Early Rehabilitation in the Intensive Care Unit: Preventing Impairment of Physical and Mental Health

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Abstract Survivors of critical illness often experience new or worsening impairments of physical, cognitive, and/or mental health, referred to as Post-Intensive Care Syndrome (PICS). Such impairments can be long-lasting and negatively affect survivors' quality of life. Early rehabilitation in the intensive care unit (ICU), while patients remain on life-support therapy, may reduce the complications associated with PICS. This article addresses evidence-based rehabilitation interventions to reduce the physical and mental health impairments associated with PICS. Implementation of effective early rehabilitation interventions targeting physical impairment requires consideration of five factors: barriers, benefits, feasibility, safety, and resources. Mental health impairments may be addressed by use of the following interventions: use of ICU diaries, early in-ICU psychological interventions, and post-ICU coping skills training. In both

cases, a multidisciplinary team-based approach is paramount to successful incorporation of early rehabilitation into routine practice in the ICU.

Keywords Critical illness · Rehabilitation · Physical therapy modalities · Mental health · Muscle weakness · Post-Intensive Care Syndrome · Mobility · ICU diary · Post-traumatic-stress disorder · Anxiety · Depression

Introduction

The term Post-Intensive Care Syndrome (PICS) refers to new or worsening impairments in the physical, cognitive, and/or mental health of intensive care unit (ICU) survivors [1]. These morbidities persist beyond acute care hospitalization and can be long-lasting, negatively affecting quality of life [1–3]. This review focuses on new research evaluating evidence-based rehabilitation interventions to reduce the physical and mental health impairments associated with PICS.

Critically ill patients are often subjected to prolonged immobilization, which can lead to neuromuscular weakness and subsequent impairment of physical function lasting for months to years after discharge from the ICU [4–6]. For instance, almost all ICU survivors are less able to perform some activities of daily living a year after discharge, and neuromuscular abnormalities persist for up to five years in 84–95 % of ICU survivors with critical illness polyneuropathy [2, 5]. In addition, survivors of critical illness are at risk of mental health problems, including anxiety, depression, and post-traumatic-stress disorder (PTSD) [7–10]. The median prevalence of clinically important anxiety and depression symptoms among ICU survivors is 24 and 28 %, respectively [7, 11], and one-third of patients develop PTSD symptoms in the first two years after critical illness [12].

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Early rehabilitation is essential to reducing complications associated with PICS [1, 13–15]. “Early” refers to rehabilitation interventions that commence immediately after stabilization of physiologic derangements, often while patients remain on mechanical ventilation and vasopressor infusions [1, 15–18]. A shift in ICU “culture” with a focus on interventions to reduce subsequent physical and mental health impairments is essential to successful implementation of an early rehabilitation program [19, 20].

Early Rehabilitation for Neuromuscular Weakness

Implementation of an early rehabilitation program, incorporating physical and occupational therapy, requires consideration of potential barriers, feasibility, benefits to be achieved, safety, and necessary resources, as described below [16]. Further information and support for ICU-based rehabilitation can be found via an international mobilization network (www.mobilization-network.org).

Potential Barriers to Rehabilitation of Critically Ill Patients

Inadequate multidisciplinary staffing and collaboration, deep sedation, and a lack of knowledge regarding benefits to patients are among the most important potential barriers to successful implementation of early rehabilitation programs [20–24]. In a prospective observational study in the ICU, rehabilitation therapy was not provided for a median (interquartile range; IQR) of 56 % (25–68 %) of ICU days per patient, because of limited availability of rehabilitation staff [22]. A subsequent quality improvement project at Johns Hopkins Hospital, including dedication of a full-time physical therapist and occupational therapist to this ICU, resulted in an increase in rehabilitation sessions and improved physical function among mechanically ventilated patients [25]. This quality improvement project also incorporated multidisciplinary education for all members of the ICU and rehabilitation teams to address potential gaps in knowledge.

Deep sedation can also limit patient participation in early rehabilitation [20, 22, 25]. The observational pilot study, mentioned above, reported that mechanically ventilated patients were ineligible for rehabilitation therapy for a median (IQR) of 27 % (15–61 %) of ICU days per patient, because of sedation and/or non-responsiveness [22]. In a pre–post study of 104 patients requiring mechanical ventilation >4 days, the absence of sedatives was predictive of increased ambulation (odds ratio (OR) 1.90; 95 % CI 1.19–3.15, $p = 0.009$) [19]. Moreover, analysis of a prospective cohort of >500 patients revealed that continuous sedative infusion was associated with longer time to first

physical and first occupational therapy sessions [23, 26]. Evidence-based protocols to limit sedation and facilitate weaning from mechanical ventilation [27–30] are advocated to assist with early rehabilitation [31].

Feasibility

An ICU “culture” supporting quality improvement and evidence-based rehabilitation interventions is essential to a successful early rehabilitation program [16, 20]. In addition to the barriers mentioned above, rehabilitation therapy in the ICU can be limited by patient availability because of diagnostic testing and therapeutic procedures. Multidisciplinary collaboration may help ensure patient availability, adequate staffing, and the coordination needed to achieve early rehabilitation in the busy ICU environment. As described below, such collaboration may be solidified by development of ICU-specific protocols and order sets to enhance the delivery of early rehabilitation programs [29, 32, 33].

A pre–post study of patients mechanically ventilated >4 days demonstrated that intra-hospital transfer from a traditional ICU to a respiratory ICU, where active mobilization is a priority, was associated with increased patient ambulation [20] (OR 2.47, $p < 0.001$) [19]. This change was not explained by improved physiologic status, but attributed to the “culture” and multidisciplinary focus on early mobilization in the respiratory ICU. Nursing and rehabilitation staffing was identical in the traditional and respiratory ICUs, demonstrating the value of a collaborative “culture” supporting rehabilitation practices. This “culture of mobility” promotes prioritization of early rehabilitation as routine care for eligible patients through multidisciplinary education and engagement [34].

Protocols and order sets may improve the effectiveness of an early rehabilitation program. In a prospective trial, 330 patients were assigned to either usual care or early physical therapy delivered according to a protocol by an ICU mobility team, consisting of a critical care nurse, physical therapist, and nursing assistant [35]. The mobility protocol included an automatic physician order for physical therapy rather than a physician-determined manual order. A greater proportion of patients in the protocol versus usual care group participated in at least one physical therapy session during their hospital stay (80 vs 47 %, $p \leq 0.001$). Of those receiving physical therapy, more patients in the protocol versus usual care group had treatment initiated while in the ICU (91 vs 13 %, $p \leq 0.001$).

The usefulness of a nurse-driven mobility protocol and computerized order set was evaluated in a pre–post evaluation including ICU and intermediate care patients [32]. The proportion of ICU and intermediate care patients ambulating within 72 h of admission increased by 14 and 56 %, respectively, after the protocol was initiated

($p < 0.001$). Moreover, a quality-improvement project including 100 consecutive patients in a surgical ICU (SICU) evaluated the mandatory entry of computerized mobility orders and a mobility protocol for nurses [33]. The protocol included physiologic criteria for patient screening with re-evaluation of ineligible patients every 6 h until eligible or transferred out of the unit. The proportion of patients with mobility orders who became mobile increased after the interventions (82 vs 58 %, $p < 0.05$ and 80 vs 22 %, $p < 0.05$, respectively). Finally, a clinical trial involving 193 patients assigned to either usual care or protocol-driven physiotherapy in an SICU reported a greater proportion of therapy sessions involving mobility in the protocol versus usual care group (82 vs 66 %, $p < 0.001$) [36]. Thus, a change in “culture”, enhanced by the addition of computerized order sets and mobility protocols, may result in greater mobility among ICU patients.

Benefits

Potential benefits for patients participating in early rehabilitation in the ICU include improved muscle strength, physical function, and quality of life [6, 13, 14, 37••]. In addition, early rehabilitation programs may be associated with reduced hospital and ICU length of stay (LOS), duration of mechanical ventilation, and hospital costs [6, 13, 14, 25, 37••, 38].

Muscle Strength, Physical Function, and Quality of Life

Early rehabilitation is associated with improved muscle strength, physical function, and quality in life of ICU survivors. In three systematic reviews [13, 14, 37••], ICU-based rehabilitation was associated with earlier achievement of mobility objectives [15, 19, 25, 35] and improved muscle strength [39, 40] including measures of respiratory, upper limb, and/or lower limb strength. In one randomized controlled trial (RCT), supine cycle ergometry for mechanically ventilated patients was associated with improved physical function and quality of life [39].

In an RCT of early physical and occupational therapy among 104 mechanically ventilated patients, ICU-acquired weakness, as evaluated by manual muscle strength testing, occurred in 31 versus 49 % of patients in the interventions versus control group ($p = 0.09$) [15]. In addition, the greatest unassisted walking distance at hospital discharge was longer in the interventions versus control group (median (IQR) 33 m (0–91 m) vs 0 m (0–30 m), $p = 0.004$). Finally, independent functional status at hospital discharge (the trial’s primary outcome) was achieved by a greater proportion of patients in the interventions group (59 vs 35 %, $p = 0.02$).

Implementation of early rehabilitation, as a part of routine care in the ICU, has also led to improved physical function. In

a prospective observational evaluation involving 104 patients requiring mechanical ventilation >4 days in a respiratory ICU, the average distance ambulated on the last day of ICU stay was 238 feet, which is much greater than otherwise expected [19]. Likewise, a prospective quality improvement project was associated with an increase in the proportion of patients receiving rehabilitation interventions having a functional mobility level of sitting or greater (56 % pre-interventions vs 78 % post-interventions, $p = 0.03$) [25].

Reduced Duration of Mechanical Ventilation, Length of Stay (LOS), and Costs

Early rehabilitation may be associated with reduced healthcare costs resulting from a reduction in the duration of mechanical ventilation, and ICU and hospital LOS [14, 35, 37, 41••]. A significant reduction in the duration of mechanical ventilation has been reported in three studies [15, 40, 42]. One of these studies, an RCT of early physical and occupational therapy versus usual care, demonstrated a median (IQR) duration of mechanical ventilation of 3.4 (2.3–7.3) versus 6.1 (4.0–9.6) days ($p = 0.02$), and a reduced median (IQR) ICU LOS (5.9 (4.5–13.2) versus 7.9 (6.1–12.9) days, $p = 0.08$) [15].

A medical ICU (MICU) quality improvement project, consisting of a multidisciplinary team approach to sedation and rehabilitation practices, was associated with a decrease in average ICU and hospital LOS of 2.1 and 3.1 days, respectively, with a 20 % increase in MICU admissions compared with the same period from the previous year [25].

In a prospective trial of 330 MICU patients, early rehabilitation with a mobility protocol versus usual care was associated with a shorter adjusted ICU and hospital LOS (mean 5.5 vs 6.9 days, $p = 0.025$ and 11 vs 15 days, $p = 0.006$, respectively) [35]. Moreover, the mean cost per patient was lower in the protocol versus usual care group (\$41,142 vs \$44,302). Total costs were also reduced in the protocol versus usual care group, even after accounting for the additional cost associated with implementing the mobility team for the interventions group (\$6,805,082 vs \$7,309,871).

A financial model based on outcomes associated with implementation of an early rehabilitation program in the Johns Hopkins MICU and existing publications projected net financial savings in 20 (83 %) of 24 different scenarios with financial estimates ranging from \$88,000 (net cost) to \$3,763,000 (net savings) from investment in an early rehabilitation program [41].

Safety

Clinical trials and studies of routine clinical care have verified the safety of early rehabilitation for critically ill patients. In two systematic reviews, no serious adverse

events resulting in death or near-death were reported, with the most common potential adverse event being a transient decrease in oxygen saturation [13, 14]. Inadvertent removal of endotracheal tubes, vascular catheters, or other support devices was rare.

Observational Studies with Safety Data

A prospective study of 31 patients participating in 69 mobilization sessions in a single ICU described the physiologic consequences of mobilizing critically ill patients [43]. The proportion of patients mechanically ventilated with a tracheostomy was 23 % (7/31); the other 24 patients were not mechanically ventilated. Activity levels consisted of sitting on the edge of the bed with progression to standing in place, transferring to a chair, or ambulating. Heart rate and blood pressure significantly increased during rehabilitation interventions and there was a non-significant decrease in oxygen saturation. In only three of 69 sessions (4 %), there was a decrease in oxygen saturation requiring a temporary increase in FiO_2 . Otherwise, no potential safety events required additional therapy, and no life-threatening adverse events occurred despite most of the sessions (91 %) involving patients with limited cardiopulmonary reserve before mobilization. Similar findings were reported in a prospective observational pilot study of early rehabilitation involving 19 mechanically ventilated patients in the Johns Hopkins MICU, in which heart rate, oxygen saturation, and blood pressure were monitored and recorded during 50 rehabilitation sessions [22]. There were only small and clinically inconsequential changes in these physiologic data.

In a prospective, observational evaluation of 1,449 early rehabilitation activities among 103 patients requiring mechanical ventilation >4 days in a respiratory ICU, adverse events were rare, occurring in only 14 (<1 %) activities [17]. Patients with an endotracheal tube participated in 593 (41 %) activities, which ranged from sitting on the edge of a bed to ambulating. Potential safety events, which included fall (five occasions), systolic blood pressure <90 mmHg (four occasions) or >200 mmHg (one occasion), oxygen saturation <80 % (three occasions), and feeding-tube removal (one occasion), did not result in any additional therapy, LOS, or healthcare costs.

Clinical Trials with Safety Data

Four clinical trials demonstrated the safety of early rehabilitation interventions for critically ill patients [15, 35, 36, 39]. In an RCT in one MICU and one SICU at a single center, 90 patients were randomized to either standard rehabilitation therapy alone or standard therapy plus active training with a bedside lower extremity cycle ergometer [39]. Of the 90 patients, 84 % were on mechanical

ventilation at the time of trial enrollment. Physiologic changes prompted the cessation of activity in only 16 (4 %) of 425 sessions with the cycle ergometer, with resolution occurring within 2 min. One Achilles tendon rupture was associated with cycling.

In another RCT, 104 patients on mechanical ventilation via an endotracheal tube in two MICUs were assigned to either usual care or early physical and occupational therapy [15]. Serious adverse events, defined as fall to knees, endotracheal tube removal, systolic blood pressure >200 or <90 mmHg, and desaturation to <80 %, occurred in only one of 498 (0.2 %) sessions. This single event was oxygen desaturation. Physiologic derangements, most commonly perceived patient-ventilator asynchrony, resulted in premature discontinuation of therapy in only 4 % of all sessions. Inadvertent removal of tubes and lines was also recorded, revealing the removal of a single radial arterial catheter. No falls or unplanned endotracheal tube removal were reported.

In another trial, 330 patients mechanically ventilated via an endotracheal tube were assigned to either usual care or protocol-driven early physical therapy with an ICU “mobility team” [35]. Of the 145 patients assigned to the interventions group, 73 % participated in at least one physical therapy session while in the ICU. There were no deaths, near-deaths, or cardiopulmonary resuscitation during physical therapy sessions. There were no potential safety events such as accidental removal of a device. Patient fatigue was the most common reason for ending a mobility session, without any clinically important change in physiologic parameters.

In a fourth trial, 163 patients in an SICU received physical therapy according to usual care or a physiotherapy protocol [36]. Protocol patients participated in a total of 615 treatment sessions, with five adverse events occurring in four sessions. These events included hemodynamic instability (two events), unintentional removal of a peripheral intravenous catheter (two events), and fall to knees (one event).

Rehabilitation with Central Venous and Arterial Catheters

Several studies have demonstrated the safety of early rehabilitation for patients with central venous and arterial catheters [18, 44, 45]. In a retrospective case-series, 30 patients in a cardiovascular ICU (CVICU) participated in 156 activities ranging from sitting to walking with a femoral arterial catheter in place, with no catheter-related adverse events occurring as a result of physical therapy [44]. In a prospective study, 77 CVICU patients with a femoral catheter participated in 210 physical therapy sessions encompassing 630 mobility activities [46•]. Catheter-related events evaluated were: bleeding, hematoma, line dislodgement, nonfunctioning catheter, or a change in

vascular status, with no events occurring during or immediately after any mobility activity.

Another evaluation of 49 MICU patients participating in 183 physical therapy sessions while on mechanical ventilation with a central venous catheter in place and 115 sessions with an arterial catheter in place reported inadvertent removal of only one arterial and no central venous catheters [18]. In this study, the internal jugular vein was the most common venous catheter site (43 % of catheter days), followed by subclavian (29 %) and femoral (10 %) veins; in 47 % of sessions an arterial catheter was present. Of all sessions taking place, continuous hemodialysis and at least one vasopressor infusion was present during nine and 17 %, respectively. Similarly, in a prospective study of 109 patients receiving continuous hemodialysis, 104 (95 %) underwent mobility sessions within 48 h of starting continuous hemodialysis [47]. No life-threatening events were associated with mobility, and the only potential safety event was one temporary disconnection from the circuit. Patients with jugular and femoral access participated in mobility, but patients with jugular access were more likely to progress to more advanced mobility interventions.

A larger prospective evaluation conducted in the Johns Hopkins MICU evaluated 101 consecutive patients who underwent 253 physical therapy sessions with a femoral catheter in situ, most commonly venous catheters, which accounted for 71 % of patient days with physical therapy [45]. No femoral catheter-related adverse events occurred during rehabilitation activity (incidence 0 %; upper 95 % confidence bound 1.4 %). Femoral catheter-related events were defined as: non-functioning catheter, removal of catheter, bleeding at catheter site, catheter line-associated bloodstream infection, retroperitoneal hematoma, and limb ischemia. The highest activity levels in physical therapy sessions conducted with a femoral catheter in situ were in-bed exercises (38 %), sitting (27 %), standing/walking (23 %), and supine cycle ergometry (12 %).

Screening for Patient Safety

Clinical judgment to assess patient appropriateness for active mobilization is important for safely implementing an early rehabilitation program in the ICU. Multidisciplinary collaboration can augment the decision-making process. An algorithm can be useful to screen patients for stability when initiating physical or occupational therapy interventions [16, 43].

Resources for Early Rehabilitation in the ICU

General Resources

Contributions from all members of the multidisciplinary team are important for the successful implementation of early

rehabilitation in an ICU [16, 20, 23, 25]. In addition, a medical director may advocate appropriate allocation of staff, resources, and equipment to ensure that all eligible patients are able to safely engage in rehabilitation activity [25].

Critically ill patients are often tethered to a variety of medical devices via lines and tubes, making mobilization, and especially ambulation, challenging. Trained staff and assistive equipment can improve the safety and efficiency of ambulation of critically ill patients [16]. A rolling IV pole enables transport of infusing medications. Ambulation of mechanically ventilated patients also necessitates either a battery-powered standard ventilator, portable ventilator, or Ambu bag with an oxygen source. Finally, patients may require use of a walker and wheelchair for support and for a seated rest break. Moreover, cardiac and oxygen saturation monitors are generally used. A mobility aid, which consolidates all of the necessary equipment into one portable device, has been used in the Johns Hopkins MICU and elsewhere to help simplify patient ambulation and reduce staffing needs [32, 48].

Neuromuscular Electrical Stimulation

Neuromuscular electrical stimulation (NMES) induces passive muscle contraction in targeted muscle groups via skin electrodes. Several phase II clinical trials of NMES in ICU populations have furnished favorable initial results. One clinical trial, which randomly assigned 46 patients mechanically ventilated <7 days or >2 weeks to NMES versus sham, found that patients on mechanical ventilation >2 weeks who received NMES had a greater improvement in quadriceps muscle thickness (+4.9 vs -3.2 %, $p = 0.013$) [49]. In another clinical trial of 140 critically ill patients mostly (97 %) requiring mechanical ventilation, daily NMES versus usual care was associated with a lower incidence of ICU-acquired weakness in the 52 patients who could be evaluated for this outcome (13 vs 39 %, $p = 0.04$) [40]. Conflicting results were presented by two small RCTs of patients with septic shock, in which NMES was applied to one leg of each patient with the contralateral limb serving as a control. In the first trial, involving eight patients, the quadriceps muscle volume between groups was similar at seven days [50]. In the other trial, 16 patients were randomized for 13 days, and quadriceps and biceps strength were greater in the group receiving NMES at 13 days ($p = 0.034$ and $p = 0.005$ respectively) [51]. Most improvement was observed for patients with greater baseline weakness.

Cycle Ergometer

A bedside ergometer is a stationary cycling device that enables passive or active cycling with increasing levels of

resistance. In an RCT of 90 critically ill patients, greater improvement in muscle strength, physical function, and quality of life at hospital discharge was observed for those assigned to standard physical therapy plus cycling exercises than for those assigned to standard therapy alone [39]. Patients in the interventions group cycled passively (if sedated or nonresponsive) or actively 20 min per day, five days per week. In the interventions group, the proportion of patients actively cycling increased from 45 to 87 % from the first to the final cycling session before ICU discharge. At hospital discharge, patients in the interventions versus control group had a greater 6 min walk distance (median (IQR) 196 m (126–329 m) vs 143 m (37–226 m), $p < 0.05$), quadriceps muscle force (2.4 ± 0.6 vs 2.0 ± 0.8 N kg⁻¹, $p < 0.05$), and quality of life, (SF-36 physical function domain score: median (IQR) 21 (18–23) vs 15 (14–23), $p < 0.01$).

Early Rehabilitation for Mental Health Impairments

Although less research has been conducted on interventions to reduce the mental health impairments associated with PICS than interventions focusing on the physical aspects of recovery, promising results have been obtained for three interventions: ICU diaries, early in-ICU psychological interventions, and out-patient telephone-based coping skills interventions [52–55].

ICU Diaries

Three studies, including two RCTs, support the use of ICU diaries to reduce mental health complications, for example anxiety, depression, and PTSD among ICU survivors [53, 54, 56]. In one multicenter RCT conducted in 12 ICUs at six general district hospitals and six university hospitals, medical staff and family kept a daily diary, including both pictures and text, for each patient during the ICU stay [54]. At one month follow-up after ICU discharge, 352 patients who were mechanically ventilated while in the ICU were randomized to receive their diaries as soon as desired (interventions) versus at three months (control). In the interventions group, 87 % of patients received their diary at randomization, with the remainder receiving the diary within the following month. Interventions group patients reported reading the diary a median (IQR) of three times (0–20). At three-month follow-up, fewer patients in the interventions versus control group had new-onset PTSD (5 vs 13 %, $p = 0.02$), with patients having the greatest PTSD symptoms at one month having the greatest benefit from diary interventions. Another RCT evaluated 36 patients in a single medical–surgical ICU [53]. Patients were assessed for symptoms of anxiety and depression on average one month

post-ICU discharge and three weeks later. Patients in the interventions group received their ICU diary at the first assessment. Anxiety and depression symptoms decreased significantly ($p < 0.05$ and $p < 0.005$, respectively) in the interventions group from the first assessment to the second, whereas scores remained the same in the control group.

A prospective pre–post trial evaluated mental health symptoms at three and 12 month follow-up among 143 patients who were assigned to either an ICU diary group or a control group [56]. A total of 49 patients were assigned to the interventions group and received their diary at hospital discharge. At three month follow-up there was no significant difference between groups with regard to anxiety and depression; at 12 months, however, patients in the interventions versus control group had fewer PTSD symptoms (impact of events scale—revised score: mean (SD) 32.1 (15.4) vs 21.0 (12.2), $p = 0.004$). Hence, clinical research supports the use of simple and inexpensive ICU diaries to reduce mental health complications associated with ICU survival. An international ICU diary network (www.icu-diary.org) is available to assist and support use of ICU diaries.

Early In-ICU Psychological Interventions

A pre–post study of 209 patients admitted to a trauma ICU in Italy evaluated mental health outcomes, at 12 month follow-up, of an in-ICU psychological interventions (delivered as part of routine care—the “post” period) versus usual care that did not include a psychologist in the ICU (the “pre” period) [52]. In the post versus pre-psychologist period, the proportion of patients with clinically important PTSD symptoms 12 months after ICU discharge was lower (21 vs 57 %, $p < 0.001$), with similar non-significant trends observed for anxiety and depression symptoms (9 vs 17 %, $p = 0.088$ and 7 vs 13 %, $p = 0.145$, respectively). In this study, the psychologist performed a range of interventions in the ICU, including providing education, counseling, stress management, psychological support, and coping strategies.

Post-discharge Coping Skills Interventions

Adaptive coping skills training is an evidence-based method for reducing symptoms of anxiety and PTSD in non-ICU patient populations [57, 58], and there is interest in evaluating this interventions in ICU patients [55]. One prospective pilot study ($n = 7$) evaluated the association between a 12-session post-discharge, telephone-based, coping skills interventions and mental health symptoms in acute respiratory distress syndrome survivors [55]. The number of patients with clinically important PTSD symptoms decreased from five patients at enrollment to one

patient after the interventions was complete. In addition, depression and anxiety symptoms decreased after the interventions (hospital anxiety and depression (HAD) sub-scale scores: depression 11.2 vs 7.3, and anxiety 12.2 vs 6.2). Further research is needed to clarify the role of coping skills in mental health recovery for ICU survivors.

Conclusion

Early rehabilitation interventions in the ICU may reduce physical and mental health complications frequently occurring in survivors of critical illness. Potential benefits associated with early physical rehabilitation include improved muscle strength, physical function, and quality of life, and reduced healthcare costs and LOS. Such ICU-based rehabilitation interventions are safe and feasible when conducted in the context of a multidisciplinary team approach. ICU diaries, along with other ICU-based and out-patient psychological interventions, are worthy of consideration as means of reducing the burden of mental health complications after critical illness. Ongoing evaluation and implementation of early rehabilitation programs for critically ill patients should be considered to address the common and long-lasting impairments associated with PICS.

Compliance with Ethics Guidelines

Conflict of Interest A.M. Parker, T. Sricharoenchai, and D.M. Needham declare they have no conflicts of interest.

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