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Strength and Cardiorespiratory Exercise Rehabilitation for Severely Burned Patients During Intensive Care Units: A Survey of Practice

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Minimizing the deconditioning of burn injury through early rehabilitation programs (RP) in the intensive care unit (ICU) is of importance for improving the recovery time. The aim of this study was to assess current standard of care (SOC) for early ICU exercise programs in major burn centers. We designed a survey investigating exercise RP on the ICU for burn patients with >30% total burned surface area. The survey was composed of 23 questions and submitted electronically via SurveyMonkey® to six major (pediatric and adult) burn centers in Texas and California. All centers responded and reported exercise as part of their RP on the ICU. The characteristics of exercises implemented were not uniform. All centers reported to perform resistive and aerobic exercises but only 83% reported isotonic and isometric exercises. Determination of intensity of exercise varied with 50% of centers using patient tolerance and 17% using vital signs. Frequency of isotonic, isometric, aerobic, and resistive exercise was reported as daily by 80%, 80%, 83%, and 50% of centers, respectively. Duration for all types of exercises was extremely variable. Mobilization was used as a form of exercise by 100% of burn centers. Our results demonstrate that although early RP seem to be integral during burn survivor's ICU stay, no SOC exists. Moreover, early RP are inconsistently administered and large variations exist in frequency, intensity, duration, and type of exercise. Thus, future prospective studies investigating the various components of exercise interventions are needed to establish a SOC and determine how and if early exercise benefits the burn survivor. (J Burn Care Res 2018;39:897–901)

In the United States, approximately 200 000 people sustain a burn injury each year. Of these patients, approximately, 4% have burns $\geq 30\%$ total body surface area (TBSA) that require treatments in burn trauma centers.¹ Fortunately, advances in modern burn care have drastically reduced the mortality related to these type of injuries; however, rehabilitation for adequate reintegration of survivors into society remains a challenge, especially for young patients.²

The severity of burn trauma contributes to extreme physical deconditioning during the intensive care unit (ICU) stay, due to prolonged bed rest³ and a catabolic/hypermetabolic response to burn injury, which is well documented.⁴ Persistent muscle breakdown reduces lean body mass, increases protein degradation, and results in metabolic dysfunction which can persist for up to 3 years postinjury.^{5–8} There is strong evidence

of the value of exercise regimens with burn patients at later stages of care, in particular postdischarge. Exercise rehabilitation programs (RP) initiated at discharge have resulted in improvements in maintaining or increasing lean muscle mass, exercise work capacity, cardiorespiratory function, and range of motion, endurance, and strength.^{9–11} National practice guidelines have recommended that strength and cardiovascular endurance be evaluated in burn survivors 7 years of age and older and if fitness levels are below normal, it is recommended that the burn survivor be prescribed a supervised resistance and/or aerobic exercise program.¹² However, to date, exercise programs postburn injury have been initiated no sooner than hospital discharge.

Early mobilization during the ICU stay is nothing new and has been shown to bring benefits in several patient

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Author Contributions

All authors made substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; J.C.D., I.P., E.R., D.N.H., and O.E.S. were involved in drafting the manuscript or revising it critically for important intellectual content. All authors gave final approval of the version to be published, participated sufficiently in the work to take public responsibility for appropriate portions of the content, and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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categories, but not in burn patients.¹³ Nonetheless, exercise regimens implanted earlier in recovery may also benefit the burn survivor, but this has not yet been formally evaluated. Clinical practice indicates that exercise may be implemented early in recovery but there have been no studies to confirm this.¹⁴ RP are needed to combat the negative insults of burn trauma. For example, several anabolic drug interventions have been demonstrated to work when combined with exercise programs.^{15,16,17} In addition, exercise RP at discharge have resulted in improvements in maintaining or increasing lean muscle mass, exercise work capacity, cardiorespiratory function, range of motion, endurance, and strength.^{18,19} However, to the best of our knowledge, there are no national standardized guidelines for rehabilitation exercise programs initiated during the ICU stay and the associated literature only focuses on retrospective mobility studies without details of exercise regimens applied.²⁰ A better understanding of current standards for exercise with burn patients at the early stages of recovery is necessary to investigate which components of exercise programs need further research.

Therefore, the purpose of this study was to survey six high volume burn centers in the United States to characterize the standard of care (SOC) treatment, specific to early strength and cardiorespiratory exercise programs in adult and pediatric patients with $\geq 30\%$ TBSA burns during the ICU hospitalization.

METHODS

Following the approval of the Institutional Review Board (IRB 14-0432), we administered a survey to six major burn centers in the United States. The blinded surveys asked questions investigating early strength and cardiorespiratory exercise protocols for patients recovering from severe burns in the ICU. The participating burn centers were as follows: University of Texas Medical Branch, Shriners Hospital for Children—Galveston, University of California “Davis,” Shriners Hospital for Children—Northern California, University of Texas Southwestern, and the U.S. Army Institute of Surgical Research. All centers were certified/verified by the American Burn Association (ABA) centers at the time of the survey and involved in a common research project regarding early exercise interventions on the ICU. The questionnaires investigated the SOC treatment and the assessment of early exercise interventions for burn survivors

with $\geq 30\%$ TBSA burned in the burn ICU’s and was sent and filled out by the RP responsible of each center. The survey was composed of 23 questions regarding general information on center demographics, and routine rehabilitation practices regarding exercise (frequency, intensity, duration, and types of exercises performed) during the ICU stay (Appendix A). The survey was distributed to all six centers electronically using a secure sockets layer online program (SurveyMonkey®, San Mateo, California). All centers responded to the survey within 12 weeks from submission.

For descriptive statistics, data are presented as means \pm standard deviations (*SD*), unless otherwise stated.

RESULTS

Characteristics of Burn Trauma Centers

All six burns centers responded to the survey: three centers (50%) treated only adults, two centers (33%) treated only pediatric patients, and the last one (17%) treated both children and adults. All centers were high volume centers with an average of 425 ± 167 burn patients’ admissions per year. The mean TBSA of these patients was $26 \pm 18\%$, with a higher prevalence of male patients. The ratio of patients to rehabilitation therapists was an average ratio of $5 \pm 1:1$. Table 1 describes the individual center characteristics

Type of Exercise and Intensity

All six centers (100%) declared that their patients receive resistive, and aerobic exercises while in ICU, and five centers (83%) declared their patients perform isotonic, and isometric types of exercises as well. The intensity of the exercise was reported to be increased in all centers when possible; however, in choosing how the exercise intensity was decided and progressed, there was high discordance between the centers. Three centers (50%) based the intensity selection on patient tolerance and one (17%) used vital signs. The two remaining centers did not describe how intensity was assessed or what it was based on. The specific determination of intensity of each type of exercise is summarized in Table 2.

Frequency and Duration of Exercise

The frequency of isotonic, isometric, and aerobic exercises was found to be relatively similar for all centers reporting daily (seven times per week) training (respectively, 80%, 80%, 83%). There was less agreement for resistive exercises, with

Table 1. Burn centers characteristics

Centers	Admissions per year (n)	Mean TBSA for admission (%)	Therapist/patient ratio (n)
1	560	10	5: 1
2	688	11.5	3: 1
3	350	40	4.5: 1
4	250	20	4.5: 1
5	400	N/d	6: 1
6	300	50	5: 1
Mean \pm SD	424.7 ± 167.3	26.3 ± 17.8	4.7 ± 1.0

TBSA, total burned surface area burned; N/d, not declared; SD, standard deviation.

Table 2. Intensity of different type of exercises

Centers	Isotonic	Isometric	Resistive	Aerobic
1	To tolerance/no formal testing	To tolerance/no formal testing	To tolerance/no formal testing	To tolerance/no formal testing
2	Medical status	Medical status	Medical status	Medical status
3	Repetitions completed	Effort/tolerance	Repetition completed	Ambulation completed
4	To tolerance	To tolerance	To tolerance	To tolerance
5	To tolerance	To tolerance	To tolerance	To tolerance
6	N/p	N/p	Manual muscle test	Progressive

N/p, not performed.

half of centers reporting daily training and the other half only three times a week (Figure 1). Lastly, exercise duration for all types of exercises was extremely variable between centers. Exercise duration details for each center are represented in Table 3.

Mobilization

As far as general mobilization as a form of exercise, which was defined as movement of limbs (eg range of motion) or whole body movement, all centers (100%) reported that they mobilize patients on the day of admission and in five centers (83%), patients received therapy rehabilitation services at least two times per day, 7 days a week. Regarding ambulation specifically, all centers initiated it on the day of admission; however, 67% (n = 4) stated that it is patient dependent and only four centers reported ambulating patients while ventilated. There was little agreement when asked about ambulation after skin grafting operations. Half of the centers (50%) reported that patients ambulate on postoperative day (POD) 1 after an upper extremity skin grafting, one center (17%) on POD day 3, and two centers (33%) wait until POD day 5. With regards to lower extremity skin grafting specifically, four of six centers (67%) typically ambulate patients on POD day 3 and the rest of the centers (23%) wait until the fifth postoperative day.

The use of ace wrapping/elastic wrap bandages in preparation of getting the patients ambulate is common practice in all centers (100%). Additionally, the use of the following techniques/equipment to prepare the patient for ambulation was reported: dangling edge of bed (100%), weight bearing activities (100%), tilt table (100%), and standing frame (83%). Regarding the use of assistive devices for ambulation, there was a strong accordance (83%) with the use of the following: walkers, IV poles, splints, and casts. In contrast, there was low agreement (33%) for the use of Unna's boots, knee immobilizers, and crutches.

DISCUSSION

The persistence of weakness, fatigue, and muscle catabolism from prolonged bed rest and protein catabolism after burn injury compromises postburn rehabilitation and results in an excessive amount of time before a patient is able to resume normal physical activities or return to work or school for the burn survivor. To blunt the negative effects of burn trauma, it has been shown that exercise rehabilitation implemented immediately at discharge from hospital settings improves

lean body mass, strength, and cardiorespiratory fitness in severely burned survivors (18, 19, 21). It is unknown whether exercise rehabilitation during the ICU care would further improve these functional capacities. Furthermore, it is unknown whether current RP with burn patients in the ICU include exercise regimens. This survey of practice in six burn trauma centers shows that exercise programs are applied at this early stage of burn recovery; however, there is a high degree of variability in the programs. We chose these six high volume centers (Texas and California), representing burn care in adults and children, in order to lay the foundation for future studies comparing various exercise regimens and their effect on recovery from burn injury. The results of this survey confirm the urgent need for uniform RP using a prescription for exercise based on sound principles in exercise physiology in order to advance the evidence in this area of practice.²²

The results of this survey reflect a high level of variability in early initiation of exercises with the burn survivor with ≥30% TBSA injury while in the burn ICU making "standard of care" difficult to define. However, we were able to determine that all centers have some commonalities in practice including implementation of an exercise routine 7 days per week. Our findings reveal the need to develop more objective and consistent practice guidelines in the ICU for standard of burn care specific to exercise. This survey provides information about current practice which can be used to design robust scientific investigations.^{20,23}

We have confirmed that strengthening and conditioning exercises are a component of rehabilitation treatment regimens with burn patients in the ICU and that standards for such practices have not yet been established. Challenges exist in implementing early exercise protocols with patients while hospitalized and there is a high degree of variability and subjectivity in these activities such that there are no structured, objective, and well-delineated guidelines.

The major limitation of our study is the limited number and geographic position (Texas and California) of burn centers included in the survey. Six of the current 64 ABA accredited burn centers represent only 9%. However, the burn-verified status and the high mean number of yearly admissions at these large well-established burn centers provided an appropriate sample for a baseline understanding of current practice. If variability exists with these surveyed centers, we expect variability in smaller, less experienced burn centers as well. An addition limitation of choosing survey design for this study is that responses may be based on protocols or guidelines and not necessarily representative of actual practice given the multiple challenges that exist with this

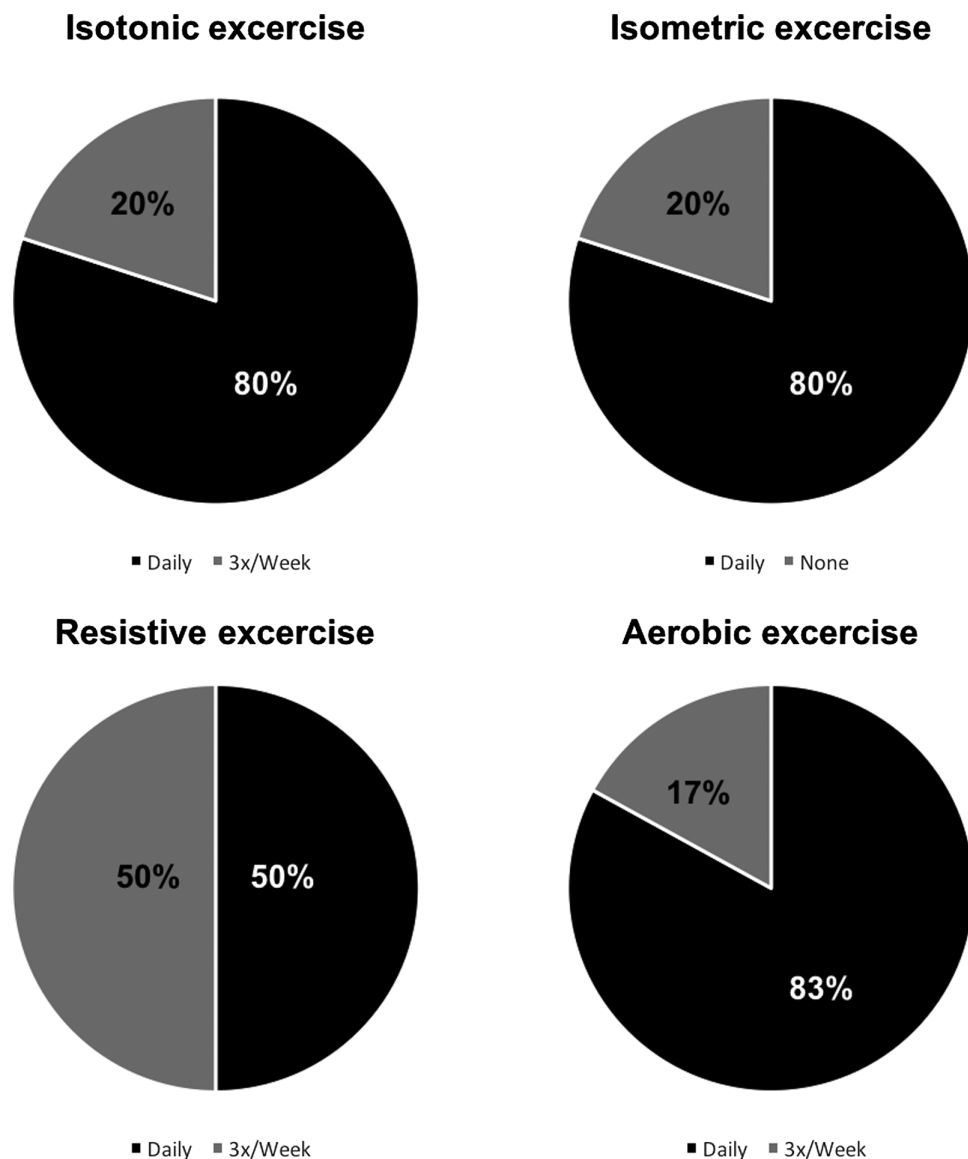


Figure 1. Exercise frequency.

Table 3. Duration of different type of exercises

Centers	Isotonic	Isometric	Resistive	Aerobic
1	Variable	5 s hold	2–3 holds, reps variable	Variable
2	30 s on/off	Variable	Sets	Depends on PT
3	30 min	10 min	15–20 reps	20 min
4	10–30 reps	30 sec, 10–20 x	10–30 reps	5–20 min, rests vary
5	2–3 sets of 10	2–3 sets of 10	2–3 sets of 10	10–15 min
6	N/p	N/p	2–3 s on/off	30–60 on/off

PT, physical therapist; N/p, not performed.

patient population. In conclusion, our survey results confirm the application of exercise programs in Texas and California as part of the rehabilitation intervention for burn patients in the ICU and demonstrate a need for future research to define and standardize components of a structured exercise routine that best benefits the burn survivor at this early stage of recovery.

CONCLUSIONS

In conclusion, our results demonstrate that although there is relative agreement between centers on the types and frequency of exercise applied with burn survivors, there is poor agreement on the methods of implementing the exercises including intensity and duration.

Establishing that these major burn centers use exercise with burn patients while in the ICU but that there is no current consensus regarding standardization of exercise regimens is a valuable step to designing more rigorously designed studies that will help advance the exercise science evidence in burn care.

SUPPLEMENTARY MATERIAL

Supplementary data are available at *Journal of Burn Care & Research* online.

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