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REVIEW PAPER

MUSICGLOVES THERAPY – RETURNING TO MAXIMUM FUNCTIONAL CAPACITY AFTER STROKE

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Highlights

- Only 4 studies assess MusicGloves therapy effectiveness after stroke.
- Presence of music, results in greater patient involvement during exercises.
- MusicGloves allows for effective individual therapy also at home.
- MusicGloves is a promising and relatively inexpensive form of neurological therapy.
- MusicGloves helps motivate patient to do more exercise.

Abstract

With the increasing number of stroke cases worldwide, there is a growing demand for more and more effective rehabilitation methods. Having suffered a stroke is associated with significant functional and motor limitations, which directly translates into a decrease in quality of life. Over the past decades, researchers have become increasingly interested in the impact of therapies using multimedia tools, such as video games, virtual reality or robots that support the movements of specific body parts, on the effectiveness of rehabilitation and the patient's return to maximum fitness. One such tool is MusicGloves, a dynamic form of post-stroke rehabilitation using movement therapy, video games, music therapy and biofeedback. In this literature review, available peer-reviewed research papers from 2011–2020 were used. The purpose of the review article was to gather existing knowledge on the benefits and risks of using MusicGloves therapy as a form of rehabilitation for patients, with upper limb disorders, after stroke. Based on selected research papers, the effectiveness of MusicGloves therapy is described in comparison with other therapies available in neurological rehabilitation departments. MusicGloves therapy, as a fairly new therapy method, is a promising rehabilitation tool, with a simple and transparent way of working, not requiring the presence of a therapist during the entire therapy process, and significantly motivating patients to undertake newer and more difficult motor tasks. The effectiveness of MusicGloves therapy is still poorly understood, current research is based on low numbers of study groups and the sheer number of available studies is negligible. Improving the recommendations, regarding MusicGloves therapy, may allow patients to recover faster and achieve a standard of living similar to that before the stroke. Med Pr Work Health Saf. 2025;76(3)

Key words: stroke, neurological rehabilitation, MusicGloves, music therapy, rehabilitation video game, hand rehabilitation

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INTRODUCTION

Stroke, a disease of civilization in the 21st century, is the third most common cause of death worldwide, and the most common cause of disability in Europe [1–3]. By 2047, the projections in Europe are that the rate of stroke mortality will decrease by 17%, while the incidence itself will increase by 27% [4]. The incidence of stroke increases with age, as it poses a serious risk for people >55 years, while stroke is rare in those aged 18–34 years [5]. There are certain risk factors of stroke which include hypertension, diabetes, dyslipidemia, nicotinism and obesity [6–10]. Post-stroke individuals show deficits in cognitive (difficulties in intellectual abilities, memory, attention and orientation), behavioral, sensory and visual functions [11,12]. The patient experiences the consequences of having suffered a stroke, especially with motor control of the trunk, lower extremities and upper extremities [12]. Hemiplegia is the main consequence of stroke, which accounts for 50–70% of all sequelae [13]. The limitation of the patient's ability to manage activities of daily living (ADLs) results in a deterioration of the patient's quality of life and may be the cause of post-stroke depression [14]. Recovery, after a stroke, is divided into 3 phases: the acute phase, occurs <7 days after the first symptoms, the regenerative-compensatory phase, lasts

<6 months, and the last phase named as chronic, which lasts >6 months [3]. Early treatment of the consequences of stroke is based on using the regenerative capacity of brain tissues, while later treatments are based on reorganization of the cortex and brain plasticity. In order to maximize the effects of rehabilitation, active rehabilitation is recommended in the acute phase of stroke rather than passive bed rest [15]. Depending on the patient's clinical needs, the standard rehabilitation process uses aspects of physiotherapy to improve overall function, constraint-induced movement therapy to restore functional capacity by forcing the use of the paresed limb, occupational therapy to improve the patient's ability to cope during ADLs, speech therapy and psychological therapy [16,17]. Intensive physical therapy, in an inpatient unit, is often limited to 2–3 weeks, after which outpatient care is recommended. Patient demographic and/or economic constraints may limit the required contact with a therapist, so exercises at home are mandatory as a common solution. Studies conducted show the risks associated with this solution, patients are at risk of premature termination of home therapy due to lack of motivation, intensity and repetition [18]. The development of multimedia therapeutic tools in post-stroke rehabilitation began in the 1980s and 1990s with computer-based programs to support brain neuroplasticity [19]. In the early 21st century, technologies such as virtual reality (VR), computer games and interactive sensory systems enabled more engaging movement exercises tailored to individual patients' needs [20]. The introduction of motion controllers, such as the Nintendo Wii (Nintendo, Kioto, Japan), revolutionized therapy, and in subsequent years, the development of VR and augmented reality allowed for the simulation of real-world tasks, speeding up rehabilitation. Nowadays, these tools use artificial intelligence and telemedicine, making it possible to personalize therapy, exercise remotely and monitor progress [21].

MusicGloves therapy

MusicGloves (Flint Rehab, Irvine, USA) is an innovative therapy system that combines elements of hand rehabilitation with interactive entertainment inspired by video games such as the popular "Guitar Hero" (Harmonix Music Systems, Cambridge, USA) series. The system is based on a specially designed sensory glove that allows patients to perform exercises to the rhythm of music. This approach not only promotes motivation for therapy but also activates various areas of the brain responsible for motor coordination, memory and learning processes. Therapy using MusicGloves is mainly aimed at people with hand movement deficits, such as after a stroke. The glove is equipped with 6 electric wires distributed over all fingers and the proximal interphalangeal joint on the lateral side of the index finger. During exercise, touching 1 of the electrodes (located on the other fingers) by a thumb closes the electrical circuit, which is recorded as a signal by a computer. A microcontroller assigns each of the 5 digital inputs a unique signal, which is then processed by the system. The therapy tasks are displayed on the screen in the form of a video game, synchronized with the music being played. They appear as colored dots, following 5 separate tracks of movement down the screen. The patient's task is to perform the assigned, color-coded point grab with his or her hand when the corresponding point is at the bottom of the screen. The patient receives points for correct and timely execution of moves, while incorrect or untimely actions are recorded as errors. The goal of the game is to achieve as many precise hand grabs as possible in the allotted time. The MusicGloves system, based on the Frets on Fire source code, allows the patient to choose the songs themselves, with each song having an individual order of required grabs. At the end of the game, the player receives a summary of the given approach, where he can find the number of correctly hit grabs (broken down by each type of grip) [22,23].

METHODS

The purpose of this work is to evaluate the effectiveness of therapy for post-stroke patients using the MusicGloves system. The scientific literature for the review, published in English in peer-reviewed journals January 2000–September 2023, were searched using the keywords "MusicGloves," "rehabilitation" and "stroke." The PubMed database was used. The literature cited in articles that meet the inclusion criteria was also reviewed. Papers published earlier than the year 2000 were not used, studies not using MusicGloves, and studies focusing on diseases other than stroke were excluded.

RESULTS

As a result of the review, only 4 original papers met the criteria (Table 1).

Movement and motor therapy

Friedman et al. [22] a study conducted in 2011, found a linear relationship between MusicGloves and *Box and Blocks Test* (BBT) scores displayed that as the score in-

Table 1. Characteristics of available original scientific papers on rehabilitation using MusicGloves since 2000 in the PubMed database

Reference	Year	Participants [n]	Characteristics of study participants	Diagnostic tools
Friedman et al. [22]	2011	10	a history of stroke within the past 3 years	assessment of motor skills with BBT, MusicGloves therapy with and without music
Friedman et al. [24]	2014	12	a history of stroke in the past 6 months	assessment of motor skills with FMA scale, BBT and *Intrinsic Motivation Inventory*, Music Gloves therapy, IsoTrainer and conventional upper limb exercise table
Zondervan et al. [25]	2016	17	a history of stroke in the past 6 months	patient evaluation with the BBT, *Nine Holes Peg Test*, the *Action Research Arm Test*, FMA scale for the upper limb, *Modified Ashworth Scale*, MusicGloves therapy and a conventional set of upper limb exercises at home
Sanders et al. [26]	2020	11	survived a stroke	assessment with the BBT, MusicGloves therapy and a conventional set of upper limb exercises at home

BBT – *Box and Blocks Test*, FMA – *Fugl-Meyer Assessment*.

creases while exercising on MusicGloves and simultaneously the score of the BBT also increases. The increase in the BBT score, a marker of upper limb functional ability, suggests the functional improvement achieved when using MusicGloves. In a 2014 study, Friedman et al. [24] compared the effectiveness of MusicGlove therapy, IsoTrainer (an isometric modification of MusicGlove) and conventional hand exercises. The 12 study participants were asked to perform the prescribed therapies at home for 2 weeks (1 hour session 3 times a week, for a total of 6 h of therapy). The researchers found improvements in mean BBT scores of 3.21 (SD = 3.82) blocks in the MusicGloves group, 0.083 (SD = 4.75) blocks in the IsoTrainer group, and –0.29 (SD = 2.27) blocks in the conventional hand exercises group, respectively. Zondervan et al. [25], during a 3-week intervention (total 9 h of therapy), using MusicGlove (control group) and written exercise sheets (study group), found no significant difference between groups in the BBT score (study group: M±SD 2.3±6.2 blocks vs. control group: M±SD 4.3±5.0 blocks). Researchers, however, discovered an advantage for MusicGlove therapy in a secondary criterion: quality of presented movement after therapy. Sanders et al. [26], based on a study, found a greater increase in BBT score in the study group using MusicGloves therapies (M±SD 12±4 blocks) than in the control group using a conventional set of upper limb exercises (M±SD 7±5 blocks).

Engagement and motivation of patients

Friedman et al. [22] asked the study participants about their experiences with MusicGloves therapy after the intervention. The respondents unanimously stated that therapy with music was more appealing and motivating than without it, and all recommended this form of therapy in both home and clinical settings. Similarly, in the 2014 study, a form was also used after the intervention ended, which included questions about the experience of using 3 different forms of therapy. The respondents unanimously decided that MusicGloves therapy was the most engaging and motivating form of therapy for further exercise [24]; 11 out of the 12 respondents preferred MusicGloves therapy and 1 person preferred IsoTrainer therapy. The study by Zondervan et al. [25] used an activity diary that participants were asked to complete. Based on the diary, it was discovered that the MusicGloves group spent more time on average on therapy than the control group (10 h vs. 8.1 h). Additionally, in this study, each participant was required to perform a minimum of 300 chuckles per 1-hour session. Out of the 15 participants, 11 of them achieved this goal, where the remaining 4 subjects had low performance in the first 2 days of using MusicGloves. This fact may indicate that the lack of noticeable progress in the first days of therapy can effectively reduce patients' motivation to continue their efforts. It is noteworthy that the subjects using MusicGloves in the first week of the intervention performed M±SD 213±301 grasps per day, while in the following 2 weeks this number increased to M±SD 466±641 per day. Patients in the Sanders et al. [26] study were more likely to increase the level of difficulty of the game as a result of their successes. Being able to see the effects of therapy on an ongoing basis, including an increasing number of correctly performed grabs, can be a motivating factor for taking on newer and more difficult challenges.

Music therapy

Friedman et al. [22] compared the results of MusicGloves therapy with and without a musical response present. On average, patients hit the right notes 10% more accurately when they heard music synchronized to the image, compared to sessions when they received no musical response. When patients filled out a questionnaire regarding their experience with MusicGloves therapy, they unanimously said that the presence of music during rehabilitation was very important (average response of about 9.5 out of 10 pts). Being able to combine familiar music with an engaging and attractive form of movement therapy, allows the patient to achieve a higher level of interest. Reflecting this, researchers found in a 2014 study that patients specifically chose MusicGloves as the therapy during which they enjoyed [24].

Availability of therapies

A study by Friedman et al. [22] concluded that MusicGloves therapy can be performed on individuals who score ≥7 pts on the BBT. This means that the therapy is suitable for people with low to maximum moderate functional hand impairment. Patients with high hand impairment will not cope with this form of therapy, as they will not be able to perform the required tasks. This finding is substantiated by a 2014 study by Friedman et al. [24], during which, a patient with the highest degree of upper limb disability was the only one who preferred the static form of therapy as opposed to the dynamic MusicGloves therapy. The patient justified his choice on the grounds that isometric training was an easier form of therapy for him. Zondervan et al. [25] found that the effectiveness of therapy in a clinical setting was similar to therapy performed independently, by the patient, at home. Patients who performed therapies (a total of 6 h) under the constant supervision of a therapist achieved a score gain on the BBT of 3.2 pts, while patients who performed therapies (a total of 9 h) alone in a home setting achieved a score gain of 2.3 pts. MusicGloves therapies are a promising form of home therapy, but the researchers emphasize that it was in the clinical setting that the better rehabilitation outcome was achieved. Sanders et al. [26], when recruiting patients for the study, found that only 13% of subjects met all inclusion criteria, including the BBT. Nearly 60% of those tested had too high a level of hand disability, making it impossible to use MusicGloves therapy.

CONCLUSIONS

Based on the reviewed works, it can be concluded that an attractive form of therapy, using games and music, can positively influence the effects of upper limb therapy after stroke. However, the available studies are characterized by a low number of participating patients, concluding the fact that there is still a strong need to study the impact of MusicGloves therapy in a larger number of subjects.

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