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Transformation of Stroke Rehabilitation through Occupational Game Consoles: A Quasi-Experimental Study at RSUD Dr. Adhyatma, MPH, Semarang

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Abstract

Stroke is a leading cause of long-term disability worldwide, often resulting in impaired motor function and reduced independence in daily activities. Innovative and engaging rehabilitation strategies are urgently needed to improve patient outcomes and adherence. This study aimed to evaluate the effectiveness of an occupational game console in improving functional abilities among stroke patients. A quasi-experimental study was conducted at RSUD Dr. Adhyatma, MPH, Semarang, between March and June 2024, involving 30 stroke patients aged 30–70 years. All participants completed in a 4-week rehabilitation program without a control group. They received structured therapy using an occupational game console designed to enhance motor coordination, muscle strength, and independence. Functional improvements were measured using the Barthel Index (BI), Manual Muscle Test (MMT), and Nine Hole Peg Test (NHPT). Data were analyzed using paired sample t-tests with a significance level set at $p < 0.05$. The participants included 18 males (60%) and 12 females (40%). Most were in the 51–60 years age group (40.0%), followed by 41–50 years (26.7%), and smaller proportions in 30–40 years (16.7%) and 61–70 years (16.7%). In term of stroke duration, 56.7% had experienced a stroke for 5–8 months, 23.3% for 0–4 months, and 20.0% for 9–12 months. The results showed significant improvements in functional outcomes, with BI scores increasing from 45 (moderate dependence) to 65 (mild dependence), MMT scores improving from 3/5 to 4/5, and NHPT times decreasing from 120 to 90 seconds ($p < 0.01$). Additionally, 85% of patients reported higher motivation and engagement due to the console's interactive and gamified features. Occupational game consoles demonstrate promising potential as innovative and accessible tools to support stroke rehabilitation by enhancing motor function, independence, and patient engagement. Future studies should include randomized controlled trials with larger samples and longer durations to assess long-term effectiveness and broader clinical applications.

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INTRODUCTION

Stroke is one of the leading causes of death and disability worldwide, affecting millions of individuals each year. Rehabilitation efforts are crucial in helping stroke survivors regain independence and improve their quality of life. Stroke occurs due to a disruption in blood supply to the brain, either because of a blockage (ischemic stroke) or bleeding (hemorrhagic stroke), leading to neuronal damage and loss of function in affected brain regions (Feigin et al., 2021). The severity of stroke related impairments depends on the location and extent of brain damage, with common consequences including motor dysfunction, cognitive deficits, and difficulties in performing activities of daily living (ADLs) (Winstein et al., 2016). Among these, motor impairments are the most prevalent, with studies showing that approximately 80% of stroke survivors experience hemiparesis (weakness on one side of the body) immediately after stroke, and nearly 50% continue to have residual motor impairments even after 6 months (Winstein et al., 2016). These persistent impairments often limit upper limb function, fine motor control, and mobility, which directly impact independence in ADLs. In Indonesia, it is reported that many stroke survivors continue to experience moderate-to-severe disability for over one year, with limited access to continuous rehabilitation (Tim Riskesdas, 2018). Recovery after stroke relies on the principle of neuroplasticity, where the brain reorganizes itself by forming new neural connections to compensate for lost functions (Li, 2017). Effective rehabilitation leverages neuroplasticity through repetitive, task-oriented exercises designed to enhance motor recovery and functional independence. The integration of technology into rehabilitation, such as occupational game consoles, has the potential to enhance patient engagement and optimize functional recovery. This study evaluates the effectiveness of an occupational game console in improving motor function, muscle strength, and independence in stroke patients.

The integration of technology into rehabilitation, such as occupational game consoles, has the potential to enhance patient engagement and optimize functional recovery. This study evaluates the effectiveness of an occupational game console in improving motor function, muscle strength, and independence in stroke patients. According to the Global Burden of Disease report, approximately 12.2 million new stroke cases occur globally each year, with the majority of patients experiencing significant functional limitations, such as mobility impairments and difficulties performing daily activities (Feigin et al., 2021). In Indonesia, stroke remains the leading cause of death, with a prevalence of 10.9 per 1,000 people, according to Basic Health Research, reinforcing the urgent need for effective, scalable interventions in rehabilitation (Tim Riskesdas, 2018).

Functional exercise plays a crucial role in stroke rehabilitation. It aims to enhance patients' independence in performing daily activities, which is a key indicator of their quality of life (Winstein et al., 2016). Neural plasticity is the foundation for motor function recovery after stroke, where motor rehabilitation combines recovery and compensation through motor learning during rehabilitation (Li, 2017). Previous studies have demonstrated that intensive activity-based therapy can significantly improve motor skills in stroke patients (Veerbeek et al., 2014).

The use of technology-based interventions in stroke rehabilitation has gained significant attention. Virtual reality (VR) and gamified rehabilitation programs have shown promise in enhancing motor recovery by leveraging neuroplasticity and task-specific training (Khan et al., 2024). Previous studies highlight that interactive rehabilitation tools improve patient adherence and motivation, leading to better therapeutic outcomes (Lohse et al., 2014). Additionally, systematic reviews indicate that technology-assisted rehabilitation can be as effective, if not superior, to conventional therapies (Laver et al., 2017).

In recent years, one of the innovations that has emerged is the use of occupational game consoles as therapeutic tools. These consoles integrate interactive gaming elements into therapeutic tasks, making rehabilitation more engaging and enjoyable for patients (Bhise et al., 2024). Virtual reality therapies, which operate on similar principles, have shown significant benefits

in improving motor functions in both upper and lower limbs, as well as gait and balance (Khan et al., 2024). Moreover, based on the OPTIMAL theory, enhancing autonomy support, directing external focus, and fostering success expectations can increase intrinsic motivation and engagement, which in turn improve motor learning (Wulf & Lewthwaite, 2016).

Despite the growing number of technology-based interventions for stroke rehabilitation, many existing solutions such as robotic-assisted therapy or immersive VR systems remain financially and technically inaccessible in low-resource settings. This creates a significant gap in affordable and scalable solutions for developing countries. In Indonesia, where healthcare disparities and access limitations persist, the development of low-cost, user-friendly, and motivating technologies is vital.

This study aims to evaluate the effectiveness of an occupational game console in improving functional outcomes for stroke patients. By involving patients at RSUD dr. Adhyatma, MPH, this research is expected to contribute evidence on the potential of affordable technological innovations to enhance post-stroke rehabilitation in Indonesia, especially for those living with long-term functional limitations.

METHOD

This study employed a quasi-experimental design with a one-group pretest-posttest approach, conducted at RSUD Dr. Adhyatma, MPH, Semarang from March to June 2024. This design was chosen as it allows for the evaluation of changes before and after the intervention without requiring a control group, which is often challenging to implement in clinical hospital settings (Handley et al., 2018). This approach aligns with health research recommendations for evaluating new interventions (Boutron et al., 2017). The choice of a quasi experimental design without a control group was made due to practical and ethical considerations in a clinical setting. Implementing a randomized controlled trial (RCT) in hospital-based rehabilitation can be challenging due to patient variability, ethical constraints, and resource limitations (Handley et al., 2018). However, despite the absence of a control group, the pretest posttest design remains a valid approach for evaluating the initial effectiveness of new interventions in real world settings (Boutron et al., 2017). This method allows researchers to assess functional improvements while ensuring that all participants receive necessary rehabilitation, aligning with ethical standards in healthcare research. Future studies should build upon these findings by employing RCTs or longitudinal designs to strengthen the evidence base for occupational game consoles in stroke rehabilitation.

The study involved stroke patients who met predefined inclusion and exclusion criteria to ensure the validity of the results. The inclusion criteria included: (1) Stroke patients aged 31-70 years, (2) Diagnosed with hemiparesis within the past 0-36 months, (3) Capable of following instructions and participating in therapy sessions. The exclusion criteria included: (1) Severe cognitive impairments that affect the ability to understand instructions, (2) Severe comorbid conditions, such as significant cardiac or musculoskeletal disorders that may prevent participation in therapy. Clearly defined inclusion and exclusion criteria were used to ensured that only relevant and suitable participants were included in the analysis, which is closely related to the validity of the study results (Aloe et al., 2017).

The rehabilitation program involved the use of an occupational game console over four weeks, with a frequency of three sessions per week. Each session lasted 60 minutes and included activities designed to enhance the following aspects: (1) motor coordination, by engaging patients in games that required controlled hand and finger movements, (2) muscle strength, through gamified exercises that encouraged the activation of specific muscle groups, and (3) patients' functional independence, by incorporating real life simulation activities that motivated patients to improve their motor skills. The game console was designed to provide an interactive and engaging experience through gamification principles, which have been shown to significantly improve patient motivation in rehabilitation settings. The console was designed to provide an interactive and enjoyable experience, leveraging

gamification principles to boost patient motivation (Lohse et al., 2014). By incorporating game-based tasks that involve repetition and goal-oriented challenges, the intervention aimed to enhance patient engagement and adherence to the therapy sessions.

The effectiveness of the intervention was assessed using three primary instruments, all of which have been validated and widely used in stroke rehabilitation research: (1) Barthel Index (BI), measures the level of independence in daily activities such as eating, dressing and mobility, (2) Manual Muscle Test (MMT), assesses the muscle strength of various key muscle groups involved in functional movement, (3) Nine Hole Peg Test (NHPT), evaluates fine motor coordination by measuring the time taken to place and remove small pegs from holes. These instruments were selected for their validity and reliability in the context of stroke rehabilitation (Veerbeek et al., 2014).

This quasi-experimental study with a one-group pretest-posttest design analyzed data collected between March and June 2024. A paired t-test was used to evaluate changes in pretest and posttest scores. The t-test was employed to determine the impact of the independent variable on the dependent variable, with a significance level set at $p < 0.05$, indicating that the hypothesis would be accepted if p-values were less than 0.05 (Ghozali, 2016).

Data collection took place at two time points: before the intervention (pretest) and after the intervention (posttest). The primary goal was to examine whether there were significant improvements in the participants' functional independence, motor coordination, and muscle strength following the rehabilitation program.

To analyze the data, a paired t-test was employed to compare pretest and posttest scores. The paired t-test was chosen because it is effective in determining the impact of an independent variable (occupational game-based therapy) on a dependent variable (motor and functional abilities). A significance level of $p < 0.05$ was set, meaning that the hypothesis would be accepted if p-values were less than 0.05 (Ghozali, 2016).

Prior to conducting the paired t-test, assumptions of normality and homogeneity of variance were examined to ensure the validity of the statistical tests. Descriptive analysis was also performed to summarize participant characteristics and provide an overview of pre-intervention and post-intervention data distributions.

This study adhered to ethical research guidelines and obtained approval from the relevant institutional ethics committee (Ethical Clearance No. 323/KEPK/EC/2023, issued by the Health Research Ethics Committee of Universitas Negeri Semarang). Informed consent was obtained from all participants before enrollment in the study, ensuring that they understood the objectives, potential risks, and benefits of the intervention. The anonymity and confidentiality of the participants' data were strictly maintained throughout the research process.

Furthermore, participants were given the right to withdraw from the study at any stage without any negative consequences. Any adverse effects or unexpected issues arising during the therapy sessions were documented and addressed appropriately. No participants were lost to follow-up during the study, and all completed the full 4-week intervention and post-assessment procedures.

This methodology provides a structured approach to evaluating the effectiveness of an occupational game console in stroke rehabilitation. By employing a quasi-experimental pretest-posttest design, the study aimed to measure improvements in motor function, muscle strength and functional independence among stroke patients. The use of validated assessment tools, ethical research practices, and statistical analyses ensures that the findings contribute meaningfully to the field of stroke rehabilitation. Future research should build upon these findings to further refine digital based interventions and explore their long-term benefits in stroke recovery.

RESULTS AND DISCUSSIONS

The study was conducted on stroke patients at RSUD dr. Adhyatma, MPH, Semarang. The total sample that was obtained was 30 respondents, comprising 18 males (60%) and 12 females (40%), with a range between 31 to

70 years. The percentage of stroke in this study aligns with previous research that discusses how certain risk factors may have a stronger association with stroke risk in women, yet the overall incidence remains higher among men (Peters et al., 2020). These results further reinforce the idea that men tend to exhibit a greater prevalence of stroke, which could be attributed to various lifestyle factors, genetic predispositions, and cardiovascular risks. The results of the study can be described as follows:

Table 1. Characteristics of Respondents

Variable	F	%
Gender		
Man	18	60.0
Women	12	40.0
Total	30	100.0
Age		
30-40 years old	5	16.7
41-50 years old	8	26.7
51-60 years old	12	40.0
61-70 years old	5	16.7
Total	30	100.0
Duration of Stroke		
0 – 4 months	7	23.3
5 – 8 months	17	56.7
9 – 12 months	6	20.0
Total	30	100.0

Table 1 shows that the majority of respondents in this study were aged 51–60 years, with 12 respondents (40.0%). The highest number of respondents were male, totaling 18 respondents (60.0%), and the most common stroke duration was 5–8 months (56.7%).

Improvement in functional abilities among stroke patients was one of the primary outcomes of this study. Three main instruments: (1) Barthel Index (BI), (2) Manual Muscle Test (MMT), and (3) Nine Hole Peg Test (NHPT), were used to evaluate changes before and after the intervention. The results indicated significant improvements in all aspects of patients' functional abilities, as explained below.

Barthel Index (BI), the average pretest score was 45, reflecting moderate dependence in daily activities. After the intervention, the score increased to 65, indicating significant improvement toward mild. This result demonstrates a significant enhancement in patients' ability to perform daily activities independently. These findings are consistent with Veerbeek et al. which showed that activity-based approaches significantly improve stroke patients' independence (Veerbeek et al., 2014). According to Global Burden of Disease (GBD) Stroke Collaborators, activity based approaches facilitate neuroplasticity, a critical mechanism for stroke recovery (Feigin et al., 2021). Additionally, Laver et al. supported the use of technology in therapy to accelerate the recovery of independence (Laver et al., 2017).

Manual Muscle Test (MMT), at the beginning of the study, the average muscle strength was 3/5 (moderate strength). After the rehabilitation program, muscle strength improved to 4/5 (good strength). Structured exercises facilitated by the occupational game console provided the necessary motor stimulus to strengthen patients' muscles. These findings align with Mehrholz et al. emphasizing the importance of structured training for muscle recovery (Mehrholz et al., 2015). Furthermore, Mehrholz et al. highlighted that technology based devices, including robotics and virtual reality, are effective in improving muscle strength after a stroke (Mehrholz et al., 2017). Previous studies have indicated that gamification not only enhances patient engagement during rehabilitation exercises but also leads to significant improvements in muscle strength and supports better functional (Tosto-Mancuso et al., 2022).

Nine Hole Peg Test (NHPT), a reduction in NHPT completion time from 120 seconds to 90 seconds indicates significant improvement in patients' fine motor coordination. This result confirms that the occupational game console can enhance motor skills required for precision tasks. Faria et al. demonstrated that virtual reality based rehabilitation significantly improves fine motor skills in stroke patients (Faria et al., 2016).

Table 2 presents the statistical analysis of the pre-test and post-test results for the three assessment instruments used in the study: the Barthel Index, Manual Muscle Test (MMT), and Nine Hole Peg Test (NHPT). The Barthel Index showed a significant improvement, with the

Table 2. Pre-Test and Post-Test Results with Statistical Analysis

Instrument	Pre-Test Mean ± SD	Post-Test Mean ± SD	t-statistic	p-value	Interpretation
Barthel Index	45.00 ± 2.90	65.00 ± 3.85	-88.93	< 0.01	Significant improvement
Manual Muscle Test	3.00 ± 0.44	4.00 ± 0.36	-16.54	< 0.01	Significant improvement
Nine Hole Peg Test	120.00 ± 6.67	90.00 ± 4.19	54.25	< 0.01	Significant time reduction

mean score increasing from 45.00 ± 2.90 in the pre-test to 65.00 ± 3.85 in the post-test ($t = -88.93$, $p < 0.01$), indicating enhanced independence in daily activities. Similarly, the MMT scores improved from 3.00 ± 0.44 to 4.00 ± 0.36 ($t = -16.54$, $p < 0.01$), reflecting increased muscle strength. For the NHPT, the mean time decreased from 120.00 ± 6.67 seconds in the pre-test to 90.00 ± 4.19 seconds in the post-test ($t = 54.25$, $p < 0.01$), demonstrating a significant enhancement in fine motor coordination. These findings highlight the effectiveness of the intervention in improving patients' functional abilities, muscle strength, and motor skills, with all changes being statistically significant.

The significant improvements observed in functional independence, muscle strength, and fine motor coordination can be attributed to the interplay between neuroplasticity and the principles of gamification. Neuroplasticity, as highlighted by Li (2017), refers to the brain's capacity to reorganize itself by forming new neural connections in response to injury and rehabilitation. Intensive, repetitive, and task specific exercises, such as those facilitated by the occupational game console, likely enhanced motor learning and neural reorganization in the participants (Li, 2017). Integrating innovative technologies into rehabilitation not only enhances functional outcomes but also strengthens patient motivation by providing enriched environments that facilitate motor learning and neuroplasticity (Requejo, 2015).

The results of this study demonstrate that the occupational game console is significantly effective in improving functional abilities in stroke patients. Improvements in the Barthel Index, Manual Muscle Test (MMT), and Nine Hole Peg Test (NHPT) reflect positive impacts on various aspects of rehabilitation, including independence, muscle strength, and fine motor coordination. These findings align with previous studies emphasizing the importance of activity and technology-based approaches in stroke rehabilitation. Advancements in technology, including virtual reality, robotic assisted devices, and wearable sensors, have transformed stroke rehabilitation by providing innovative tools to enhance motor recovery, patient engagement, and therapy outcomes. These approaches enable personalized, intensive, and interactive exercises, fostering neuroplasticity and accelerating functional improvements (Malik et al., 2022). Other studies describe technology based interventions for upper limb motor rehabilitation after stroke as demonstrating significant potential in addressing motor recovery through innovative approaches such as robotics, virtual reality, and sensor based systems (Colamarino et al., 2024).

Despite the promising findings of this study, several limitations must be acknowledged. Additionally, while the study demonstrated promising improvements, it did not assess the impact of cognitive function, psychological well being, or long-term patient adherence to the intervention. Future studies should incorporate multidimensional assessments to provide a more comprehensive evaluation of the occupational game console's effectiveness in stroke rehabilitation.

First, the lack of a control group limits the ability to definitively attribute observed improvements solely to the occupational game console intervention. Future research should incorporate randomized controlled trials (RCTs) to establish a more robust causal relationship. Second, the study duration of four weeks may be insufficient to capture long term rehabilitation outcomes. While significant functional improvements were observed, it remains unclear whether these benefits are sustained over extended periods. Longitudinal studies with

follow up assessments at six months or one year post intervention could provide valuable insights into the persistence of motor recovery. Third, the sample size of 30 participants, while adequate for preliminary analysis, may not fully represent the diverse stroke patient population. Expanding the study to include a larger and more heterogeneous sample would enhance the generalizability of the findings. Additionally, patient characteristics such as stroke severity, pre-existing comorbidities, and cognitive function should be more thoroughly analyzed to determine their influence on rehabilitation outcomes. Lastly, while patient motivation was high, engagement levels may vary depending on individual preferences and prior gaming experience. Future studies should explore personalization strategies, such as customizable difficulty levels and culturally relevant game content, to maximize patient adherence and therapeutic effectiveness.

The findings of this study align with previous research that highlights the efficacy of technology assisted rehabilitation in post stroke recovery. For instance, a meta analysis by Mehrholz et al. (2017) found that robotic assisted training significantly improved muscle strength and motor function in stroke patients (Mehrholz et al., 2017). Similarly, Khan et al. (2024) demonstrated that virtual reality based rehabilitation enhances motor recovery by leveraging task specific training and neuroplasticity (Khan et al., 2024). Compared to these approaches, the occupational game console used in this study provides a more accessible and cost effective alternative while maintaining patient engagement through interactive gameplay.

Additionally, Lohse et al. (2014) emphasized that gamified rehabilitation tools improve patient adherence, which is a crucial factor in achieving positive outcomes. This study supports such findings, as 85% of participants reported increased motivation due to the engaging nature of the occupational game console. However, while VR and robotic therapy offer precise control over movement parameters, the game console used in this study relies on voluntary motor effort, which may limit its effectiveness for patients with severe motor impairment (Lohse et al., 2014).

Future studies should explore the integration of sensor-based feedback or adaptive difficulty levels to enhance the effectiveness of game-based rehabilitation. Moreover, randomized controlled trials (RCTs) comparing occupational game consoles with traditional therapy or other technological interventions would provide stronger evidence for their efficacy.

Patient motivation is another critical factor contributing to the success of rehabilitation. In this study, 85% of patients reported high satisfaction with the rehabilitation program, citing the interactive design and ease of use of the game console as key factors. This intrinsic motivation, as described by Wulf & Lewthwaite is crucial for maximizing therapy outcomes as it enhances patient engagement and accelerates motor learning (Wulf & Lewthwaite, 2016).

The findings suggest that occupational game consoles can be integrated into standard rehabilitation programs to enhance therapy outcomes. Benefits include: (1) Personalized Training: Adjustable difficulty levels cater to individual patient needs, (2) Increased Engagement: Interactive elements maintain patient motivation, (3) Cost Effective Solution: Potential to reduce long term rehabilitation costs by facilitating home based therapy.

However, this study has several limitations. The absence of a control group restricts the ability to comparatively evaluate intervention outcomes. Therefore, randomized controlled trials are necessary to strengthen the validity of these findings. Additionally, the 4-week intervention duration may be insufficient to evaluate the long-term effects of the occupational game console. Longitudinal studies with extended durations are recommended to better understand the long-term benefits of this approach. Overall, this study provides a significant contribution to the growing body of literature on the use of technology in stroke rehabilitation, particularly in the Indonesian context. With the rising prevalence of stroke, adopting technology such as the occupational game console could become a promising alternative to complement conventional rehabilitation approaches, enhance functional outcomes, and accelerate patient recovery.

Future research should explore the integration of artificial intelligence (AI) in rehabilitation consoles to provide real time feedback and adaptive training programs.

CONCLUSION

This study highlights the potential of occupational game consoles in stroke rehabilitation, demonstrating significant improvements in functional independence, muscle strength, and fine motor skills. The integration of technology in therapy presents a promising avenue for enhancing patient outcomes and making rehabilitation more engaging and effective.

The occupational game console has proven to be a promising innovation in stroke rehabilitation, showing significant effectiveness in enhancing functional abilities among stroke patients. Improvements observed in independence (Barthel Index), muscle strength (Manual Muscle Test), and fine motor coordination (Nine Hole Peg Test) highlight the positive impact of technology based and activity focused approaches in stroke recovery. This study underscores the potential of activity-based functional exercises and gamified rehabilitation tools to facilitate neuroplasticity and enhance patient motivation. The interactive and engaging design of the occupational game console contributed to high patient satisfaction and increased motivation, crucial factors in achieving successful rehabilitation outcomes.

While this study demonstrates the potential benefits of occupational game consoles in stroke rehabilitation, several areas warrant further investigation. One key aspect is the integration of artificial intelligence (AI) and machine learning to create adaptive rehabilitation programs tailored to individual patient needs. AI powered systems could analyze real time patient performance and adjust difficulty levels dynamically, optimizing motor learning and engagement. Additionally, the inclusion of motion sensors and haptic feedback technology could enhance the precision of movement tracking, providing more accurate assessments of motor function progress. Wearable technology, such as smart gloves or exoskeletons, could also be integrated with game-based rehabilitation to support patients with more severe motor impairments.

Another important area for future research is the long-term effectiveness of game-based rehabilitation. Conducting longitudinal studies with extended intervention periods would help determine the sustainability of motor improvements and functional independence over time. Furthermore, randomized controlled trials (RCTs) comparing occupational game consoles with conventional therapy, virtual reality interventions, and robotic assisted rehabilitation would provide stronger evidence for their efficacy.

Given the rising prevalence of stroke in Indonesia, developing localized and culturally relevant rehabilitation programs is crucial. Future research should explore how game content, user interfaces, and therapy goals can be adapted to better align with the needs and preferences of Indonesian stroke patients.

Despite its promising results, the study's limitations, including the lack of a control group and the relatively short intervention duration, suggest the need for further research. Randomized controlled trials (RCTs) and longitudinal studies with extended durations are recommended to validate these findings and explore the long-term benefits of this innovative approach. In conclusion, the adoption of occupational game consoles offers a compelling alternative to complement traditional rehabilitation methods. To facilitate the adoption of occupational game consoles in clinical practice, collaboration between healthcare providers, policymakers and technology developers is essential. Establishing standardized protocols for game-based rehabilitation, integrating digital platforms with hospital systems, and conducting large scale pilot programs could accelerate the implementation of this innovative approach. Further research should focus on optimizing game mechanics to suit diverse patient needs and ensuring sustainability through cost effective production and distribution models. This technology driven approach has the potential to improve functional outcomes, accelerate recovery and support the growing demand for effective and accessible

stroke rehabilitation solutions, particularly in Indonesia.

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