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J Burn Care Res. Author manuscript; available in PMC 2014 January 03.

Published in final edited form as:
J Burn Care Res. 2008 ; 29(6): . doi:10.1097/BCR.0b013e31818b9e0e.

Effects of a 12-week Rehabilitation Program with Music & Exercise Groups on Range of Motion in Young Children with Severe Burns

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Abstract

Previous studies indicate that rehabilitation programs supplemented with a strength and endurance-based exercise program improve lean body mass, pulmonary function, endurance, strength, and functional outcomes in severely burned children over the age of 7-years when compared to standard of care. To date, supplemental exercise programming for severely burned children under the age of 7-years has not yet been explored. The purpose of this study was to determine if a 12-week rehabilitation program supplemented with music & exercise, was more effective in improving functional outcomes than the standard of care alone.

METHODS—This is a descriptive study that measured elbow and knee range of motion (ROM) in 24 severely burned children between ages two and six years. Groups were compared for demographics as well as active and passive ROM to bilateral elbows and knees. A total of 15 patients completed the rehabilitation with supplemental music and exercise, and data was compared to 9 patients who received standard of care.

RESULTS—Patients receiving the 12-week program significantly improved ROM in all joints assessed except for one. Patients receiving standard of care showed a significant improvement in only one of the joints assessed.

CONCLUSION—Providing a structured supplemental music and exercise program in conjunction with occupational and physical therapy seems to improve both passive and active ROM to a greater extent than the standard of care alone.

Keywords

music; music therapy; burns; rehabilitation; pediatrics

INTRODUCTION

Rehabilitation of young children with severe burns is intensely challenging. One of the most serious physiological effects of a severe burn is the body's prolonged hypermetabolic reaction, which results in long-term damage to the muscular and skeletal systems.[1] The consequences of this rapid metabolic change include severe loss of muscle mass and bone

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Presented at the 37th Annual Meeting of the American Burn Association, May 10–13, 2005, Chicago, Illinois.

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density increasing the risk for muscle weakness, osteoporosis, and functional disability. Previous studies with older children have shown that participation in an intensive rehabilitation programs incorporating strength, resistance, and endurance training leads to improved functional and physiological outcomes. [2,3,4,5]

Severely burned children who received moderate intensity, progressive resistance, and aerobic exercise three times weekly for 12 weeks significantly improved overall strength as well as distance walked as compared to patients receiving traditional outpatient rehabilitation therapy.[2] A 12-week resistance exercise program significantly improved muscle strength, power, as well as lean body mass relative to burn patients who received a standard rehabilitation program without exercise.[3] Pulmonary function was also improved in severely burned children who received a supplemental exercise program with endurance training as compared to severely burned children who did not receive the supplemental endurance training.[5] Moreover, in comparing the number of major surgical interventions (release of burn scar contractures) required for up to two years post burn, children who received a 12-week supervised exercise program required a significantly lower number of surgeries than those children that received standard of care alone.[4] These findings showed that supplemental exercise programming for children with severe burns, namely, burns with greater than 40% of the total-body-surface-area (TBSA), can significantly improve overall physical status to a greater degree than traditional therapy alone.

Because established resistance and endurance training programs are not developmentally appropriate, nor recommended for very young children, supplemental exercise programming for severely burned children under the age of 7 years requires an alternative approach.[6,7] Since 2004, our facility developed and implemented a supplemental exercise program for young children with severe burns incorporating music therapy rehabilitation techniques. The evidence base for the use of music in rehabilitation can be found in both the basic and clinical science literature.[8,9,10,11,12] The strong interconnection between the auditory and motor systems in the brain results in the ability of rhythmic & auditory cues to prime motor programming and synchronize movement.[8,9,10] Studies further validate the therapeutic benefits of using rhythm and music to improve gait and muscular control in both adults and children.[11,12]

Based on the need to develop effective and developmentally appropriate exercise programs for younger children, we designed a study to determine if young children with severe burns who participated in a 12-week supplemental music & exercise group program in addition to standard of care would improve functional outcomes as compared to the rehabilitation standard of care alone. We hypothesized that severely burned children who participated for the duration of 12-weeks would significantly improve passive and active range of motion (ROM) to a greater extent than patients who received the standard of care.

METHODS

Participants

This study was approved by our Institutional Review Board. Patients were identified according to the flow of inpatients treated at this facility. We identified children, ages 2–6 years, with 40% or greater TBSA burns, who were recently discharged from the intensive care and medically ready, per the attending physician, to participate in an intensive outpatient exercise/rehabilitation program. At this facility, patients are released from the intensive care unit (ICU) when medically discharged, and then receive ongoing treatment as “residential” outpatients. Meaning, patients stay within or nearby the hospital with their caregiver in an apartment/dormitory-style room while coming to the hospital daily for treatments that include wound care, rehabilitation, school, and psychological services.

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Patients continue to receive post ICU treatment until medically discharged to home. At discharge from the intensive care unit, assignment to the group music and exercise program (GMEP) or the standard of care (SOC) group was done. All patients were allowed the opportunity to participate in the GMEP program, which was dependent upon the family's willingness and capability to remain for the duration of the twelve-week program. If unable to remain for the full duration of the program, patients were assigned to the SOC group. This descriptive study was non-randomized and patients were excluded if they sustained amputations to the legs, had a history of developmental delay prior to hospitalization, had a history of neurological injury, or have previously sustained a significant hearing or vision loss.

Group Music and Exercise Program (GMEP)

Participants began the GMEP upon discharge from the burn intensive care unit. For patients who did not live locally, housing was provided nearby the hospital so that participants could travel daily to participate in treatments at the hospital. The GMEP group received one- hour rehabilitation sessions with a licensed occupational or physical therapist five days/week. Other clinical services included psychological, nutritional, and wound care support if needed and weekly check-ups with the burn physician. All participants received supplemental music and exercise groups for 60-minutes every Monday, Wednesday, and Friday for a period of 12 weeks. We defined exercise as purposeful active and functional movement tasks designed to improve endurance, coordination, and strength using goal specific developmentally based activities.[13]

Supplemental group interventions consisted of structured therapeutic movement and exercise-based music activities designed to promote active ROM, endurance, and functional movement based upon age appropriate motor skill development. Two techniques used in the Neurologic Music Therapy model namely, therapeutic instrumental music performance (TIMP) and patterned sensory enhancement (PSE), were the primary treatment strategies. Music-facilitated movement and developmental music activities incorporating active movement were also integrated during the sessions. Activities integrated cognitive and social skill tasks such as following directions and cooperative play and included active parental/caregiver involvement. Group sessions lasted approximately 60-minutes, which included a 5–10 minute warm-up, followed by 35–45 minutes of endurance and functional movement activities, and ending with a 5–10 minute cool-down/relaxation period. Caregivers often assumed a primary role in assisting children during the activities with support guidance from the music therapist. Examples of therapeutic activities included endurance-related musical games (e.g., egg-shaker relay races; obstacle courses, musical chairs), playing instruments using upper and lower extremities, modifications of folk dances, and other developmentally suitable targeted movements (e.g., throwing & catching a ball), all of which incorporated some component of music. Music was used in primarily two ways. First, musical instruments served as targets for goal-directed movement and secondly, musical accompaniment using live and/or recorded music was utilized to provide auditory cues for the targeted movements or to enhance endurance throughout the motor task. For example, drums were placed low to promote bending of knees, or high to promote elbow extension when reaching. Upbeat music with a strong tempo, such as marching band music, was played to promote endurance and motivation while children completed an obstacle course. A board-certified music therapist planned and implemented the groups. The use of music was selected and used purposefully for each activity planned. Occupational and physical therapists were regularly consulted so that therapeutic activities could reinforce the individualized clinical goals of patients participating in the groups. An exercise physiologist was also readily available for consultation and guidance. Range of motion measurements

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were taken at the start of the GMEP and taken again after completion of the 12-week program.

Standard of Care (SOC)

We defined standard of care as the typical and reasonable rehabilitation interventions routinely provided by burn care centers. Participants in the SOC group received this facility's traditional rehabilitation approach as residential outpatients. In this facility, residential outpatients are those outpatients who are housed nearby the hospital and return to the hospital on a daily basis to participate in a multidisciplinary rehabilitation program that includes occupational and physical therapy services as well as psychological, nutritional and wound care support if needed and check-ups with the burn physician. Upon discharge from the burn intensive care unit, participants received daily outpatient occupational and physical therapy sessions as residential outpatients until rehabilitation goals were met. The discharge criteria included achieving functional range of motion for the performance of basic activities of daily living (ADLs) appropriate for their developmental age. Upon medical discharge to home, they were prescribed home OT/PT exercises or were referred to outpatient rehabilitation therapy sessions. The patient's primary rehabilitation therapist prescribed the specific OT/PT home rehabilitation program according each patient's rehabilitative needs. Patients and families received instruction on this home program verbally, via demonstration, and using written handouts with pictures. Discharge from the hospital was possible after the patients and their families demonstrated competency in the performance of the prescribed home rehabilitation program. These participants did not receive the 12-week supplemental group music and exercise program. Some patients were discharged with outpatient therapy while others who did not have access were trained and given a home rehabilitation program. Length of stay in the hospital for rehabilitation varied according to each patient. The SOC was not a homogeneous group and therefore, specific methodology for these participants cannot be fully described. Range of motion measurements were taken at the initial discharge from the hospital and were repeated upon their first routine follow-up appointment. It is standard care at this facility that patients with burns over 40% TBSA return to the hospital at 3, 6, 12, 18 and 24 months for follow-up visits. Therefore, ROM measurements taken were approximately at the end of the 12-week time duration as the GMEP participants.

Range of Motion (ROM)

Trained rehabilitation therapists collected all ROM data using standard goniometric measurements that refer to the American Association of Orthopedic Surgeons' normative guidelines for the joints that were assessed.[14] Function was measured using active and passive ROM in bilateral elbows and knees using a goniometer and measuring methods as outlined by Norkin & White.[15] Elbow extension to flexion range of motion was set at 0° – 150° and knee extension to flexion range of motion was set at 0° – 135°. Physical and occupational therapists trained in pediatric burn rehabilitation administered all ROM assessments.

Range of motion data were recorded and documented in each patient's medical record as part of the hospital's standard procedure for treatment. Goniometric data was collected and recorded by performing a retrospective chart review of active and passive ROM to bilateral elbows and knees on all participants.

Data Collection and Analysis

Range of motion measurements on all participants were recorded into the patients' medical records as part of routine hospital procedure. Active and passive ROM in bilateral elbows and knees were completed and data was analyzed using *t*-tests. Significance level was set at a p value of 0.05 and values presented as means (+/−) the standard deviation. Pre-treatment

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passive and active ROM scores were also compared between groups and are shown in Table 6. Demographical data was collected which included each participant's age, percentage TBSA, burn distribution to elbow and knee joints, gender, and pre, post, and percentage change on measures of height and weight. Demographic data was compared between groups using descriptive statistics and *t*-tests as appropriate and standard deviation values presented.

RESULTS

A total of 24 pediatric patients were studied with fifteen patients enrolled in the 12-week GMEP as compared to nine patients who were assigned the rehabilitation SOC program. In comparing distribution of burns to the elbow joints, the SOC had one participant that did not have burns to the bilateral elbow joints whereas the GMEP group had two participants without burns to the bilateral elbow joints. In comparing burn distribution to the knee joints, one participant in the SOC group did not have burns to the left knee joint whereas one participant in the GMEP group did not have burns to the bilateral knee joints. Demographic data and descriptive statistics are summarized in Table 1. There were no statistically significant differences between groups in comparing age, percentage of burn, and height. Groups differed significantly in starting weights ($p < 0.03$) with the GMEP group having a significantly higher starting weight than the SOC group. No other differences were noted in the post weight or percentage change in weight measures within or between groups. No significant differences were found between groups in comparing pretreatment passive and active ROM scores (Table 6).

Passive ROM: Elbows

Within Group—In comparing pre and post program intervention passive range of motion (PROM) goniometric measurements of the elbow joints, participants in the GMEP group showed significant improvements in the right elbow ($p < .001$), but did not show significant improvements in the left elbow. Of the fifteen subjects in this group, none lost PROM in the right elbow whereas one (6%) lost PROM in the left elbow. In contrast, subjects in the SOC group did not show significant ROM improvements in the left nor right elbow when comparing pre and post program implementation PROM. In this group, three out of nine subjects (33 %) lost PROM to the right elbow and four out nine (44 %) lost PROM in the left elbow.

Between Groups—In comparing PROM differences between groups no significant differences were found for either the left or right elbow joints.

Active ROM: Elbows

Within Group—In comparing active range of motion (AROM) in the elbow joints, the GMEP participants showed significant ROM improvements in both the right and left elbow joints, ($p < .0007$) and ($p < .0001$) respectively. None of the subjects in this group lost AROM in bilateral elbow joints. In contrast, subjects in the SOC group demonstrated no significant AROM improvements in bilateral elbow joints. One (11%) subject in this group lost AROM in the right elbow and two (22%) lost AROM in the left elbow.

Between Groups—In comparing AROM to the elbow joints between groups, no significance was found for the right elbow. However, in comparing AROM to the left elbow, a statistically significant difference was found ($p < .003$). Tables 2 and 3 further summarize the differences in comparing range of motion to bilateral elbow joints.

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Passive ROM: Knees

Within Group—Statistical PROM analysis of the bilateral knee joints for the GMEP group revealed statistically significant improvements in both the left and right knee joints ($p < .0001$). One (6%) out of the fifteen subjects lost PROM in both the left and right knee joints. In contrast, statistical analysis showed significant improvement in PROM in the right knee joint ($p < .026$) but did not show significant improvement in the left knee joint. One (11%) of the nine subjects lost PROM to the right knee and two (22%) lost PROM to the left knee.

Between Groups—In comparing PROM differences between groups no significant differences were found for either the left or right knee joints.

Active ROM: Knees

Within Group—In comparing the AROM differences in the knee joints, subjects in the GMEP showed statistically significant improvements in both the right and left knees, ($p < .0006$) and ($p < .0004$) respectively. None of the subjects in this group lost AROM in neither the left nor right knee joints. Participants in the SOC group did not show any significant ROM improvements in bilateral knee joints. Of the nine participants in this group, three (33%) lost AROM in the right knee and one (11%) lost AROM in the left knee.

Between Groups—In comparing AROM to the knee joints between groups, no significance was found for the left knee. However, in comparing AROM to the right knee, a statistically significant difference was found ($p < .047$). Tables 4 and 5 further summarize the differences in comparing ROM to bilateral knee joints.

DISCUSSION

To our knowledge, this study is the first to explore the effects of a structured supplemental exercise program for children with severe burns under the age of 7-years. This age group has been highly under represented in the burn literature and much need exists to develop treatment approaches that elicit the most successful outcomes for this challenging age group. Our study does support findings from the burn literature that rehabilitation programs supplemented with an organized and structured exercise regimen improves outcomes for children with severe burns.[2,3,4]

In our study that integrated music with exercise for young children, patients in the supplemental GMEP group significantly improved in all passive and active ROM measures except for PROM to the left elbow whereas patients in the SOC group did not show any significant improvements in the joints assessed except for passive ROM to the right knee joint. In comparing differences between groups, no significant differences were found for PROM. However, it is interesting that significant differences were found between groups when comparing AROM to the left elbow and right knee joints. Perhaps the nature of the GMEP program, which focused on functional and active movement versus passive movement tasks, contributed to these significant improvements in AROM.

Furthermore, participants in the GMEP were less likely to lose ROM as compared to the SOC group. Interestingly, the SOC group, although smaller in number than the GMEP group, had a higher number of participants lose both passive and active ROM. This observed outcome might have resulted from the subjects in the GMEP receiving a structured and continuous exercise regimen for the 12-week duration. Overall, the participants in the GMEP group showed a greater percentage improvement in both AROM and PROM than participants in the SOC group.

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We chose ROM measures as a means to objectively quantify functional outcomes. The joints assessed, elbows and knees, are joints commonly required to perform activities of daily living. Participants in each group were well matched in regards to distribution of burns with the majority of patients in both groups having burns to both the bilateral elbow and knee joints. Previous studies have used ROM measures to determine functional outcomes and quality of life in burn patients and found that limitations in range of motion diminished both function and quality of life variables.[17,18] These joints were also areas that did not undergo surgical procedures such as contracture releases for any of the participants during the study.

Although we cannot isolate the specific mechanisms of this 12-week program that generated the positive ROM outcomes, we believe that providing a structured and developmentally appropriate program with active caregiver involvement was a significant component to the outcomes obtained. The benefits for engaging severely burned children in developmentally appropriate pre-burn activities as soon as possible have been supported by the literature.[19,20,21] Children in the 12-week program were able to actively reinforce and practice gross motor skills that were carried out during their occupational and physical therapy sessions. Repetition of gross motor movements during play and engagement in continuous active movement for the duration of each group sessions were the primary methods used to enhance strength, endurance, and ROM. The group format not only allowed for social interaction but also enhanced motivation for children to complete the various motor tasks presented.

We believe that integrating music as a therapeutic tool during the groups was critical to the program's overall effectiveness. Music was integrated into our group exercise program because of the benefits previously found in combining these two modalities with this age group. In young children, a study revealed significant positive changes in perceptual-motor performance for children who participated in a combined music/physical education program as compared to those who participated in physical education only.[22] Another study found that school-aged children demonstrated better performance on gross motor tasks such as throwing/catching and balancing when tasks were paired with music than with no music.[23] Information on the application of music and music therapy to burn rehabilitation is sparse and primarily clinical in nature. In one study, music was used to promote relaxation for adult patients undergoing range of motion exercises.[24] Clinical applications of music therapy have been used to reinforce physical and occupational therapy goals by enhancing active ROM and endurance via active movement while playing musical instruments and following the movement cues of the music.[25,26] Moreover, the motivational properties of music have been shown to enhance sustained attention and increase active participation when music was used as an integral component with young children.[27,28] It was common for us to observe a child in the GMEP group show signs of increased motivation after observing another child in the group complete the same movement task.

Music also helped to establish a positive environment, which may have improved the moods of the participants. Music has been shown to enhance positive mood during exercise, which may lead to increased participation in exercise programs.[29,30,23] In the exercise literature, music listening has been found to significantly increase endurance in both muscular and cardiovascular-related tasks.[31,32] Because musical elements such as rhythm, tempo and dynamics can be manipulated and varied, music may have also served as an ideal means to capture and sustain the attention of the participants. Due to its strong attention-capturing attributes, music listening during exercise can lower the threshold of perceived exertion resulting in longer participation in endurance-related tasks.[33,34]

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Music provided the structure and context for therapeutic movement activities. Each group began with a greeting song that served as a physical warm-up activity and ended with a closing song to promote a cool-down or relaxation period. Several therapeutic movement activities were then planned and implemented in between the opening and closing songs with attention made to targeting a variety of functional motor tasks at various levels of difficulty. In most of the activities, live music, played using piano or guitar, was used to guide the direction and duration of the goal-specific movements using auditory and musical cues to facilitate each motor task. For example, the tempo or speed of the music played was manipulated to cue the children to walk slowly or fast. Musical instruments were also integral to many group activities as specific instruments were selected according to the movement task desired. For example, playing the cymbals required children to move arms to midline. Musical instruments were also placed strategically during activities to serve as targets for movement. Drums were positioned low when encouraging participants to bend their knees and positioned up high when encouraging them to reach with their arms high above their shoulders. It is important to recognize that music was chosen therapeutically and its purpose was specific and planned toward establishing therapeutic goals. Music was neither selected randomly nor chosen for the purpose of providing distraction.

Active caregiver involvement was most likely another beneficial element to the successful outcomes. Having family members assume a significant role throughout the recovery process has been shown to contribute to successful rehabilitation outcomes.[35,19] The group environment offered support and role modeling for caregivers to learn how to interact with their newly injured child. Injury and hospitalization often disrupt the safety and routine that young children need to grow and develop. The format of the music and exercise groups was highly structured which helped to provide some of that safety and routine necessary for emotional recovery. A caregiver learned by observing other caregivers and the group leader was available to demonstrate how to encourage a child with physical limitations to complete a task as independently as possible.

Another factor to consider is the degree of compliance and its potential influence on the results. Compliance is a significant component to maintaining any successful rehabilitation program yet non-compliance can be a realistic obstacle when treating severely burned young children. Younger children often pose unique rehabilitation challenges due to possible behavior problems during sessions, shorter attention span, anxiety related hospitalization, and inability to comprehend the importance of movement and exercise in recovery.[36,13] For participants in the SOC group, it is unknown if caregivers were consistent and compliant in administering their prescribed home rehabilitation program. Non-compliance may have been a factor in several subjects losing ROM upon follow-up. Resistance to participate in therapeutic exercise may contribute to poorer functional outcomes.[36] However, because the standard of care group was not a homogenous group, it creates a limitation in understanding what specific components of the standard of care approach resulted in poor ROM outcomes. We can speculate that not receiving a structured and hospital-based rehabilitation program integrating supplemental exercise to specifically target functional movement and endurance decreased the likelihood that these children would improve in range of motion outcomes.

We also need to address the issue of defining standard of care. In fact, in the burn treatment area, there has not been a well defined standard of care for long-term outpatient rehabilitation. In other words, it is not as clearly defined as cardiac rehabilitation or pulmonary rehabilitation. Nevertheless, standard of care as used in our study, should be acceptable, as it reflects the reasonable minimum amount of medical, rehabilitative care that would occur in a typical burn rehabilitation setting. That is, most children with severe burns once discharged from the acute unit would receive some type of physical therapy or occupational therapy exercises to be given by a licensed therapist or parent/guardian who

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showed competency in assisting the patient with a prescribed home exercise program. This standard of care refers to the typical and reasonable surgical and medical care during the acute phase, as well as after discharge from the acute unit.[37,38,39,40,41,14] We refer to standard of care as the typical degree of care, which is medically reasonable, and generally practiced under similar circumstances (i.e. severe burns). We believe that this is mostly done using written exercises to be followed or done at home. Our program is different because it is administered as an outpatient program, but in a hospital setting, with patients and families living in hospital owned or rented housing units or apartments. Many practical and logistical factors need to be considered when implementing such a program. Considerations for the family include costs, time away from home, school, job, and living expenses as well as other health-related costs such as insurance and third-party reimbursement. The facility implementing an outpatient exercise program also needs to consider costs of therapists' time, space, and equipment.

A significant limitation to our study is that it was not randomized nor controlled but rather a descriptive outcomes analysis. We offered all children who met the criteria the opportunity to participate in this extended comprehensive rehabilitation program. However, reasons for children not to stay did not include physical limitations or lack of physical limitations. Reasons included parents' job-related issues, family issues (such as taking care of other children at home), and travel logistics. Based on these reasons, we feel that bias was decreased. Interestingly, the demographic comparisons between our groups were well matched for age, gender, % TBSA and height (Table 1). We did find a significant difference between groups for pre program weights with the GMEP group having a greater mean weight than the SOC group. However, we believe that this difference had no effect on the ROM outcomes found in our study. In comparing pre-treatment differences on range of motion, no significant differences were found between groups although the ROM scores tended to be higher in the SOC group as compared to the GMEP group (Table 6). Because ROM measures for the SOC group were taken when the patients met the treatment criteria for discharge, it would be expected that ROM scores would initially be higher. In addition to the ROM scores, we compared how many participants in both groups lost ROM after the duration of the study. We found that more participants lost ROM in the SOC group as compared to the GMEP, which further supports the clinical effectiveness of the GMEP program. However, due to the shortcomings of not randomizing this study, we cannot account for other differences between groups such as motivation, compliance, social support systems, that may have influenced the internal validity of the ROM results.

We should also consider the variance in accuracy and continuity of ROM measurements since patients received goniometric measurements from different therapists. The study did not control for the same person administering ROM on all patients in the study but rather retrospectively gathered information from the patient's medical record. However, studies on goniometry have shown that little variance occurs between therapists when using this method and that goniometric elbow and knee measurements are highly reliable in the clinical setting.[42,43]

CONCLUSION

Findings from this study suggest that patients under the age of 7-years-of-age, receiving a comprehensive rehabilitation program with supplemental music and exercise groups are more likely to significantly improve in both passive and active ROM than children receiving SOC. In order to determine which specific mechanisms and components of this comprehensive rehabilitation program are causative for these positive outcomes, a prospective randomized-controlled experimental study needs to be done. Future research should also explore other effects pertaining to rehabilitation outcomes of young children

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such as endurance, strength, lean body mass, nutrition, developmental status, and quality of life. It will also be important to determine if a carryover effect exists upon long-term follow-up. Ultimately, the goal of all research related to young children with severe burns should be to develop best practice methods that achieve improvements in overall quality of life outcomes.

Acknowledgments

Supported by:

National Institutes of Health Grants P50-GM60338, KO1-HL70451; National Institute for Disability and Rehabilitation Research Grant H133A70019. Shriners Hospitals Grants #8952 and #8760

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Table 1

Demographic Data (two-sample *t*-test)

	Group Music & Exercise		Standard of Care	
Gender, M:F	**(n = 15) 12:3**		**(n = 9) 5:4**	
	Mean	**SD**	**Mean**	**SD**
Age, years	3.67	1.54	3.33	1
% TBSA	61.0	16.0	61.0	14.0
Height, cm (pre)	98.1	11	90.7	9
Height, cm (post)	99.9	11.3	94.5	8.9
Height, % change	1.8	1.4	4.3	5
Weight, kg (pre)*	16.5	4.2	12.9	2.6
Weight, kg (post)	16.7	4.1	14	3
Weight, % change	1.7	6.8	9.5	15.6

* Denotes significant differences between groups; values are mean ± SD

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Table 2

Right Elbow Range of Motion (ROM)

	Passive ROM			
	Pre	**Post**	**Mean Difference**	**# Lost ROM**
GMEP (n = 15)	112° ± 28.2	128.9° ± 25.6	14.6° ± 14.2*	0
SOC (n = 9)	131.1° ± 28.5	129.4° ± 20.8	(−)1.6° ± 36.4	3
	Active ROM			
	Pre	**Post**	**Mean Difference**	**# Lost ROM**
GMEP (n = 15)	88.4° ± 39.9	122.8° ± 33.4	33.4° ± 26.7*	0
SOC (n = 9)	102.8° ± 27.3	115.7° ± 28.8	9.1° ± 28.8	1

*Denotes significant differences within groups; values are mean ± SD

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Table 3

Left Elbow Range of Motion (ROM)

	Passive ROM			
	Pre	**Post**	**Mean Difference**	**# lost ROM**
GMEP (n = 15)	122° ± 30.4	132° ± 18.1	10.6° ± 22.5*	1
SOC (n = 9)	125° ± 23.8	118.3° ± 30.7	(−)6.6° ± 32.6	4
	Active ROM			
	Pre	**Post**	**Mean Difference**	**# lost ROM**
GMEP (n = 15)	91.4° ± 39.4	124.2° ± 21.8	32.8° ± 23.9*†	0
SOC (n = 9)	113.5° ± 23.5	115° ± 18.4	(−)6.0° ± 11.9	2

*Denotes significant differences within groups;

†Denotes significant difference between groups; values are mean ± SD

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Table 4

Right Knee Range of Motion (ROM)

	Passive ROM			
	Pre	**Post**	**Mean Difference**	**# lost ROM**
GMEP (n = 15)	108.6° ± 18.7	128.6° ± 11.09	20.0° ± 20.2*	1
SOC (n = 9)	106.1° ± 21.1	121.6° ± 10.8	15.5° ± 17.2*	1
	Active ROM			
	Pre	**Post**	**Mean Difference**	**# lost ROM**
GMEP (n = 15)	93.1° ± 23.5	129.2° ± 11.1	32.9° ± 24.2*†	0
SOC (n = 9)	99.2° ± 25.7	100° ± 23.6	5.0° ± 29.5	3

*Denotes significant differences within groups;

†Denotes significant difference between groups; values are mean ± SD

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Table 5

Left Knee Range of Motion (ROM)

	Passive ROM			
	Pre	**Post**	**Mean Difference**	**# lost ROM**
GMEP (n = 15)	105° ± 16.0	129° ± 12.9	24.0° ± 17.9*	1
SOC (n = 9)	114.4° ± 21.2	123.3 ± 12.2	8.8° ± 18.1	2
	Active ROM			
	Pre	**Post**	**Mean Difference**	**# lost ROM**
GMEP (n = 15)	86.9° ± 29.6	130.7° ± 10.3	39.5° ± 27.5*	0
SOC (n = 9)	107.8° ± 29.2	115° ± 17.3	15.8° ± 29.2	1

*Denotes significant differences within groups; values are mean ± SD

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Table 6

Pre-Treatment Range of Motion (ROM) Comparisons Between Groups

	Group Music & Exercise (n = 15)		Standard of Care (n = 9)		
	Mean	**SD**	**Mean**	**SD**	***p* value between groups**
Left Elbow Passive ROM	122°	30.4	125°	23.8	0.80
Left Elbow Active ROM	91.4°	39.4	113.5°	23.5	0.19
Right Elbow Passive ROM	112°	28.2	131.1°	28.5	0.12
Right Elbow Active ROM	88.4°	39.9	102.8°	27.3	0.41
Left Knee Passive ROM	105°	16.0	114.4°	21.2	0.23
Left Knee Active ROM	86.9°	29.6	107.8°	29.2	0.15
Right Knee Passive ROM	108.6°	18.7	106.1°	21.1	0.76
Right Knee Active ROM	93.1°	23.5	99.2°	25.7	0.59

No significant differences were found between groups