

Midicine: Using MIDI (Musical Instrument Digital Interface) in Medicine for Treating Patients who experienced a Stroke – Review article

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Theoretical background: MIDI (Musical Instrument Digital Interface) is a connectivity standard that musicians use to hook together musical instruments (such as keyboards and synthesizers) and computer equipment. By applying MIDI-technology the experience induced by different types of software can create an inner motivation for stroke patients to go on the successful healing process. *Aim of the review:* The aim of writing the review is to determine the relevance and importance of applying MIDI applications in treatment of stroke patients. The research questions were: 1) What kind of interventions can be accomplished by using MIDI applications in treatment of strokes patients? 2) What are the outcome and result of applying MIDI instruments during the treatment of stroke patients? 3) What type of MIDI applications proved to be effective in the treatment of stroke patients? *Material and Methods:* Three databases (PubMed, Scopus, Web of Science) were systematically searched for relevant data. The papers were selected by focusing on key words: midi, musical instrument digital interface, stroke, cerebral accident, seizure. *Results:* Finally ten articles were selected and represented by focusing mainly on the type of intervention, treatment duration, outcomes and instruments used with a total of n=219 treatment and n=147 control patients. *Conclusions:* The conclusion is that the range of possible improvements provided by proper application of MIDI instruments is rather wide: from hand rehabilitation through limb and gait movement optimization till improving overall quality of life of patients. MIDI technology can be suggested because of two main reasons: 1) adjustability and flexibility of instruments, 2) it can improve the motivation of patients by gamifying the treatments. Further research is needed to discover more possibilities by applying the opportunities offered by the wide range of MIDI applications. The suggested name for such intervention is Midicine.

Keywords: Midicine, stroke, MIDI, MST, Medicine

1. Introduction

Applying new tools in medical practice has been always an important aim of physicians. Sometimes instruments already existing and used on another field of life prove to be suitable for medical purposes. An example of it is Nintendo Wii that discovered to be very helpful in rehabilitation (Anderson, Annett, & Bischof, 2010; Loo & Gan, 2013). The creativity of medical experts has led to the use in medical care of a growing number of devices which were not initially planned for this purpose. One of such tools is MIDI (Musical Instrument Digital Interface).

MIDI (Musical Instrument Digital Interface) is a connectivity standard that musicians use to hook together musical instruments (such as keyboards and synthesizers) and computer equipment. Using MIDI, a musician can easily edit and create digital music tracks. The MIDI system can record the notes played, the length of the notes, the dynamics (volume alterations), the tempo, the instrument being played, and hundreds of other parameters, called control changes. Since MIDI records each note digitally, editing a track of MIDI music is much easier and more accurate than editing a track of audio. The musician can change the notes, dynamics, tempo, and even the instrument being played with the click of a single button.

MIDI-compatible hardware or software is needed to record and playback MIDI files. (Christensson, 2006). MIDI can be considered as an easy and ideal recording method for sounds because of its coding efficiency and high-quality sound reproduction capability. (Modegi, 2001)

The simplest structure of a MIDI instrument is connecting a MIDI keyboard to a PC (Figure 1).

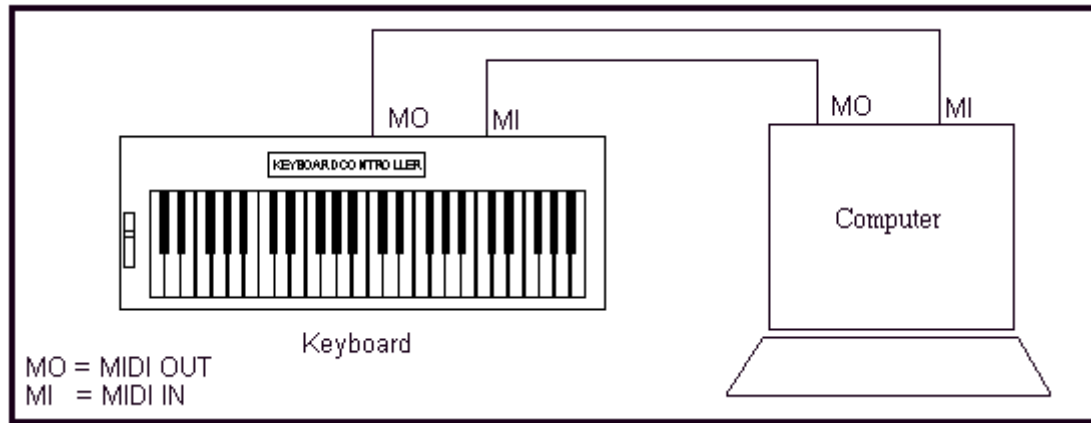


Figure 1. Connecting a keyboard to a PC¹

A definite advantage of using MIDI technology is that different software types can be used by the technology: sequencers, notation and scoring software, editors, auto-accompaniment, synthesis and sampling programs depending on the aim of application. In my review my objective was providing a picture about the different application possibilities of MIDI in treating stroke patients. The review is focusing on stroke patients because stroke can be considered as the leading cause of chronic adult disability in Western countries. After a long time of inpatient physiotherapy, stroke patients are forced to continue unguided and monotonous therapy at home. Consequently, these patients often lose their motivation to continue the therapy and therefore do not recover to their potential (Friedman, Reinkensmeyer, & Bachman, 2011). By applying MIDI-technology the experience induced by different types of software can create an inner motivation for patients to go on the successful healing process. Motor impairment of stroke patients are very common and motoric skills can be improved by music-supported therapies. MIDI instruments can be used either as a piano or as drum machine thus providing the opportunity for rhythmic stimulation of patients. Gross motor skills with respect to speed, precision, and smoothness of movements can also be improved by using MIDI technology (Altenmuller, Marco-Pallares, Munte, & Schneider, 2009).

Based on the above scientific results the aim of this study was to determine the relevance and importance of applying MIDI instruments in treatment of stroke patients. The research questions were: What kind of interventions can be accomplished by using MIDI applications in treatment of strokes patients? What are the outcome and result of applying MIDI instruments during the treatment of stroke patients? What type of MIDI applications proved to be effective in the treatment of stroke patients?

¹ <http://music-technology.tripod.com/connections.html>

2. Material and Methods

The search strategy contained a systematic search of several medical databases (PubMed, Scopus, Web of Science). Searching were performed from the 31st August till 4th September 2015 using the terms: “musical instrument digital interface” [AND] cerebral accident, midi [AND] cerebral accident, “musical instrument digital interface” [AND] seizure, midi [AND] seizure, “musical instrument digital interface” [AND] stroke, midi [AND] stroke. There were no language restrictions. All databases were searched from their start date to September 4 2015. The results are shown in *Table 1*.

Table 1. The result of searching articles about using midi technology in treatment of stroke patients

Databases	Keywords					
	musical instrument digital interface AND cerebral accident	midi AND cerebral accident	musical instrument digital interface AND seizure	midi AND seizure	musical instrument digital interface AND stroke	midi AND stroke
PubMed	0	0	0	7	3	18
Scopus	0	0	0	1	4	23
Web of Science	0	0	0	0	4	15

The PRISMA guidelines were followed by making the review (Moher, Altman, Liberati, & Tetzlaff, 2011). The results are shown in *Figure 2*. Reasons for excluding documents in the screening phase were as follows: the word “stroke” was used in other sense than a medical problem, for e.g. keystroke or two-stroke engine (5), the word “midi” was used in other sense than Musical Instrument Digital Interface, for example size, MIDI ventriculography, mid-clotting activity etc. (5), Midi was a name of a person or a company (7), Midi was a geographical place (Midi-Pyrenees) (14). In the eligibility phase 3 articles were excluded because they did not contain clinically controlled experiments.

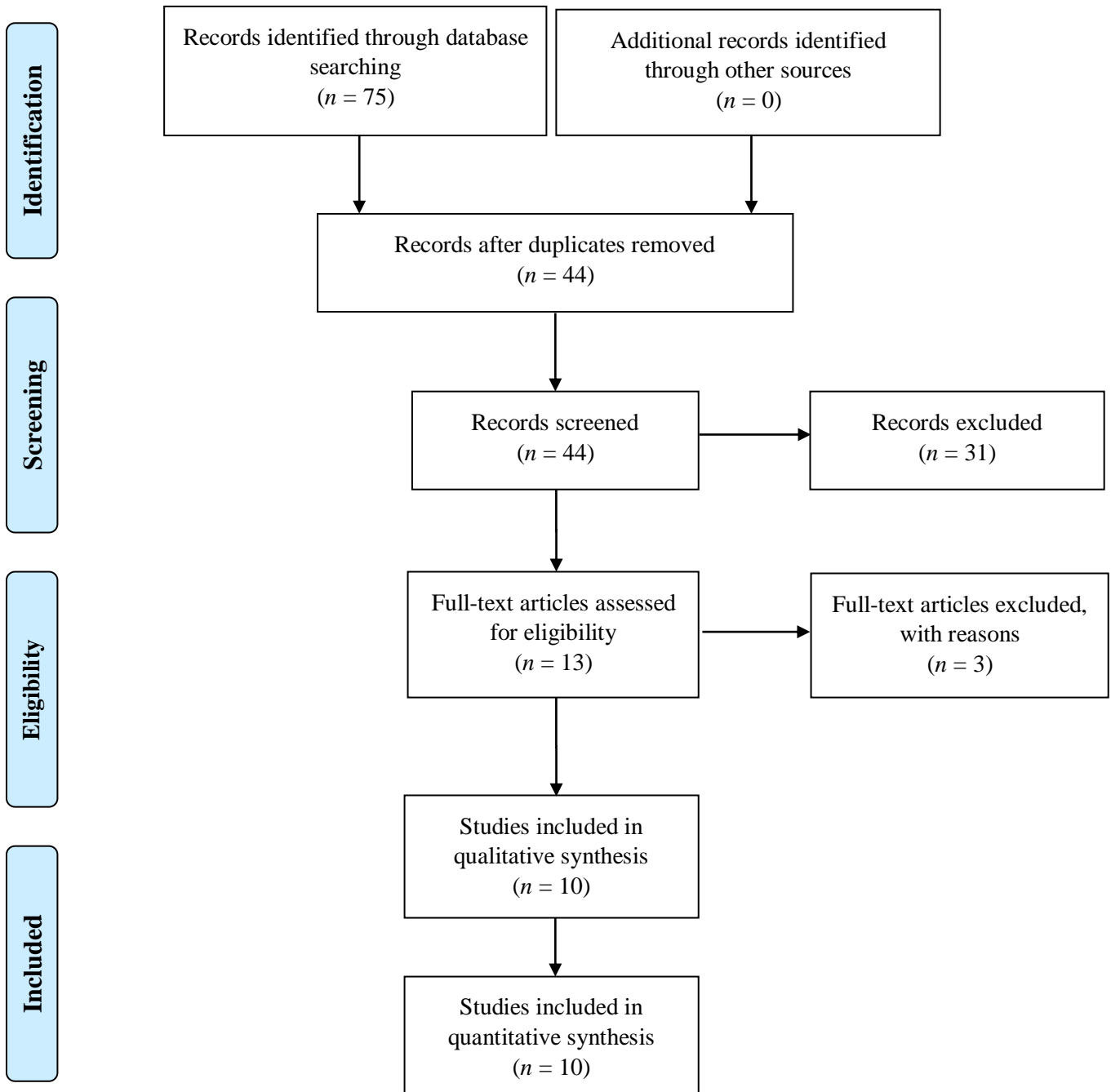


Figure 2. Study selection process based upon PRISMA guidelines (Moher et al., 2011)

3. Results

The literature search revealed 10 clinical controlled experiments with a total of n=219 treatment and n=147 control patients. All studies were carried out between 1996 and 2014. 4 of 10 articles applied MIDI keyboard and electric drum set 3 used MIDI keyboard with special software (Cubase and KM Player, DAT recorder) and 3 of 10 used only MIDI piano but one of them utilized the special feature of MIDI namely beat adjustment. All of the treatments can be considered as music-supported therapies (MST) where behavioral indices and electrophysiological measures were investigated either before and after the treatments or after the treatments comparing the results of a control group. The types of intervention differed by adapting the treatment to the special injuries and therapeutic aims. Thus 5 of the studies were focusing on hand movement rehabilitation (Altenmuller et al., 2009; Chong, Cho, & Kim, 2014; Chong, Han, Kim, Park, & Kim, 2014; Rojo et al., 2011; Villeneuve & Lamontagne, 2013) 2 of them aimed at improving gross motor skills by focusing on hand movement (Schneider, Munte, Rodriguez-Fornells, Sailer, & Altenmuller, 2010; Schneider, Schonle, Altenmuller, & Munte, 2007) 1 focused on improving gait performance (Cha, Kim, Hwang, & Chung, 2014) 1 on improving leg movements (Schauer, Steingruber, & Mauritz, 1996) and 1 was investigated the formation of new neural networks in music perception (Schuppert, Munte, Wieringa, & Altenmuller, 2000).

The outcomes of the treatments support the application of MST by applying MIDI instruments. Marked improvement of motor function, better cortical connectivity, formation of new neural networks, improved activation of the motor cortex, improved balance and gait performance, improved hand function and movements, better leg function, improved emotional indices and thus better quality of life were the results of treatments. Since the characteristics of the injuries were individual the treatments had to accommodate to such circumstances namely MST could be applied only in individual sessions not as a group therapy. The results are shown in *Table 2*.

Table 2. Characteristic of the studies on applying MIDI-based technology for improving life quality of patients who experienced a stroke

First author	Year	Type of intervention	Treatment duration	Outcomes	Instrument	N treatment	N control
Altenmüller, E.	2009	Self-paced index finger movements on a defined piano key or gross movements with the whole arm by hitting a defined drum pad each 3–5 s.	3 weeks (15 sessions)	Music-supported therapy leads to marked improvements of motor function after stroke and these are accompanied by electrophysiological changes indicative of a better cortical connectivity and improved activation of the motor cortex.	MIDI piano and electronic drum set	32	30
Cha, Y.	2014	Rhythmic auditory stimulation for improving gait performance.	6 weeks (30 min/day)	Gait training with rhythmic auditory stimulation improves balance and gait performance as well as quality of life, in individuals with chronic hemiparetic stroke	MIDI Cubase musical instrument digital interface program and a KM Player version 3.3	10	10

Table 2. Characteristic of the studies on applying MIDI-based technology for improving life quality of patients who experienced a stroke (cont.)

First author	Year	Type of intervention	Treatment duration	Outcomes	Instrument	N treatment	N control
Chong, H.J.	2014	Piano playing (Simple melodic patterns were based on repeated movements of a single finger and successive movements of adjacent fingers Also, random movements of the fingers or combinations of more than two finger movements were executed)	4-6 weeks (Two 25 minute training per week)	The results support using keyboard playing for hand rehabilitation, especially in the pressing force of individual finger sequential movements	MIDI-connected keyboard	8	-
Chong, H.J.	2014	Hand-function test: sequential key pressing on a MIDI keyboard.	3 trials with 30 seconds rest in between them.	MIDI-keyboard playing scores demonstrated moderate to high correlations with hand function tests except for participants at the chronic stage and the JTHF.	Steinberg's Cubase 6 software, MIDI program and a Yamaha P-85 keyboard.	66	-

Table 2. Characteristic of the studies on applying MIDI-based technology for improving life quality of patients who experienced a stroke (cont.)

First author	Year	Type of intervention	Treatment duration	Outcomes	Instrument	N treatment	N control
Rojo, N.	2011	Hand function test: the patient proceeded from playing single notes to playing sequences of notes and beginnings of children's songs.	4 weeks (20 sessions, 30 minutes per each).	Music-supported therapy led to a clinical improvement and to an increased quality of rapidly alternating movements.	Midi piano and an electronic drum set	1	-
Schauer, M.	1996	Rhythmic auditory stimulation for improving motor performance of the leg.	One session per patient.	Synchronizing the beat of the music and the motor performance in terms of recognizing the movements of the legs to the music of stroke patients with mild leg paresis.proved to be successful.	MIDI music system with beat adjustment.	12	12

Table 2. Characteristic of the studies on applying MIDI-based technology for improving life quality of patients who experienced a stroke (cont.)

First author	Year	Type of intervention	Treatment duration	Outcomes	Instrument	N treatment	N control
Schneider, S.	2007	Finger tapping and hand tapping aiming at improving gross motor skills.	3 weeks (15 sessions, 30 minutes per each).	Patients showed significant improvement after treatment in gross motor skills with respect to speed, precision and smoothness of movements and motor control in everyday activities improved significantly.	MIDI piano and electronic drum pad.	20	20
Schneider, S.	2010	Producing tones, scales, and simple melodies aiming at improving gross motor skills.	3 weeks (15 sessions, 30 minutes per each).	Music-supported training is efficient and seems to be more efficient in improving gross motor skills than functional motor training because of motivational and emotional factors.	MIDI piano and electronic drum pad.	32 +15	30

Table 2. Characteristic of the studies on applying MIDI-based technology for improving life quality of patients who experienced a stroke (cont.)

First author	Year	Type of intervention	Treatment duration	Outcomes	Instrument	N treatment	N control
Schuppert, M.	2000	Recognition of familiar song melodies, testing discrimination of pitch, testing discrimination of interval and rhythm, testing discrimination of sound contour and metre.	One session per patient.	Individual aspects of musicality and musical behaviour very likely contribute to the definite formation of new neural networks.in music perception.	Midi-piano and Sony DAT recorder.	20	45
Villeneuve, M.	2013	Step-by-step musical training.	3 weeks (9 sessions, 1 hour per session) + home program: biweekly piano exercises of 30min.	All participants showed improvements in note accuracy and timing accuracy within and across the training sessions with improvements in manual dexterity, finger movement coordination, and functional use of upper extremity.	Midi-piano (Yamaha P155)	3	-

4. Discussion

The review focused at collecting studies on applying MIDI-based technology for improving life quality of stroke patients. As far as we know this is the first study on this field focusing on the relevance and importance of applying MIDI technology in treatment of stroke patients. The findings clearly support the application of MIDI instruments in music supported therapies even if the patients have little or no musical training and can be considered as musically inactive (Schuppert et al., 2000). The range of possible improvements is rather wide: from hand rehabilitation through limb and gait movement optimization till improving overall quality of life of patients. MIDI technology can be suggested because of two main reasons: 1) adjustability and flexibility of instruments, 2) it can improve the motivation of patients by gamifying the treatments. Most of the patients enjoy playing on MIDI instruments and thus the healing team working with them will be able to build an inner motivation in the patients instead of urging them to do exercises time to time.

MIDI keyboards were used in all of the treatments with or without different other applications. MIDI keyboard has several advantages like “Midification, versatility, reproduction sound quality and creative credibility (Writing, 2015). The meaning of “Midification” is allowing keyboard keys to function as various instrument samples or to act as a channel to control a previously recorded and programmed instrument sound. Such samples are available in wide spectrum on the music market from different companies like Best Service, East-West, Native Instruments Sony etc. Versatility is one of the greatest advantages of MIDI keyboard since with a proper interface it can produce the sounding of a whole live orchestra by using synchronized patches and sound banks. The user needs only a small amount of time investment and a minimal musical knowledge for reaching motivating result. Sound quality depends on the instrument samples and distortion ability of the system but even with a limited amount of financial background good result can be reached. Creative credibility is one of the most important and inspiring quality of the system since it allows the user to have complete control to the millisecond during recordings and gives inspirations for trying other instrument samples as well. By pushing a single key the user is capable of creating whole melodies and for a stroke patient who needs to learn how to use again the fingers for example it gives the experience of great success thus building inner motivation for continuing the therapy.

Electric drum set were used in 3 of the treatments. An electric drum set connected to a MIDI instrument is capable of creating wide variety of sounds (even piano sounds) by allowing to measure the exact beat rate and rhythm the user produces. It proved to be extremely advantageous in those treatments where movement rhythm of a defined finger or arm was in the focus of the treatment.

3 studies reported about applying special types of software (Cubase, KM Player DAT recorder). Cubase is a music software product developed for music recording arranging and editing. KM Player is a flexible multimedia player and DAT (Digital Audio Tape) recorder is a signal recording and playback medium. All of such software types can be applied for processing data provided by MIDI instruments.

By applying MIDI devices patients will be able to discover their inner strength and creativity thus helping themselves to recover as fast as they can. Such technology makes even home practicing is feasible and leads to further, sustainable and significant improvement. The choice offered by the wide range of MIDI applications (sequencers, notation and scoring software, editors, auto-accompaniment, synthesis and sampling programs) can provide much wider possibilities for applying them on the field of rehabilitation.

5. Conclusions

Most of the stroke patients lose the two most important elements of their life: rhythm and harmony. Music supported therapies have already proven undoubtedly beneficial in treatment of stroke patients. By applying the flexibility and gamification characteristic of MIDI applications both the patients and the healing team can enjoy significant benefit. It can be considered as a revolutionary way of treatment. The aim of this review is giving a short introduction to the possibilities of using MIDI instruments in treatment of stroke patients. Making a comparison between the different methods and their results can be the topic of another article. Overall, the option of utilizing MIDI technology for treating stroke patients and discovering new possibilities on this field. I suggest to name this special application as *Medicine*.

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Conflict of Interest Statement

The author declares that he has no conflict of interest.

Medicine: MIDI (Musical Instrument Digital Interface) eszközök alkalmazása orvosi célokra, sztrók-betegek kezelése során – áttekintő cikk

KOLLÁR JÁNOS

Elméleti háttér: A MIDI (a Musical Instrument Digital Interface rövidítése) billentyűs hangszerek és számítógép összekapcsolása révén keletkező elektronikus hangszerek összefoglaló neve. A MIDI-technológia alkalmazása segítségével, különböző szoftverek használata révén a gyógyulás iránti belső motiváció kiépíthető, illetve erősíthető sztrókon átesett betegek esetében. *Célkitűzés:* A tanulmány célja rávilágítani a MIDI-technológia alkalmazásának lehetőségeire és jelentőségére sztrókos betegek kezelése során. A szakirodalmi kutatás során feltett kérdések a következők voltak. 1. MIDI-alkalmazások segítségével milyen beavatkozások végezhetőek el sztrókos betegek esetében? 2. Milyen eredménnyel alkalmaznak MIDI-technológiát sztrókos betegek kezelése során? 3. Milyen MIDI-alkalmazások bizonyultak hatékonyaknak sztrókos betegek terápiaja esetén? *Módszerek:* A kutatáshoz szükséges adatokat három adatbázis (PubMed, Scopus, Web of Science) szisztematikus átvizsgálása segítségével sikerült megszerezni. A keresés során alkalmazott kulcsszavak a következők voltak: midi, musical instrument digital interface, stroke, cerebral accident, seizure. *Eredmények:* Összesen tíz olyan publikációt sikerült találni, amelyek megfeleltek a keresési feltételeknek. Ezek vizsgálata a beavatkozás típusa, a kezelés hossza, az eredmények, valamint az alkalmazott MIDI-eszközök szerint történt. Összesen 219 vizsgálati és 147 kontroll személy vett részt a kezelésekből. *Következtetések:* A kutatás eredményei szerint a MIDI-eszközök sztrókos betegek kezelése során történő alkalmazásának skálája meglehetősen széles: a végtag-rehabilitációtól kezdve a testtartásjavításon át a betegek életminőségének javításáig. A MIDI-technológia alkalmazása két fő ok miatt ajánlható: 1. az eszközök széles skálája és rugalmasságuk miatt, 2. a kezelések „gamifikációja” (játékossá tétele) révén a gyógyulás iránti belső motiváció építhető ki a betegekben. A MIDI-alkalmazások további felhasználási lehetőségeinek felderítése további kutatások tárgyát képezheti. A MIDI-technológia orvosi alkalmazási lehetőségeinek közös elnevezésére a Medicine nevet javaslom.

Kulcsszavak: Medicine, sztrók, MIDI, MST, gyógyítás.