



Article

Dalcroze Eurhythmics-based music and movement training in transitional care brain injury patients: A feasibility study

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ABSTRACT

Cognitive and motor impairments from brain injury are associated with sedentariness, falls and depression. We determined whether group-based multitask training based on Dalcroze Eurhythmics (DE) is a feasible tool to engage motor, cognitive, cardiovascular and affective function in individuals with a brain injury. Transitional care patients with traumatic brain injury or stroke were recruited from a rehabilitation hospital. The DE intervention took place for 50 minutes a day, twice a week, for 6 weeks, and included activities based on musical cues that required the use of memory, attention, coordination and balance. Typical DE activities were modified for this population. Affect, postural control, cognitive function and cardiovascular fitness were assessed before and after. Seven males aged from 23 to 71 completed the pre-test. Three used mobility aids. Six participated in the intervention, and three completed the post-test. Dropouts were due to transportation difficulty, concerns regarding medical insurance unrelated to the study, the lack of support from the staff and family, and the discomfort of being paired with another male for activities. In the three who completed the post-test, no measurable changes in function were found. A programme of longer duration may be needed to improve clinical outcomes. DE was a feasible intervention for a group of mixed physical function brain injury patients. This was facilitated with assistants to provide social variety. Adherence was high (67%). Participants responded well to the use of props and recorded music of their choosing.

KEYWORDS

brain injury, cardiovascular, eurhythmics, cognitive function, clinical, feasibility, music therapy, transitional care

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INTRODUCTION

Brain injury (BI) is associated with pain, motor and cognitive deficits, and the ensuing economic burden and loss of independence lead to a poor quality of life (Marshall et al. 2007; Thompson, McCormick & Kagan 2006; Centers for Disease Control and Prevention 2013). Therefore, a majority of treatments for BI focus on specific motor, cognitive, speech or cardiovascular impairments such as spasticity, balance, gait, speech or activities of daily living (Yang et al. 2007). However, individuals with BI often live a sedentary lifestyle outside of physical therapy (Carlozzi, Tulsy & Kisala 2011), leaving them susceptible to secondary health problems such as physical issues (fatigue, pain, sleep disturbance, cardiovascular problems), emotional issues (depression, anxiety, anger) and social isolation. This results in a further burden to individuals as well as the healthcare system (Carlozzi, Tulsy & Kisala 2011).

In addressing sedentariness in those with BI, aerobic exercise (Schwandt et al. 2012; Wise et al. 2012) and Tai Chi (Blake & Batson 2009) are used to improve mood and quality of life. Mobility training can improve mobility and balance (Schwandt et al. 2012; Wise et al. 2012) and aerobic capacity (Bateman et al. 2001) in BI patients. However, current models of therapy generally do not address all of these conditions in combination, and in particular, their psychosocial aspects. Physical therapy methods generally do not directly address cognitive or social needs of the patients. Likewise, cognitive therapies do not provide adequate aerobic exercise. Multi-factorial interventions are

generally a collection of separate activities, rather than an integrated whole.

Neurologic music therapy has gained much attention recently. Although the exact neurobiological mechanisms by which these interventions work are not well-known, entrainment cues and timing information contained in the music appear to improve motor planning and execution (Thaut, McIntosh & Hoemberg 2015). These paradigms are based on melody intonation, beating time, singing familiar songs, and using tones of specific syllables or phrases (Lim et al. 2013). Yet these paradigms are generally conducted individually and do not include physical activity, social interaction or use such interaction as a part of the treatment itself.

Dalcroze Eurhythmics (DE) has been recognised as a unique intervention for reducing fall risk and improvement in gait in community-dwelling older adults (Trombetti et al. 2011). DE incorporates games and activities cued by music, which engage memory, attention, social interaction, coordination and balance. DE likely provides its benefits partly through mechanisms related to neurologic music therapy (Hegde 2014). Consequently, DE may be effective as an intervention in brain injury patients to simultaneously address multiple domains of physical, cognitive and social functions of gait, balance, cognitive function and reducing fall risk (Medley, Thomson & French 2006), as well as providing cardiovascular fitness in an environment with social interaction. Here the multiple domains of function are built into each activity, which may

better simulate the demands of everyday life, and may lead to improved outcomes. The use of music may also improve adherence (Johnson, Otto & Clair 2001). However, DE has not been studied in post-acute care brain injury patients. This may be because such group-based interactive care may not always meet the specific needs of individual patients, the patients' current functional limitations may make participation in such activities difficult and also because such group-based therapies are not the norm for neurologic rehabilitation.

Therefore, our purpose was to determine whether DE is a feasible intervention for transitional post-acute care BI patients that could be used for improving cardiovascular fitness, mobility and cognitive functions. We determined the feasibility of (1) implementing DE class for a mixed-level group of BI patients and (2) the pre/post testing of cardiovascular, motor and cognitive outcome measures. We also measured attendance and attitudes towards DE as an intervention.

METHODS

Recruitment

Participants were recruited from a post-acute rehabilitation residential facility (Transitional Living Center (TLC)). Specifically, participants were patients transitioning from inpatient care to outpatient care in a residential and day treatment programme located at the hospital campus. The TLC clinicians recommended those who met the inclusion and exclusion criteria for the study. Inclusion criteria included: being a TLC patient, aged 18 or over, able to understand verbal directions and a diagnosis of stroke or traumatic brain injury (TBI).

Written consent was obtained with a form with ethics approval by California State Polytechnic University, Pomona and Casa Colina Hospital Institutional Review Boards. Pre-test data collection of health history, neuropsychological battery, cardiovascular fitness and balance took place a week prior to intervention. A set of 10 classes of Dalcroze Eurhythmics (DE) classes was offered as the intervention. Attendance was based on attending the 10 classes. DE was offered for six weeks, or 12 classes, in order to maximise participation. Post-test data collection was completed within the week after the intervention. All

data were collected at the TLC.

Participants

Seven male participants between the ages of 23 and 71 volunteered for the study and three completed the entire protocol (Table 1). The sample consisted of four participants of moderate function and three participants of high function. Six were diagnosed with TBI and one with stroke. This particular hemiplegic stroke patient had moderate function similar to some of the other moderate function patients and therefore was grouped together for the purpose of this study. Disabilities of the participants included hemiplegia, vertigo, double vision and deficits in standing balance. High function participants could walk without assistance and the middle function participants used a wheelchair and/or a walker. Two of the participants had experienced a fall in the past year.

Age (yrs)	Gender	Diagnosis	Height (m)	Weight (kg)
M=50	7 males	6 TBI	M=1.69	M=82.09
SD=18		1 stroke	SD= 0.069	SD=10.21

Table 1: Participant characteristics (N=7)

Design

The DE intervention consisted of 10 classes of 50 minutes each over six weeks. To maximise participation a total of 12 classes was offered over six weeks, twice a week. These allowed participants to make up any missed classes and complete the full intervention of 10 classes. The DE class included a wide range of activities based on music that required the use of memory, attention, coordination and balance. Activities were improvised and adjusted to the ability of the participants.

DE was offered as a replacement for one hour of the usual therapy (UT) twice a week. The UT normally took place at TLC for six hours a day for five days a week, so during DE class days, participants received five hours of UT and one hour of DE. UT included a combination of physical therapy, occupational therapy, speech therapy and neuropsychology. On a weekly basis, DE replaced two of the 30 hours of UT.

Pre-test and post-test

All testing took place with one person at a time for confidentiality. The pre-test and post-test included: health history, Montreal Cognitive Assessment (MOCA) (Cumming et al. 2013), Center for Epidemiologic Studies Depression Scale – Hopkins Revision (CESD-R) (Eaton et al. 2004), Verbal Fluency, Trail Making Test A & B (Lezak, Howieson & Loring 2004), Simple Reaction Time (Jensen 2006), 6-Minute walk/mobility Test, Quality of Life in Neurological Disorders (Neuro-QOL) (Carlozzi, Tulsy & Kisala 2011) and Balance Assessment. The post-test also included an exit survey on the participants' opinions on the DE class. Pre-test and Post-test were performed by the second author (VV) and a student research assistant.

Health history included questions on history of cardiovascular, orthopaedic and neurologic conditions and medications. MOCA was used to assess overall cognitive function. CESD-R was used to assess mood. Verbal fluency was measured by counting the number of words starting with the letter F a patient could generate within one minute. This was repeated for letters A and S. Simple reaction time was measured using a computer mouse and timing software. Cardiovascular fitness was measured using the 6-Minute Walk/Mobility test (Kosak & Smith 2005). Due to two participants not being able to ambulate independently, their mobility on a wheelchair was assessed. The distance travelled and the Rating of Perceived Exertion (RPE) were measured (Borg 1970). Balance was measured by using a force platform (Kistler Instrument Corp., Amherst, NY) to determine postural sway while standing (or sitting for the two who could not stand). Six 60-second quiet-standing/sitting trials were performed with each participant, half of which included the dual task (counting backwards by three) (Leveille et al. 2008). We used the standard deviation of the displacement of centre of pressure to describe the root-mean-squared (RMS) amplitude of postural sway.

Quality of life was measured using a self-report instrument (Carlozzi, Tulsy & Kisala 2011). The health-related quality of life cognition, lower and upper extremity function questions were used. Neurology Quality of Life (Neuro-QOL) is a set of self-report measures that assesses the health-related quality of life (HRQOL) of adults and children with neurological disorders (Carlozzi, Tulsy & Kisala 2011). Neuro-QOL is comprised of

item banks and scales that evaluate symptoms, concerns, and issues that are relevant across disorders, along with measures that assess areas most relevant for specific patient populations. Self-report measures include physical health, emotional health and social health (National Institute of Neurological Disorders and Stroke 2010).

Intervention based on Dalcroze Eurhythmics

An instructor with a license in the DE method (Author 3, SH) offered 12 classes for 50 minutes twice a week over six weeks. Attendance in 10 of the 12 was considered 100% attendance. These classes were held in the hospital campus in a large conference room to allow for moving freely. The instructor provided a wide range of activities cued by live improvised music on the piano and also used recorded music of participants' choosing that required the use of memory, attention, coordination and balance. Many of the activities were improvised and adjusted to the participants' ability. Activities included: walking and stopping as cued to the music; walking in tempo as music quickens or slows; mirroring other participants' movements; manipulating props such as balls and sticks; creative freeform movements; memory and quick reaction games; and self-directed and designed activities. A sample of the activities and their purpose is described in Table 2. The DE instructor involved the participants in the music selection for the DE classes as well as generating the activities for the day. Activities were designed with DE principles of follow, echo, exploration, improvisation, social interaction, sequences, disassociation, inhibition and quick reaction (Farber & Parker 1987; Jaques-Dalcroze 1921). Participation required processing and interpreting musical and auditory cues presented through the music, managing temporal patterns and spatial reasoning in the same task, and performing cognitive, social and motor tasks in the same context. The all-male participant group responded well to the use of props, particularly balls. Therefore many activities involved balls as props.

Recorded music was selected based on the interests of the participants, as personally meaningful music has many benefits. Although participants enjoyed the improvised music from the piano, they requested specific recordings, which included Motown, rock, dance and pop genres. The instructor selected certain music to be used before

class as the participants gathered in the room, which helped them 'loosen up' and get into the mood of the class. As they arrived to the room filled with their favourite music, they showed their enthusiasm by dancing spontaneously in their wheelchairs.

During class, the recordings were incorporated into the activity in two ways. First, recordings served as background music to accompany the activity, giving the participants a sense of enjoyment while working on specific cognitive and/or motor skills (Table 2). For example, Desmond's *Take Five* and Springsteen's *Born in the USA* were used during the ball-kicking activity that involved memory, coordination and attention. Second, recordings were used to cue movements, taking specific musical elements such as tempo

changes, meter and strong and weak beats. For example, in Theodorakis' *Zorba the Greek*, the tempo becomes progressively faster. This was used to cue the ball-passing activity. Participants had to listen and respond to the tempo changes by passing the ball faster; in addition, a signal was given to change the direction of the ball passing. In Richie's *La Bamba*, participants explored 4/4 meter by shaking and placing the maracas in four different points in space in each direction: right, left, up, and down. They also experienced its simple verse-chorus form by moving sideways during the verse, moving up and down during the chorus, and improvising movements during the instrumental interlude. Participants needed to anticipate the ends and beginnings of the phrases by interpreting the musical form.

Activity description	Goals
<p>Mirroring with the hoop</p> <ol style="list-style-type: none"> 1. Explore different ways of moving with the hoop. 2. Move the hoop with the music. When the music stops, stop wherever you are in space. (Improvised music cues the starts and the stops). 3. Find a partner. 4. The leader leads the movement; the follower mirrors the leader's movements. 5. Switch roles. 6. Do this with a recording (<i>What a Wonderful World</i> by Louis Armstrong and <i>Moon River</i> by Frank Sinatra). (Verbal cues to switch roles given by the instructor). 	<p>Encourage participants to widen their motor pattern repertoire, and become aware of their range of motion.</p> <p>Engage participants' set-switching executive function, creativity, visual-spatial processing, visual-motor transformation, coordination, weight shifting.</p> <p>Notes: These recorded songs were requested by participants. They were used in this activity due to their slow tempo and legato phrases. These then cued fluid, continuous movement, a difficult task for those with motor deficits.</p>
<p>Dance with maracas</p> <ol style="list-style-type: none"> 1. Explore different ways of moving with the maracas. 2. Learn a movement sequence with maracas, with four shakes in each direction: <ul style="list-style-type: none"> o To the right, back to the centre, to the left, back to centre, during the verse. o Go up, go down, during the chorus. o Free style – improvise movements. 3. The movement sequence was applied to the simple verse-chorus form of <i>La Bamba</i>. The teacher cued the sections of the form. (Recording: <i>La Bamba</i> by Valens Richie). 	<p>Learn a movement sequence requiring memory and set-switching between the verse and the chorus without the use of visual cues.</p> <p>Notes: This song contains marked rhythm that cued discrete, controlled movements.</p>
<p>Accents</p> <ol style="list-style-type: none"> 1. Explore different ways of using the drum. 2. When you hear a strong beat from the piano, tap it on the drum. 3. The patients describe the groupings or meter (groupings of 4, 3, or 2). 	<p>Engage attention and temporal perception in finding the musical meter.</p> <p>Notes: Placing the drum requires temporal perception, decision making, and motor response generation.</p>

<ol style="list-style-type: none"> 4. Find a partner. Person A is the strong beat and holds the drum. Person B is the weak beat. 'A' places the drum in a definite spot on the accent and 'B' taps the weak beats on the 'A's' drum. 5. Do with a recording, which is in a slow feeling of twos. (<i>Daddy's Home</i> by Shep and the Limelites). 	
<p>Ball pass</p> <ol style="list-style-type: none"> 1. Explore different ways of passing a ball in the circle. 2. Pass the ball around with a steady beat. 3. When you hear a signal, pass the other way (change direction). The music might go faster or slower. 4. Do this with a recording in which the tempo accelerates (<i>Zorba, the Greek</i> by Mikis Theodorakis). 	<p>Ball pass engages coordination, set-switching, and motor response generation.</p> <p>Accelerating tempo required faster motor reactions.</p>
<p>Memory game</p> <ol style="list-style-type: none"> 1. Using one big yoga ball, kick to someone in the circle as you call their name. 2. Next person kicks the ball to another person. 3. Remember the pathway of the ball between the individuals. 4. Create three different pathways and practise them. 5. Do it with a recording (<i>Born in the USA</i> by Bruce Springsteen; <i>Take Five</i> by Paul Desmond). Pass according to the pathway called. 	<p>Kicking engages balance and coordination, as well as memory and set-switching.</p>

Table 2: Descriptions and goals of selected activities

Aside from the participants, the class also consisted of the Dalcroze instructor, a TLC residence assistant for the patients with mobility difficulty, two research assistants and two to three student volunteers. The additional volunteers provided a wider range of musical ideas, social variety for the programme participants and assistance to the patients. Although being alongside others with a similar level of function may have provided more social safety, the participants asked for and expected additional social variety.

The intervention replaced two of the 30 hours per week of UT, consisting of physical, occupational, speech, and neuropsychological therapy. As a feasibility study, this dose of 10 classes was based on the constraints of the study. Dose-dependent effects have been considered by Trombetti et al. (2010) and Hars et al. (2014), but these studies were of older adults over four years. Dose-dependence in brain injury patients is not yet known.

Analysis and statistics

Pre-test and post-test results were compared with paired t-tests using Microsoft Excel 2010.

RESULTS

Participation

Participants were able to provide consent and participate in the pre-test and the intervention. There were no adverse reactions or events during the DE intervention. No accidents occurred such as falls, cardiovascular events or injury during the intervention or assessments. Of the seven participants, only three participants completed the 10-week DE intervention including the pre- and post-testing and questionnaire (Table 3). One individual completed the pre-test, but did not participate in any of the DE classes due to difficulty in arranging transportation. Another terminated his participation because of health insurance coverage concerns at the hospital unrelated to the study. Another was no longer willing to take part because of discomfort of being paired with another male for certain activities.

Reasons for not taking the post-test include dropout during the intervention period and fatigue from other therapy activities on the date of the test. For some participants, the post-test had to be conducted after the usual six hours of UT in order

not to interfere with the clinical needs of the patient participants and therefore they could not perform well during the tests.

Pre-test and post-test

Fatigue in BI is common, which was evident in the decrease distance in the post measurements. When measuring fitness in BI patients, we had to take into account any disabilities and/or impairments such as vertigo and being unable to walk or stand. While measuring cardiovascular fitness, accommodations were made for participants who used wheelchairs and walkers through measuring the distance wheeled or walked with the mobility aid.

Due to the small sample size, no statistically significant differences were found between pre-test and the post-test in balance, cognitive function or cardiovascular function. However, trends indicate improvement in these measures (Table 4).

Subject	Pre-test	Dalcroze Class												Post-test	Attendance Rate
		1	2	3	4	5	6	7	8	9	10	11	12		
1	√		√	√	√	√	√	√	√	√	√		√	√	100%
2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	100%
3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	100%
4	√	√	√	√	√										50%
5	√														0%
6	√		√	√	√		√	√		√	√				70%
7	√	√	√	√	√	√									60%
														Pooled: 47/70 = 67%	

Table 3: Attendance and rate of participation¹

¹ The check mark (√) represents attendance on the specified date. Subject 5 did not attend the DE class, but only participated in the pre-test. Attendance rate is based on the completion of 10 classes over six weeks. Post-tests occurred after attendance of 10 classes, after which participants were free to participate in any remaining classes.

	Pre-test (all, n=7)	Pre-test (study completers; n=3)	Post-test (study completers; n=3)	p-value (study completers; n=3)
Static posture				
AP sway (mm)	*	3.0 (1.55)	0.745 (0.274)	0.358
ML sway (mm)	*	3.44 (3.45)	1.35 (0.211)	0.34
AP sway during CB (mm)	*	4.38 (4.56)	3.42 (3.54)	0.82
ML sway during CB (mm)	*	4.58 (4.58)	3.41 (2.55)	0.15
Cognitive and affective				
MOCA	23 (4)	22 (2.08)	25 (3.22)	0.22
CESD-R	23.1 (23.1)	24 (31.56)	26 (33.2)	0.72
TMT-A (s)	53.0 (22.4)	71 (7.55)	67 (2.83)	0.874
TMT-B (s)	76.5 (25.6)	68.5**	95.5 (75.73)	
Verbal Fluency (#words)	13.0 (4.5)	16 (2.64)	17 (1.41)	0.77
Reaction Time (ms)	385 (100)	361 (16.4)	337.6*	
QOL Cognitive	23.5 (12.1)	26 (11.8)	27 (4.5)	0.85
QOL Upper extremity	37 (4.8)	34 (5.57)	38 (3.46)	0.19
QOL Lower Extremity	29.5 (12.2)	22.7 (14.8)	26 (12.8)	0.11
Cardiovascular				
6MWT (m)	229 (123)	120 (15.7)	94 (19.1)	0.19
HR after 6MWT (bpm)	73 (9.0)	72 (8.96)	69.3 (1.15)	0.68
RPE	9.5 (3.8)	11.7 (4.5)	14 (2)	0.42

Table 4: Postural, cognitive, affective, and cardiovascular measures²

² **AP** = anteroposterior direction of body movement; forward-back sway (Raymakers, Sampson & Verhaar 2005); **ML** = mediolateral direction; side-to-side sway; **mm** = millimetres; **CB** = counting backwards, a dual task challenge; **MOCA**: Montreal Cognitive Assessment. The total possible maximum score of MOCA is 30 points; a score of 26 or above is considered normal. **CESD-R**: Center for Epidemiological Studies Depression Scale- Hopkins Revision. A score <15 display no depressive symptoms, 15-21 mild to moderate depression and > 21 possibility of major depression. **TMT**: Trail making test. Longer TMT-A or -B times reveal greater impairment. TMT-A greater than 78 seconds is considered of concern; TMT-B over 273 seconds is considered of concern. **Fluency**: Average number words generated during F, A, S, and Animal names.

Exit survey and informal feedback

One participant completed the exit survey. The participant strongly agreed with the following statements: DE was helpful for my rehabilitation; I enjoyed the class; DE would be helpful to other patients; I would recommend DE to others; I would take more DE classes. The majority of the verbal feedback received during or after the DE classes was positive. Participants enjoyed the interpersonal interaction and the music amongst the group.

The participants raised the issue that the DE classes only consisted of male participants and had fewer participants than expected. This was a serious concern for one who ended his participation before the end of the tenth week due to being paired with other males for certain activities.

Other issues

The DE classes occurred in a conference room that had adequate space for the movement activities, but was adjacent to the audiology clinic and other conference rooms. The music caused some complaints from these neighbouring rooms. Also, the conference room was far away from the TLC clinic and required extra time for transportation to and from class.

DISCUSSION

We set out to determine whether Dalcroze Eurhythmics (DE) was a feasible intervention to engage cognitive function, postural control and cardiovascular fitness in brain injury patients. DE was a feasible intervention for post-acute rehabilitation patients and the participants enjoyed the DE classes. However, there were many challenges with programme delivery and

participation in implementing this group-based intervention in a clinical setting. We found that a close collaboration with clinicians, participants' perspectives of the benefits and caregiver support would be important for success of the intervention. Not unexpectedly, DE was not an effective intervention at the dose given. An extended intervention may be needed to achieve clinically significant improvement in balance, cognition and cardiovascular fitness.

Feasibility of programme delivery

The participants were able to give consent and participate in the classes. The challenge of meeting the needs of a multiple patients of mixed levels of physical function in a group setting was overcome through the assistance from student volunteers, as well as the design of the activities. As one participant dropped out due to concerns about medical insurance unrelated to the study, proactively addressing concerns unrelated to the study may improve attendance. Both male and female participants in the intervention may be necessary in order to provide social variety.

The classes included many non-patient participants. Some activities that require working in small groups benefitted greatly from the extra people who could give each participant individual attention. The additional persons provided social stimulation as well as required additional visual attention during various navigational tasks that simulated daily life. Also, the participants asked for more social variety. Although the addition of several people could potentially have interfered with the class, non-patient participants facilitated the participation rather than detracted from it. Finding volunteers to help with the classes is likely to be a key part of future delivery of the programme for this population.

Feasibility of testing procedures and research methods

Many testing procedures were modified for participants using wheelchairs, who otherwise would not have been able to perform tests of motor function as designed. Of note, the motor deficits led to extraneous body movements when verbalising during postural tasks. Therefore the postural sway during a verbal dual task needs to be interpreted with caution. Fatigue from the daily UT can also confound test results. The testing time and other

task. Number of words generated under 17 indicates concern, although 14 is sometimes used as a cut-off. **ms**: milliseconds; **QOL**: Neurological Disorders Quality of Life. High QOL scores indicate more desirable self-reported health.

Subject 1 and Subject 3 decreased distanced travelled in six minutes because they participated in swimming and other fatiguing activities earlier in the day before the post-test. **HR** = Heart Rate; **bpm** = beats per minute; **6MWT** = Six minute walk/mobility test (Crapo et al. 2002; Mossberg 2003). **RPE** = Ratings of Perceived Exertion, a scale of six to 20 (Borg 1970). *Only the post-test completers completed the standing balance test; **Only one person completed.

research activities would need to be built into the treatment time, so that this activity does not occur outside of the daily therapy hours.

Musical perceptual ability could easily influence both the willingness to participate in the intervention as well as the efficacy. However, we did not have any measure of participants' musical abilities pre-injury or post-injury and were not able to measure this in our study due to lack of an instrument for music perception suitable to our population. In the future, this assessment would better inform the design of the activities as well as its efficacy.

In addition to the current feasibility study of pre- and post-testing of physiological function and outcomes due to the intervention, a qualitative study of participants' attitudes, interests and experiences would have yielded useful information for improving the programme delivery and study design for the future. Psychotherapy based on dance movements has been used to address the psychosocial aspects of illnesses (Meekums, Karkou & Nelson 2015), but this intervention has not been fully investigated in brain injury patients. The interactive nature of DE likely provides this psychosocial benefit as well. This benefit will need to be investigated in future studies.

Recruitment and retention

The study sample size was smaller than expected. This smaller sample size was in part due to the nature of the study population that is transitioning from the hospital to the home. We only recruited from transitional care patients, rather than inpatients or outpatients. Some of the potential participants needed to travel from home to receive therapy. For them, the arrangement of transportation for the pre- and post-tests was difficult. Since the pre- and post-tests needed to occur outside of the therapy time, additional transport arrangement was needed and often not possible. This made enrolment into the study difficult.

The intervention competed for time during UT and therefore the clinicians did not actively recommend DE in place of UT due to other clinical needs. To address these challenges, future studies need to expand the sample to include inpatients or outpatients. Also, it is crucial for clinical and non-clinical staff to be further informed of the potential benefits and the requirements of the study. The support of the family, non-clinical facility staff, and from care coordination, transportation and personal

assistants, is critical for the encouragement and support to continue participation. Furthermore, transportation of commuting patients would need to be arranged prior to the start of the study. The participants' perspective of the benefits of the study is also important. In this study, informing the participants about the independence of the research study from the clinical care or insurance reimbursement issues may have helped with retention.

Future work needs to consider factors that determine dropouts from the programme and how changing those factors may increase participation and retention. Also, as these transitional care patients move back home, studying the effects of DE on this transition process, such as adjustment, social ties, and managing disabilities may better inform future programme delivery.

Intervention dose

To our knowledge, ours is the first study of DE as an intervention for brain injury patients. Without a *priori* knowledge, the dose was based on the constraints of the study. The effective dose amount is not yet known. In our study, DE was offered over 10 classes, twice a week, for 50 minutes a day, a total of 10 hours over 6 weeks. Trombetti et al. (2011) used an intervention for a total of 24 hours over 6 months to produce a large reduction in fall rates. An extended intervention may therefore be needed to achieve clinically significant improvement in balance, cognitive and cardiovascular fitness in patients with TBI. Since the intervention occurred simultaneously with UT, a control group is needed to measure efficacy of DE alone. It is not clear if DE can indeed replace some UT, or work best in addition to it.

Conclusion and future work

In conclusion, DE was a feasible intervention in a group of male brain injury patients of mixed physical function levels. This group responded well to the use of recorded music of their choosing to cue the activities and the use of props. Group-based intervention in a mixed functioning group was successful with helpers who provided social variety. An extended intervention is necessary to determine the dose needed to see improvements in function. It is likely this will need to be an outpatient setting where patients can participate for a longer duration. Support from all stakeholders in the

patients' welfare is critical for offering a novel intervention, including clinicians, coordinators, staff and caregivers.

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