthesis in PRM
    - Development and validation of AI models for rehabilitation medicine
3. **Educational Applications**:
    - AI tools for training PRM professionals
    - AI-enhanced simulation for skill development
4. **Administrative Applications**:
    - AI for resource allocation and scheduling in rehabilitation facilities
    - AI-assisted quality improvement in PRM services
5. **Ethical Considerations**:
    - Data privacy and security in AI-driven rehabilitation
    - Ethical use of AI in decision-making processes
    - Regulatory compliance and legal implications of AI in PRM

This position statement does not cover:

- Detailed technical specifications of AI algorithms or systems
- Specific product recommendations or comparisons
- Financial or reimbursement models for AI in rehabilitation

The UEMS PRM Section and Board recognise that AI in rehabilitation is a rapidly evolving field. This position statement provides the base for understanding and implementing AI in PRM, with the expectation that it will be regularly reviewed and updated to reflect technological advancements and emerging best practices.

## 1. Introduction

The UEMS PRM Section and Board promote this position statement and recognise the transformative potential of Artificial Intelligence (AI) in healthcare, particularly in Physical and Rehabilitation Medicine (PRM). This position statement addresses the definitions, benefits, challenges, and ethical principles surrounding the use of AI in medical rehabilitation while referencing key documents and studies in the field.

The World Health Organization (WHO) has emphasised the importance of AI in healthcare, establishing that when used ethically and effectively, it can improve health outcomes and quality of life for millions of people (1). In rehabilitation, AI presents unique opportunities to enhance patient care, streamline processes, and advance research. At the same time, we must address privacy and security concerns.

## 2. Definitions

2.1. Artificial Intelligence (AI): The simulation of human intelligence processes by machines, especially computer systems. These processes include learning, reasoning, and self-correction (2).

2.2. Machine Learning (ML): A subset of AI that develops algorithms and statistical models that enable computer systems to improve performance on a specific task through experience (3).

2.3. Deep Learning: A subset of machine learning based on artificial neural networks with representation learning. It can be supervised, semi-supervised or unsupervised (4).

2.4. Large Language Models (LLMs): Large Language Models (LLMs) are very large deep learning models pre-trained on extensive datasets. They are designed to understand and generate human-like text, enabling them to perform various tasks in natural language processing. In software engineering, LLMs bring novelty and creativity to activities such as coding, design, and documentation, showcasing their potential to enhance the efficiency and reliability of software development processes. (5)

2.5. Physical and Rehabilitation Medicine is an independent medical speciality concerned with promoting physical and cognitive functioning, activities (including behaviour), participation (including quality of life), and modifying personal and environmental factors. It is thus responsible for the prevention, diagnosis, treatment, and rehabilitation management of people with disabling health conditions and co-morbidity across all ages (6).

## 3. Potential benefits of AI in Medical Rehabilitation

3.1. Personalized Treatment Plans: AI can analyse vast amounts of patient data to create tailored rehabilitation programs, optimising individual patients' outcomes. Studies have shown that AI-driven personalised care can improve functional outcomes in stroke rehabilitation (7)

3.2. Early Diagnosis and Prognosis: AI algorithms can identify subtle patterns in patient data, potentially leading to earlier and more accurate diagnoses and prognoses. For example, machine learning models have been developed to predict recovery trajectories in spinal cord injury patients accurately (8).

3.3. Robotics and Assistive Technologies: AI-powered robotic systems can assist in physical therapy, providing consistent and precise movements for patients. A systematic review found that electromechanical and robot-assisted arm training improved activities of daily living, arm function, and arm muscle strength in stroke patients (9).

3.4. Remote Monitoring: AI can enable more effective remote patient monitoring, allowing timely interventions and reducing hospital readmissions. Tele-rehabilitation systems enhanced with AI have shown promise in maintaining continuity of care and improving patient engagement (10)

3.5. Decision Support: AI systems, such as those using Contextual Model-based Reinforcement Learning (CMDP), personalise treatment plans by adjusting timing, dosage, and intensity to maximise long-term outcomes for stroke patients. These systems collaborate with clinicians to customise plans based on clinical judgment and patient preferences (11).

3.6. In Physical and Rehabilitation Medicine, LLMs have the potential to assist in various areas such as clinical decision support, patient education, research literature analysis, and personalised treatment planning. However, their use also raises essential considerations regarding data privacy, bias, and the need for domain-specific validation (12)

3.7 Transformative Impact of AI: The integration of AI in medical rehabilitation programs is shown to enhance patient care significantly. AI technologies are not just supplementary tools; they represent a transformative approach that can lead to better outcomes for patients undergoing rehabilitation (13)

## 4. Challenges

4.1. Data Privacy and Security: AI requires large amounts of patient data, raising concerns about data protection and patient confidentiality. The European Union's General Data Protection Regulation (GDPR) provides a framework for addressing these concerns (14).

4.2. Algorithmic Bias: AI systems may inadvertently perpetuate or amplify existing biases in healthcare, leading to unfair or discriminatory outcomes. Research has shown that if not carefully designed and validated, AI algorithms can exhibit bias based on race, gender, and socioeconomic status (15).

4.3. Integration with Existing Systems: Implementing AI technologies into healthcare infrastructures can be complex and resource-intensive. A survey by the European Commission found that lack of interoperability and technical difficulties were significant barriers to AI adoption in healthcare (16).

4.4. Lack of Explainability: Some AI models, intense learning models, can be "black boxes," making it difficult to understand how they arrive at their conclusions. This poses challenges for clinical adoption and regulatory approval (17).

4.5. Regulatory and Legal Framework: The rapid development of AI outpaces current regulatory frameworks, creating uncertainty regarding liability and accountability. The European Parliament has called for a comprehensive and future-oriented regulatory framework for AI in healthcare (16).

## 5. Ethical Principles

Our ethical framework is guided by the principles outlined in the WHO guidance on ethics and governance of artificial intelligence for health (1) and the European Commission's Ethics Guidelines for Trustworthy AI (18).

5.1. Beneficence: AI applications in PRM should aim to benefit patients and improve their quality of life.

5.2. Non-maleficence: Measures must be taken to prevent harm from AI systems, including rigorous testing and ongoing monitoring.

5.3. Autonomy: Patients should be informed about using AI in their care and have the right to make informed decisions about their treatment.

5.4. Justice: AI systems should be designed and implemented to ensure fair and equitable patient care access.

5.5. Transparency: The use of AI in patient care should be disclosed, and efforts should be made to explain AI-derived decisions in understandable terms.

5.6. Privacy: Patient data used in AI systems must be protected, and patient confidentiality must always be maintained in compliance with GDPR and other relevant regulations.

5.7. Accountability: Clear lines of responsibility and accountability must be established for AI systems' development, implementation, and outcomes in PRM.

5.8 Climate changes: The rapid growth of AI infrastructure is creating significant environmental challenges through electronic waste generation, intensive water usage, unsustainable mining of rare minerals, and massive electricity consumption that contributes to greenhouse gas emissions (19).

## 6. Recommendations

6.1. Education and Training: PRM professionals should receive ongoing education and training in AI technologies and their applications in rehabilitation medicine. The International Society of Physical and Rehabilitation Medicine (ISPRM) has emphasised the importance of digital literacy for rehabilitation professionals (20).

6.2. Interdisciplinary Collaboration: Encourage collaboration between PRM professionals, AI researchers, ethicists, and policymakers to ensure responsible development and implementation of AI in rehabilitation. The European Alliance for Artificial Intelligence has called for increased cross-sector collaboration in AI development (21).

6.3. Research and Development: Support further research into AI applications in PRM, focusing on clinical validation and real-world effectiveness. The Horizon Europe program provides funding opportunities for AI research in healthcare (22)

6.4. Ethical Guidelines: Develop and regularly update ethical guidelines for using AI in PRM, building on existing frameworks such as the WHO guidance (1)and the EU Ethics Guidelines for Trustworthy AI (18)

6.5. Patient Involvement: We need to foster transparency and trust, aligning with principles of patient-centred care. This will ultimately lead to more effective and accepted AI applications in rehabilitation and other healthcare settings (23)

. 6.6. Regulatory Framework: Work with policymakers to develop appropriate regulatory frameworks that balance innovation, patient safety, and ethical considerations. The proposed EU AI Act provides a starting point for such regulations (16).

6.7. Artificial Intelligence systems in medicine have demonstrated diagnostic capabilities comparable to expert clinicians, often outperforming less experienced professionals. However, optimal results occur when AI complements, rather than replaces, clinical judgment. Adoption remains slow primarily due to a lack of trust and insufficient integration into existing clinical workflows. Importantly, AI strengths complement those of human professionals, with decision systems exhibiting different biases. While cognitive biases and fatigue can influence human reasoning, AI systems may develop distortions based on training data or algorithms. This complementarity suggests that the future of medicine lies in a synergistic human-machine approach (24).

## 7. Risks and Limitations of AI in Physical and Rehabilitation Medicine

While Artificial Intelligence (AI) offers significant potential benefits in Physical and Rehabilitation Medicine (PRM), it is crucial to acknowledge and address the associated risks and limitations:

1. **Overreliance on AI Systems**:
    - Risk of diminishing clinical reasoning skills among practitioners
    - Potential for overlooking nuanced patient factors not captured by AI models
    - The danger of automation bias, where clinicians may excessively trust AI recommendations
2. **Data Quality and Bias**:
    - AI models are only as good as the data they're trained on
    - Risk of perpetuating or amplifying existing biases in healthcare data
    - Potential for reduced efficacy in underrepresented patient populations
3. **Lack of Interpretability**:
    - Many AI models and profound learning systems operate as "black boxes."

    - Difficulty in explaining AI-driven decisions to patients and regulatory bodies
    - Challenges in identifying and correcting errors in AI reasoning
4. **Privacy and Security Concerns**:
    - Increased risk of data breaches due to the large amounts of sensitive patient data required
    - Potential for unauthorised access or misuse of personal health information
    - Challenges in ensuring GDPR compliance and other data protection regulations
5. **Integration and Interoperability Issues**:
    - Difficulties in integrating AI systems with existing healthcare IT infrastructure
    - Potential for errors or data loss during information transfer between systems
    - Need for standardisation of data formats and AI algorithms across different platforms
6. **Limited Generalizability**:
    - AI models developed in one clinical setting may not perform well in others
    - Challenges in adapting AI systems to diverse patient populations and healthcare contexts
7. **Ethical Dilemmas**:
    - Questions of accountability when AI systems contribute to clinical decisions
    - Potential for AI to exacerbate healthcare disparities if not carefully implemented
    - Ethical concerns surrounding patient autonomy and informed consent with AI-driven care
8. **Regulatory and Legal Uncertainties**:
    - The evolving regulatory landscape for AI in healthcare in the light of the EU document
    - Unclear liability frameworks for errors or adverse events involving AI systems
    - Challenges in certifying and auditing AI systems for clinical use
9. **Resource Intensiveness**:
    - High costs associated with developing, implementing, and maintaining AI systems
    - Need for specialised personnel to manage and interpret AI in clinical settings
    - Potential for increasing healthcare costs, at least in the short term
10. **Resistance to Change**:
    - Potential reluctance among healthcare professionals to adopt AI technologies
    - Patient scepticism or discomfort with AI involvement in their care
    - Organisational challenges in managing the cultural shift required for AI integration
11. **Limitations in Complex Decision-Making**:
    - AI may struggle with cases requiring complex, multifaceted decision-making typical in PRM
    - Difficulty in capturing the holistic, patient-centred approach central to rehabilitation medicine
12. **Continuous Learning and Updating**:
    - Need for ongoing monitoring and updating of AI systems to maintain performance
    - Challenges in ensuring AI systems adapt to changing clinical practices and new evidence

By acknowledging these risks and limitations, the PRM community can work proactively to address them, ensuring that AI is integrated into rehabilitation practice responsibly, ethically, and effectively. Ongoing research, interdisciplinary collaboration, and robust governance frameworks will mitigate these challenges and maximise AI's benefits in PRM.

## 8. AI in rehabilitation as a complex intervention: research perspectives

1. Defining AI in rehabilitation as a complex intervention (25):
    a) AI in rehabilitation likely involves multiple interacting components, targets various levels (e.g., individual patients, healthcare providers, and healthcare systems), and aims to produce different outcomes.
    b) These characteristics align with the definition of complex interventions provided in the document.
2. Research perspectives: To fully understand AI in rehabilitation, we might need to consider multiple research perspectives:
    a. Efficacy: Controlled studies to determine if AI-based rehabilitation interventions produce intended outcomes under ideal conditions.
    b. Effectiveness: Real-world studies to assess how AI rehabilitation tools perform in typical clinical settings.
    c. Theory-based: Investigate how and why AI interventions work in rehabilitation, considering mechanisms and contexts.
    d. Systems: Examine how AI rehabilitation tools interact with and adapt to the broader healthcare system.

3. Phases of research:

    a) Development:
    - Clearly define the AI rehabilitation intervention
    - Develop a program theory explaining how AI is expected to improve rehabilitation outcomes.
    - Engage stakeholders (patients, clinicians, health systems) in the development process.

    b) Feasibility:
    - Assess if AI rehabilitation interventions can be implemented in practice
    - Evaluate acceptability to patients and clinicians
    - Determine the likelihood of cost-effectiveness

    c) Evaluation:

    - Conduct appropriate studies based on research questions (e.g., RCTs, adaptive trials, or system-level evaluations)
    - Include process evaluations to understand implementation challenges
    - Consider both quantitative and qualitative methods

    d) Implementation:

    - Plan for real-world implementation from early stages

- Study how AI rehabilitation tools can be integrated into existing healthcare systems
- Monitor long-term outcomes and adaptations

4. Core elements to consider:

    a. Context: How does the healthcare setting influence AI implementation and effectiveness in rehabilitation?
    b. Program theory: Develop and refine theories about how AI is expected to improve rehabilitation processes and outcomes.
    c. Stakeholders: Involve patients, clinicians, AI developers, and healthcare administrators throughout the research process.
    d. Uncertainties: Identify key questions about AI in rehabilitation (e.g., efficacy, safety, cost-effectiveness, ethical considerations).
    e. Refinement: Continuously improve AI rehabilitation tools based on research findings.
    f. Economic considerations: Assess the cost-effectiveness of AI in rehabilitation compared to standard care.

5. Challenges and considerations:

- Ethical issues around AI decision-making in healthcare
- Data privacy and security concerns
- Ensuring equitable access to AI-based rehabilitation
- Potential for AI to complement rather than replace human clinicians
- Need for interdisciplinary collaboration (e.g., AI experts, clinicians, rehabilitation specialists)

By applying this framework, researchers can systematically evaluate AI in rehabilitation as a complex intervention, generating evidence to inform its implementation in clinical practice. This approach would help ensure that AI is effectively and responsibly integrated into rehabilitation care, potentially improving patient outcomes and healthcare efficiency.

## 9. Conclusion

The UEMS Section and Board recognise AI's transformative potential in Physical and Rehabilitation Medicine. While embracing these technological advancements, we must remain committed to ethical practice, patient-centred care, and the highest standards of clinical excellence. This position statement serves as a foundation for the responsible integration of AI into PRM practice, aiming to improve patient outcomes and quality of life.

We call on all stakeholders in PRM to engage in ongoing dialogue, research, and collaboration to ensure that AI's benefits are realised while potential risks are mitigated. As the field evolves, the UEMS Section and Board commit to regularly updating this position statement to reflect new developments, challenges, and opportunities in AI and rehabilitation medicine.

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