Review: AI-Driven Advances in Physiotherapy Stimulation Devices

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Abstract

This embraces rehabilitation medicine as it significantly boosts the doctor's way of working and presents new ways or new tools that the doctor might consider to enhance or augment the results that the patients benefit from physically. This review focuses on applying AI technologies such as robotic systems, virtual reality (VR), machine learning algorithms, wearable devices and predictive analytics in different fields, including stroke recovery, neuromuscular disorder rehabilitation, orthopedic and critical care. AI utilization improves patient treatment, the accuracy of therapy, and the administration of evaluation to deal with issues such as a lack of therapists, comparative analysis, and the expensive nature of conventional treatment. Although the outlook for its progress is positive, there are twofold problems: ethical questions, data privacy and policy concerns, and regulatory challenges. Future directions indicate directions for research and practice and call for increased interdisciplinary cooperation, large-scale validation studies and appropriate ethical standards to unlock the full potential of AI in reinventing rehabilitation medicine and rendering patient-centered care possible.

Keywords: Artificial Intelligence; Rehabilitation Medicine; Personalized Therapy; Robotic Systems; Virtual Reality; Neuromuscular Disorders.

1. Introduction

Artificial intelligence and other technological developments have impacted rehabilitation medicine, and broader opportunities exist for improved patient care and results. The background of this literature review is based on adopting AI-driven tools and systems in diverse rehabilitation practices. It demonstrates their improvement across multiple areas, such as stroke, neuromuscular disorders, orthopedic rehabilitation, and intensive care. Specific uses, including wearable technology, VR or Robotic devices, and tests and assessments, are discussed, and their capacity to meet individual patient requirements with a scalable result is encouraged. Such progress transforms rehabilitation by solving several crucial issues, including the lack of qualified therapists, the reliance on subjective assessments, and high-fidelity, expensive classic rehabilitation paradigms. This section arranges the discussion into serious topics: Artificial Intelligence in Stroke Rehabilitation, AI in Neuromuscular Disorder Rehabilitation, Relevance of AI in Orthopedic Rehabilitation, AI Robots for Critical Care, and Trends and Challenges of Rehabilitation Technology that discusses specific issues related to present and future application of AI in rehabilitation medicine.

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2. AI in Stroke Recovery

AI plays an increasingly important role in stroke rehabilitation, as it helps make therapy more individual, implement VR interventions and perform assessments automatically.

1.1. Individualized Rehabilitation Programs

AI can deliver effective therapy because data determines the therapy regimens that best serve a patient. That way, it helps enhance the recovery process, making it efficient and effective. For instance, AI applications in computing can dynamically set the intensity of exercise following the patient's performance [1].

1.2. Virtual Reality-Based Interventions

Integrating AI and VR provides places that mimic functional settings where the patient can develop a specific motor task. This also increases patient activity and interest during the therapy process. A literature review has established that using video-based games for rehabilitation can go a long way in helping stroke patients who could have. Waterman et al.. (2010) also demonstrated that VR-based rehabilitation can enhance balance and gait in stroke patients [2].

1.3. Automated Assessments

Implementing decision-support AI to grade patient progress excludes the need to rely on human opinions. The algorithms interpret movements to offer accurate information and assist therapists in supervising and modifying the therapy process. AI studies have been supported by finding a high correlation with the assessor's evaluation made by the therapist, making the AI approaches reliable [3].

The adoption of AI technology in stroke rehabilitation improves the approach to therapy and patient participation as well as the assessment of the results of the stroke treatment, thus improving stroke patients' rehabilitation.

3. AI and Neuromuscular Disorder Rehabilitation

Robotic therapy, MLAs, and neutral fuzzy systems have improved the rehabilitation of neuromuscular disorders among patients.

2.1. Robotic-Assisted Therapy

Robotic systems integrated with artificial intelligence help patients needing particular, repetitive motions. These systems improve the recovery of motor function by providing consistent therapy. For instance, a cooperative bilateral upper-limb rehabilitation robotic system derived from mirror therapy has been designed to help hemiplegic patients train in rehabilitation. Representing the second order, the system employs an adaptive proportional-–integral–derivative (PID) controller with radial basis function (RBF) neural networks to enhance tracking performance for the side of the robotic arm affected [4].

2.2. Machine Learning Algorithms

It is based on using artificial intelligence algorithms to develop individual rehabilitation programs suitable to such patients. Thus, computers can change exercises in response to current performance, making therapy as effective as possible. Synthesizing evidence reported in a previous systematic review, the authors pointed to the use of machine learning in the delivery of robotic-assisted therapy to improve the specificity and efficiency of the administered treatments [5].

2.3. Neural-Fuzzy Systems

Neural-fuzzy systems use both neural networks and fuzzy logic to handle uncertainties in the responses given by the patients. They enable adaptive control in rehabilitation devices since different users require different levels of force exertion. Studying the impact of neural fuzzy adaptive controllers has realized that controlling them can guarantee precise tracking of the desired trajectory even when working under uncertain conditions, improving rehabilitation results [6].

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Client-centered, individualized, effective interventions are part of AI technologies' application in neuromuscular disorder rehabilitation.

4. AI in Orthopedic Rehabilitation

In orthopedic rehabilitation, applications of AI companies with analytic predictions, wearable gadgets, and tailored treatment plans.

3.1. Predictive Analytics

AI predictive analytical tools predicted surgical results and possible adverse effects. This helps the clinician to be in a position to decide when, which and how to operate on each patient, thus improving preoperative planning [7].

3.2. Wearable Devices

Smart wearables are used to continually examine the patient's status with the help of Artificial Intelligence. This entails issues such as flexibility, muscle power, and balance and offers instant results. This makes the patients stick to the rehabilitation regimes and recover faster [8].

3.3. Customized Treatment Strategies

This paper focused on how AI algorithms develop solutions that can help treat patients. These plans are flexible, corresponding to personal requirements, increasing the efficacy and productivity of the rehabilitation courses [9].

AI is currently used in critical care settings to apply robotic systems that may help improve patient care outcomes while simultaneously relieving the workload at the facilities.

4. AI Robots in Critical Care

Health information technology is a favorite technology for easing hospital patient care. For instance, technology is used in patient status observation, creating care maps, and enhancing the decision-making process in clinical practice. In the future, newly developed A I may be applied to diagnose diseases at an early stage. Besides, it may be applicable in the nursing process, where it may be used to perform routine activities such as paperwork [10].

The use of AI in critical care equally has some ethical implications. The advancement and personal moral application of Artificial Intelligence (AI) in the context of healthcare through different clinical models has its quagmire, especially in intensive care where clinicians confront life-emergent circumstances and patients with decision-maker incapability [11].

In recent years, rehabilitation technology trends have been in telehealth and virtual environments. Nonetheless, some difficulties remain, including access, regulations and data privacy.

5. Rehabilitation Technology Current State, Issues and Future Directions

COVID-19 has posed a significant stimulus to the evolution and advancement of digital and technology-enabled health systems. Some examples include Metaverse, which is expected to revolutionize healthcare by involving clinicians, patients, educators and researchers and involving them in the virtual world for community assessment, prevention and treatment [12].

However, there is a problem with government regulation to promote digital health technologies. Information-related concerns like availability, exchange and unity, and data confidentiality and security for emergent Indi Telehealth are sensitive information, and data delivery and safety must be prioritized. Safety of sensitive medical data during transfer, patient data on telehealth interfaces, and privacy while involving teleconsultation are issues of concern [13].

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AI is currently experiencing dynamic development in orthopedic rehabilitation and intensive care. Like every other method, it has some added advantages but disadvantages that should be implemented considering some level of ethics [14].

There is a detailed examination of the role of AI in rehabilitation within each theme and the presented challenges. Hence, each theme contains a vision for further investigation and improvement of the technology.

Literature Review

Rehabilitation medicine has witnessed a shift in its practice due to the implementation of advanced technologies, including advanced intelligence and AI. AI technologies and solutions are revolutionizing patient care, from neuromuscular diseases to strokes to orthopedics. This paper focuses on the prospects of AI for rehabilitation and its ability to supplement the approaches that allow for the creation of individualized treatment plans, increase the accuracy of diagnostics, and result in more positive therapeutic effects to be achieved. The main topics include employing innovative wearable technology, virtual reality systems, robots, and automated tests to meet patients' needs for different infirmities. However, understanding these innovations and the associated opportunities and concerns constitutes the basis for this review's appreciation of AI's reinvention of rehabilitation techniques.

As outlined in the paper [15], Long COVID presents a complex global health challenge due to its multifaceted nature and the lack of effective treatments, prompting the exploration of innovative solutions such as artificial intelligence (AI)-guided transcranial direct current stimulation (TDCS). The study highlights how AI can optimize TDCS protocols by personalizing treatment based on individual characteristics and real-time symptom fluctuations, enhancing clinical trial design, and developing more sensitive outcome measures. Additionally, the authors emphasize the role of machine learning in patient stratification and its potential to facilitate targeted interventions. Ethical considerations, including data privacy, algorithmic bias, and equitable access, are addressed to ensure the responsible implementation of AI-guided TDCS. Future directions outlined in the study include large-scale validation studies and investigations of long-term efficacy, emphasizing interdisciplinary collaboration and patient-centered approaches to advance this promising technology for managing Long COVID.

As detailed in the paper [16], neuromuscular diseases significantly challenge individuals and healthcare systems by impairing motor functions, necessitating innovative rehabilitation approaches. This research explores AI-driven interventions such as robotic-assisted therapy, virtual reality-based rehabilitation, and machine learning algorithms designed to optimize personalized treatment plans. The study highlights advancements like neural-fuzzy adaptive controllers for precise trajectory tracking under uncertainty and algorithms capable of dynamically recognizing patient motor intentions to adapt training. By integrating these technologies, the research envisions a future where tailored, AI-enhanced interventions improve functional independence and quality of life for individuals with neuromuscular disorders.

In the research presented in [17], stroke is identified as a leading cause of long-term disability, with advancements in sensor technologies and artificial intelligence (AI) offering significant potential to improve stroke rehabilitation. This scoping review, encompassing 704 studies, categorizes AI applications into four themes: impairment, assisted intervention, prediction and imaging, and neuroscience. The impairment theme emphasizes motor function, gait, and mobility, while assisted intervention includes robotic systems and brain-computer interfaces (BCIs). Over time, AI applications evolved from conceptual stages to advanced techniques such as supervised learning, artificial neural networks (ANN), natural language processing (NLP), and deep learning, with a particular focus on upper limb rehabilitation using tools like inertial measurement units (IMUs) for functional movement analysis. These advancements highlight the potential of AI to deliver personalized therapeutic solutions, optimize recovery outcomes and bridge the gap between rehabilitation and real-world application.

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As detailed in the paper [18], the growing aging population requires innovative solutions to restore autonomy in individuals affected by stroke, cerebral hemorrhage, and muscle atrophy. The study proposes AI-based next-generation sensors and automated tools for enhanced rehabilitation monitoring and analysis. These sensors employ motion recognition algorithms to capture precise gait data and customize rehabilitation plans tailored to individual needs. Virtual rehabilitative environments incorporating visual and auditory stimuli are designed to foster engagement and improve training outcomes, demonstrating comparable efficacy to real-world settings. The research also introduces adjustable lower limb exoskeletons to accommodate individual differences and rehabilitation progress. Performance evaluation includes metrics such as PGWBI scores, balance ability, gait improvement, blood pressure, heart rate, R2 scores, and confidence intervals, underscoring the practical and theoretical advancements in rehabilitation for an aging society.

In the article denoted as [19], the integration of artificial intelligence (AI) in physical therapy is explored to unify Eastern and Western approaches to rehabilitation. Western methods emphasize biomechanical tasks and evidence-based practices, while Eastern approaches focus on holistic techniques addressing the body-mind connection. The results demonstrate how the amalgamation of AI technologies such as machine learning and real-time data analytics improve biomechanical assessments, customizable treatments, and practical assessments of conventional treatment techniques such as acupuncture, including issues with data privacy, algorithm transparency, and the integration of diverse data sources, highlighting the need for a balanced strategy that leverages the strengths of both modalities to optimize therapeutic outcomes.

Artificial intelligence (AI), rooted in a mathematical foundation, is revolutionizing the healthcare system by enabling innovative delivery methods, informed decision-making, and enhanced patient engagement. According to the research presented in [20], AI has significant potential to expedite diagnosis, optimize healthcare performance, and produce reliable outcomes for both patients and professionals. Physiotherapists, as essential contributors to contemporary clinical practice, can leverage AI and robotics to enhance rehabilitation protocols, ultimately improving the quality of life (QOL). Intelligent systems analyze patient-specific data to design tailored interventions, while robotic devices facilitate precise, repetitive movements essential for targeted therapy. This integration of AI and physiotherapy holds promise for delivering more effective and personalized care.

In the research presented in [21], AI robots are highlighted as transformative tools in critical care, particularly in ICU settings, where they address the reliance on extensive medical data and aim to improve patient outcomes. This review analyzed 77 studies from 5908 screened publications, classifying robotic systems into therapeutic assistance, nursing assistance, rehabilitation assistance, telepresence, and logistics and disinfection robots. Many of these systems are already commercialized, offering personalized, efficient medical services and alleviating the workload on ICU staff. The study emphasizes the potential of AI robots to streamline ICU operations, from admission to discharge, while addressing ethical and operational challenges such as safety, privacy, responsibility, and cost-effectiveness. Proposed solutions aim to ensure the safe adoption of these technologies, which are anticipated to be pivotal in advancing ICU care through innovative and automated practices.

In the research presented in [22], stroke is identified as a significant cause of long-term disability worldwide, with advancements in sensor technologies and artificial intelligence (AI) offering transformative potential for stroke rehabilitation. Based on 704 studies, this scoping review categorizes AI applications into four themes: impairment, assisted intervention, prediction and imaging, and neuroscience. The impairment theme focuses on motor function, gait, and mobility, while assisted interventions incorporate robotic systems and brain-computer interfaces (BCIs). Over time, AI applications have expanded from conceptual frameworks to advanced techniques such as supervised learning, artificial neural networks (ANN), natural language processing (NLP), and deep learning, with particular attention to upper limb rehabilitation. Machine learning (ML) and sensors like inertial measurement units (IMUs) are highlighted for functional movement analysis. These developments underscore AI's ability to enable personalized therapeutic strategies, optimize rehabilitation outcomes, and bridge the gap between recovery and real-world functionality.

As outlined in [23], neuromuscular diseases impose significant challenges on individuals and healthcare systems due to their profound impact on motor functions. This research explores artificial intelligence (AI) 's transformative role in revolutionizing rehabilitation through robotic-assisted therapy, virtual reality-based

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rehabilitation, and machine learning algorithms tailored to individual needs. The study highlights advancements like neural-fuzzy adaptive controllers for precise trajectory tracking and machine learning techniques for recognizing patient motor intentions and adapting training dynamically. By leveraging these innovations, the research underscores the potential of AI to optimize personalized treatment plans, enhance rehabilitation outcomes, and improve the quality of life and functional independence of individuals with neuromuscular disorders.

In the study referenced as [24], Long COVID is highlighted as a complex global health challenge requiring innovative treatment approaches due to its multifaceted nature and lack of effective therapies. The study explores the potential of AI-guided transcranial direct current stimulation (TDCS) to optimize treatment by personalizing protocols based on individual patient characteristics and real-time symptom fluctuations. Machine learning is emphasized for patient stratification and developing more sensitive clinical trial outcome measures. Ethical considerations, including data privacy, algorithmic bias, and equitable access, are addressed alongside opportunities for implementing AI-guided TDCS in diverse healthcare settings. Future research directions include large-scale validation studies and long-term efficacy and safety evaluations. The authors advocate for interdisciplinary collaboration and patient-centered approaches to harness the promise of AI-guided tDCS for managing Long-term COVID and other neurological conditions.

As discussed in [25], the increasing aging population necessitates innovative solutions to restore autonomy for elderly individuals affected by conditions such as stroke, cerebral hemorrhage, and muscle atrophy. The study proposes AI-based next-generation sensors and automated tools for enhanced rehabilitation monitoring and analysis. Using precise motion recognition algorithms, these sensors capture gait data to customize individualized rehabilitation plans tailored to unique patient needs. Virtual rehabilitative environments incorporating visual and auditory stimuli foster engagement and improve training effectiveness, with outcomes comparable to real-world settings. Adjustable lower limb exoskeletons are introduced to adapt to individual differences and rehabilitation progress. Performance metrics, including PGWBI scores, balance ability, gait improvement, blood pressure, heart rate, and statistical measures like R2 scores and confidence intervals, validate the effectiveness of these technologies. The study underscores the theoretical and practical significance of integrating virtual spaces and smart sensors, offering dynamic solutions that address the challenges of an aging society while advancing rehabilitation practices in line with the digital era.

As outlined in [26], post-stroke therapy faces challenges such as a shortage of qualified therapists, high costs, and subjective evaluations, prompting the development of automated systems to enhance rehabilitation with minimal human intervention. This review examines advances in robot-assisted, virtual reality-based rehabilitation and automated assessments using data-driven learning approaches following the PRISMA methodology. Experiments on KIMORE and UI-PRMD datasets demonstrate a high concordance between automated methods and therapist assessments. Deep learning techniques utilizing spatiotemporal skeleton data and dynamic attention achieved superior performance, with an RMSE as low as 0.55. While fully automated rehabilitation remains under development, these findings highlight its potential to improve objective assessments and expand accessibility to effective post-stroke therapy.

In the analysis conducted in [27], integrating artificial intelligence (AI) in physical therapy transforms treatment by bridging Eastern and Western approaches to rehabilitation. While Western practices emphasize biomechanical tasks and evidence-based methods, Eastern approaches focus on holistic techniques addressing the body-mind connection. AI technologies, including machine learning and real-time data analytics, enhance biomechanical assessments, personalize rehabilitation plans, and objectively evaluate traditional therapies such as acupuncture and Tai Chi. Challenges such as data privacy, algorithm transparency, and integrating diverse data sources are acknowledged. The study advocates for a balanced approach that leverages the strengths of both modalities to optimize rehabilitation strategies effectively.

In the study referenced as [28], artificial intelligence (AI) is identified as a transformative force in healthcare, particularly within orthopedic rehabilitation. The research explores the integration of AI technologies, such as virtual assistants, personalized treatment plans, wearable devices, and predictive analytics, reshaping rehabilitation practices. These advancements aim to improve patient outcomes and enhance efficiency for healthcare providers. The study also examines the benefits of AI, including tailored interventions and streamlined processes, alongside challenges such as data integration, algorithm transparency, and ethical

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considerations. This intersection of AI and orthopedic rehabilitation offers promising opportunities to revolutionize patient care and optimize rehabilitation outcomes.

As detailed in [29], rehabilitation technology continues to evolve, significantly transforming healthcare in 2023 by integrating innovative tools to support patient recovery. Wearable technologies, such as smart sensors and activity trackers, enable real-time monitoring and provide patients and healthcare providers with actionable feedback for informed treatment decisions. Virtual reality (VR) is highlighted as a transformative tool, immersing patients in realistic scenarios to enhance motor skills and balance, thereby accelerating recovery from lower limb injuries. Telehealth further supports this evolution by enabling remote access to rehabilitation services, reducing the need for clinic visits while maintaining quality care. Robotics enhances rehabilitation by assisting with exercises, reducing injury risks, and tracking progress, while artificial intelligence (AI) personalizes treatment plans by analyzing data from wearable devices. Despite these advancements, challenges such as accessibility, regulatory concerns, technical requirements, and data privacy remain barriers. Addressing these limitations is critical to fully realize the potential of rehabilitation technologies, which promise to revolutionize recovery outcomes and patient care in the coming years.

Table 1 presents a comprehensive systematic review of important studies on AI integration in different rehabilitative fields, including the latest development, approach, and practice. Below are the tables that divide the studies by the focus areas, including stroke rehabilitation, neuromuscular disorders, orthopedic care, and critical care, demonstrating the effectiveness of the AI. Some research findings include deploying robotic-assessed therapy, implementing neural-fuzzy systems, integrating predictive analytics for personalized treatment plans, improving rehabilitation processes, and optimizing clinical outcomes. Examples of wearable sensors, VR, and telehealth constitute the continuation of demonstrating the utilization of possibilities AI offers for enhancing patient observation, involvement, and access. However, various issues like ethics, regulatory, and data privacy issues need to be addressed to reach the true potential of AI in rehabilitation medicine.

Table 1: Summary of Literature Review

Study Reference	Study Focus	Key Findings	Applications in Rehabilitation
[15]	AI-guided transcranial stimulation for Long COVID	AI optimizes TDCS protocols, personalizes treatments, and facilitates patient stratification.	Enhances clinical trials and enables targeted interventions.
[16]	Neuromuscular rehabilitation using AI	Robotic-assisted therapy, machine learning, and neural-fuzzy systems improve motor functions.	Tailored therapies, dynamic adaptation of training.
[17]	AI in stroke rehabilitation	Four themes: impairment, intervention, prediction, neuroscience, AI tools for mobility and motor function.	IMUs for functional analysis, BCIs for interventions.
[18]	Rehabilitation for aging populations	AI sensors, virtual environments, and exoskeletons for individualized plans and improved gait.	Balance improvement, tailored therapy for seniors.
[19]	Integrating Eastern and Western therapy	AI enhances biomechanical assessments and	Personalizes care and balances holistic and clinical methods.

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		traditional therapies like Tai Chi.	
[20]	AI in physiotherapy	Intelligent systems design tailored interventions; robotic devices assist therapy.	Improves precision and supports repetitive movements.
[21]	AI robots in critical care	Robotics address ICU workload and enable personalized care.	Nursing, rehabilitation, logistics in ICU settings.
[22]	AI in stroke recovery	Advances in sensor technologies and machine learning for personalized stroke rehabilitation.	Enhances therapy efficiency and functional recovery.
[23]	AI in neuromuscular disease rehabilitation	Neural-fuzzy controllers, robotic systems, and ML improve patient outcomes.	Precise trajectory tracking, adaptive therapy.
[24]	AI for Long COVID	Explores TDCS personalization using AI and large-scale validation of treatment efficacy.	Advanced monitoring, customized therapies.
[25]	Next-gen sensors for rehabilitation	AI sensors capture precise gait data; virtual environments improve engagement.	Tailored plans and performance tracking for elderly care.
[26]	Automated stroke rehabilitation	Data-driven learning, robotic and VR-based rehabilitation with automated assessments.	Increases accessibility and reduces human dependency.
[27]	AI in physical therapy	Bridges Eastern and Western techniques, including holistic approaches and biomechanical tasks.	Integrates diverse data for holistic rehabilitation.
[28]	Orthopedic rehabilitation with AI	Virtual assistants, wearables, and predictive analytics reshape care.	Streamline processes and personalize treatment.
[29]	Trends in digital technology for rehabilitation	Wearable sensors, VR, telehealth, and AI revolutionize lower limb injury recovery.	It improves real-time monitoring and enhances motor skills.

The conclusion drawn from this literature analysis highlights how AI can revolutionize the field of rehabilitation medicine, bring about positive changes to the lives of patients and operate a breakthrough in the process and efficiency of working in the field. Machine learning, robotic process automation, and virtual reality are some AI applications that are breaking the traditional modes of rehabilitation with the help of patient-centered, unique, and large-scale applicable approaches. However, issues including availability, protection of personal data, and ethical issues persist and should be resolved fully to achieve an equal, efficient and accurate provision. Future empirical work and multispecialty cooperation will be paramount for

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these obstacles' surmountal and AI's optimization. They will further advance the existing opportunities for rehabilitation and bring new trends that will help improve the delivery of care to patients.

Discussion

Rehabilitation medicine has been enhanced by artificial intelligence (AI), which provides new approaches to old problems in the management of patients. Indeed, it has been identified that clinicians can deliver customized, effective and scalable care treatments by employing AI-based technologies like robotic systems, VR, or predictive analytics. Concerning the gaps, these technologies are solutions to the scarcity of professional therapists and the reliance on self-report methods, as well as to enhance the patient's quality of life. Real-world cases in the stroke, nervous system, orthopedic fields, and ICU demonstrate that AI enhances therapy through exquisite target specificity and automation. This discussion aims to outline how AI can be applied in rehabilitation in the present to reveal the possibilities for its application in the future and the problems that need to be solved to achieve it.

1. **AI in Stroke Recovery**
   - Individualized Rehabilitation: AI makes therapy more effective since it is built uniquely for each patient, increasing effectiveness and efficacy [30].
   - Virtual Reality Interventions: AI integrated with VR provides functional settings for motor task development and enhances recovery-centered care's fun quality and extent [31].
   - Automated Assessments: Objective assessment is made easier as there is no need to depend on subjective judgments by the therapist[32].
2. **AMNH neuromuscular disorder rehabilitation**
   - Robotic Therapy: In this context, robotic systems developed using artificial intelligence techniques deliver standardized treatment to regain motor functions [33].
   - Machine Learning: There are personalized artificial intelligence algorithms of therapy that would suit the learners better based on their progress [34].
   - Neural-Fuzzy Systems: These incorporate artificial intelligence for a desirable treatment control and its adaptation for various strategies to fit the patient, given the variability in patient conditions, which may make the traditional regulatory methods imprecise [35].
3. **Orthopedic Rehabilitation**
   - Predictive Analytics: AI makes predictions concerning the patients' surgery and helps make decisions during the planning process [36].
   - Wearable Devices: AI continuously tracks vital signs in wearables to remind patients to follow the set regimes needed in their rehabilitation phase [37].
   - Customized Treatment Plans: AI provides a patient-centered proximal and progressive model of care that adjusts according to need [38].
4. **Critical Care and ICU Support**
   - AI-powered robots assist in critical care by performing repetitive tasks, improving patient outcomes, and reducing clinician workload [39].
   - Also, important issues are ethical, such as privacy and decision-making processes in critical life events [40].
5. **Trends and Challenges**
   - Since Metaverse is a relatively new construction, few studies have explored the impacts of adopting the Metaverse or proposed AI-aided rehabilitation tools; however, they are not exempt from potential favorable and unfavorable stratified legal and ethical effects.
   - Data security, privacy issues, and equal access are significant challenges affecting the adoption of the new technology [41].
6. **Future Directions**
   - There is a pressing need for large-scale validation studies and interdisciplinary collaborations to enhance the use case of AI in rehabilitation [42].
   - Legal and ethical requirements have to grow correspondingly to the progress of AI-specified technologies [43].

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The embracing of AI in rehabilitation medicine is a new step forward that will help provide better opportunities to improve patients' conditions and make clinical work easier. These technologies in patients' treatment and homes and factories allow a scalable data-orientated approach that can be patient-specific. Nevertheless, significant concerns like data privacy or ethical issues, such as attacks on regulations, must be resolved to achieve global acceptance. Advancements towards the future will, therefore, demand the combinations of ideas from various fields, sound approaches towards validation, and, most importantly, patient-centered approaches for optimal utilization of AI. With constant advancement in Artificial Intelligence, the world will witness new approaches to patient rehabilitation methodology.

5. Conclusion

The introduction of AIS in rehabilitation medicine entails modifying the traditional scope of practice and aims to improve precision, time efficiency, acc, and possibility. Advanced technologies in artificial intelligence technologies, including robotic systems, machine learning algorithms, virtual reality, and wearable devices, are some of the artificial intelligence technologies that have revolutionized the traditional rehabilitation practice by ensuring comprehensive and scalable practice to fit the patient's needs. These advancements solve the limitations of general methods, such as the lack of professional therapists, the use of self-report data collection, and the generally high costs of regular therapies. This review shows that AI offers additional therapeutic benefits, including more personalized remote therapy, and enhances patient compliance rates to prescribed remedies.

In stroke rehabilitation, AI has scaled and individualized programs and interventions based on virtual reality and automated assessments that provide accurate results. Likewise, in the case of neuromuscular disorder rehabilitation, applications of robotics, machine learning and neural fuzzy systems for movement disorder instruction have enabled accuracy and flexibility based on patient needs. Through changed predictive analytics, wearable monitoring, and a fully tailored treatment plan that improves preoperative and postoperative help, orthopedic rehabilitation has also advanced due to AI. Such progress points to the AI's capability to play the middle ground between clinical objectives and patient-oriented approaches.

However, there is still room for improvement in general AI rehabilitation practices, as we will discuss below. Some issues that have to be taken into consideration in order to construct these technologies for the maximal positive impact on patients without worsening existing disparities are Algorithmic bias, data privacy, and equal access. Furthermore, the existing rules and regulations must be updated every time there is a new development in the technological sector, primarily for safety reasons and for the development of generally accepted procedures regarding the use of AI tools. These problems need to be solved to establish trust, without which it is impossible to use AI in rehabilitative work in the long term.

In the future, the increased cooperation of experts from different fields and large-scale validation studies of AI use in this field can be helpful. It will involve clinicians, engineers, data scientists, and policymakers in the future to address current challenges and develop new ideas to incorporate AI in rehabilitation. In the future, as AI advances, its potential influence cannot be underestimated, and its future as an adjunct to rehabilitation medicine and an improvement in the outcomes experienced by patients with a wide variety of conditions is bright. The integration of artificial intelligence will only continue to progress within the field, which will inevitably shift the bar for personalized, efficient, and affordable rehabilitation techniques.

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