Physical Rehabilitation of Patients in the Intensive Care Unit Requiring Extracorporeal Membrane Oxygenation: A Small Case Series
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Originally published online October 25, 2012

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Physical Rehabilitation of Patients in the Intensive Care Unit Requiring Extracorporeal Membrane Oxygenation: A Small Case Series

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Background and Purpose. Neuromuscular weakness and impaired physical function are common and long-lasting complications experienced by intensive care unit (ICU) survivors. There is growing evidence that implementing rehabilitation therapy shortly after ICU admission improves physical function and reduces healthcare utilization. Recently, there is increasing interest and utilization of extracorporeal membrane oxygenation (ECMO) to support patients with severe respiratory failure. Patients receiving ECMO are at great risk for significant physical impairments and pose unique challenges for delivering rehabilitation therapy. Consequently, there is a need for innovative examples of safely and feasibly delivering active rehabilitation to these patients.

Case Description. This case report describes 3 patients with respiratory failure requiring ECMO who received physical rehabilitation to illustrate and discuss relevant feasibility and safety issues.

Outcomes. In case 1, sedation and femoral cannulation limited rehabilitation therapy while on ECMO. In the 2 subsequent cases, minimizing sedation and utilizing a single bicaval dual lumen ECMO cannula placed in the internal jugular vein allowed patients to be alert and participate in active physical therapy while on ECMO, illustrating feasible rehabilitation techniques for these patients.

Discussion. Although greater experience is needed to more fully evaluate the safety of rehabilitation on ECMO, these initial cases are encouraging. We recommend systematically and prospectively tracking safety events and patient outcomes during rehabilitation on ECMO to provide greater evidence in this area.
As medical advances give rise to an increasing number of intensive care unit (ICU) survivors, physical therapists and critical care physicians are challenged with preventing and treating the long-term consequences of critical illness. One common sequela is neuromuscular weakness and associated impairment in physical function, which can persist for years and contribute to decreased quality of life and increased health care utilization. There is growing consensus that early physical therapy has multiple benefits, including less delirium, more ventilator-free days, shorter ICU and hospital length of stay, improved physical function at hospital discharge, and reduced health care utilization. Even in ICU patients who are mechanically ventilated, early physical therapy and occupational therapy interventions and exercise including using a motorized bedside cycle ergometer are safe, feasible, and beneficial in improving strength and function. Consequently, there is an evolving cultural shift in the ICU, with greater interdisciplinary collaboration between physical therapy and critical care medicine to support early rehabilitation interventions.

Among patients with severe respiratory failure, morbidity and mortality remain high. Recently, there has been growing interest in and utilization of extracorporeal membrane oxygenation (ECMO) in patients with severe respiratory failure. Extracorporeal membrane oxygenation utilizes large-bore cannulae, a pump-driven extracorporeal circuit, and a membrane oxygenator to provide both oxygenation and carbon dioxide removal. In adults, ECMO has traditionally been mediated via a femoral vein cannula to remove deoxygenated blood and an internal jugular vein cannula to deliver oxygenated blood. However, the development of a bicaval dual lumen catheter (Avalon Laboratories, Rancho Dominguez, California) allows for a single internal jugular vein cannula without the need for femoral access, which has potentially important implications for physical therapy interventions. Patients receiving ECMO are at high risk for significant physical impairment and pose unique challenges for physical therapy. Consequently, there is a need for innovative examples of successful physical therapy in these patients as preliminary data regarding feasibility and safety. We describe 3 patient cases to illustrate and discuss the challenges, as well as the feasibility and safety, of physical rehabilitation in patients receiving ECMO.

Case 1 Patient History and Systems Review
A 23-year-old man with no significant past medical history was transferred to our medical ICU (MICU) after presenting to an outside hospital with acute respiratory distress syndrome (ARDS) of unclear etiology. Despite broad-spectrum antimicrobial agents, prone positioning, and high-frequency oscillatory ventilation with deep sedation, he continued to have refractory hypoxemia. Consequently, on day 5, ECMO (via 1 internal jugular and 2 femoral vein large-bore cannulae) was initiated, with improvement in oxygenation. Although ECMO stabilized his respiratory failure, he remained critically ill and deeply sedated. Over 1 month, repeated attempts to wean him from ECMO failed secondary to persistent respiratory failure. Due to the femoral cannulae and his level of sedation, the patient did not receive physical therapy while on ECMO. On day 35, due to his irreversible respiratory failure, he underwent bilateral orthotopic lung transplantation with removal of the ECMO cannulae. On day 40, he was weaned from his sedation medications, and he was evaluated by the physical therapy team.

Clinical impression 1. Both traditional mechanical ventilation and rescue strategies, such as high-frequency oscillatory ventilation, failed to stabilize this patient’s severe respiratory failure. Consequently, he underwent urgent initiation of ECMO with placement of 2 large-bore femoral drainage cannulae for adequate blood flow rates. Extracorporeal membrane oxygenation was instituted as a bridge to recovery, with the ultimate goal being liberation from both ECMO and mechanical ventilation. Unfortunately, his pulmonary disease process was irreversible, and after a prolonged course on ECMO, a decision was made by the clinical team and patient’s family to list him for lung transplantation. The severity of his critical illness, level of sedation, and femoral cannulae were barriers to initiation of early rehabilitation and placed him at high risk for ICU-acquired weakness. After his successful lung transplantation and reduction of sedation, we evaluated his level of weakness and ability to participate in physical therapy interventions in order to develop a rehabilitation strategy.

Examination
According to the patient’s family, he had no functional limitations prior to

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- Audio Podcast: “Rehabilitation of Patients With Critical Illness” symposium recorded at CSM 2013, San Diego, California.
ICU admission. The initial physical therapist examination occurred 5 days post-transplant and decannulation from ECMO. The patient was positioned supine in bed, intubated, and received mechanical ventilation via an oral endotracheal tube. He was moderately sedated but arousable to voice. He was able to follow 1-step commands intermittently but made no attempt to communicate. Due to the patient’s cognitive impairments, a limited examination was performed. He exhibited full range of motion for all extremities with the exception of his left hip, which was not tested due to the presence of a hemodialysis catheter.

Due to the patient’s cognitive impairments, a limited examination was performed. He exhibited full range of motion for all extremities with the exception of his left hip, which was not tested due to the presence of a hemodialysis catheter and continuous hemodialysis. An assessment of his strength revealed profound, diffuse muscle weakness (Tab. 1). The patient and his family were educated regarding the role of physical therapy interventions and plan of care, as well as how to conduct range of motion exercises to help prevent joint contractures.

**Clinical impression 2.** Our assessment (Tab. 1) revealed that the severity of his critical illness and prolonged immobilization resulted in significant ICU-acquired weakness, impaired physical function, and development of a sacral pressure ulcer. In order to improve his functional status, decrease the risk of respiratory complications after lung transplantation, and improve his cognitive status, we developed and implemented an intensive, interdisciplinary rehabilitation plan.

**Intervention/Hospital Course**

Daily interprofessional meetings were held to discuss the patient’s progress with physical therapy and barriers to advancing his rehabilitation goals. For each session, physicians adjusted narcotic and anxiolytic medications to optimize mental status and analgesia for participation. Nurses communicated updates to the physical therapists regarding the patient’s clinical condition, recent changes in pertinent medications, and scheduled tests and procedures. Nurses also assisted during physical therapy sessions by temporarily disconnecting any unnecessary lines, holding enteral nutrition, and assisting with mobilization. Lastly, respiratory therapists adjusted ventilator settings to allow for adequate support with activity.

Interventions began on day 44, while the patient was receiving mechanical ventilation (pressure support 20 cm H₂O, positive end-expiratory pressure [PEEP] 5 cm H₂O, fraction of inspired oxygen [FIO₂] 0.25), and included active-assisted range of motion (AAROM) and passive in-bed cycle ergometry using a MOTOMed Letto cycle ergometer (Ri LLC, Tampa, Florida). Bed mobility, including rolling and supine-to-sit transfers, began on day 46. Due to the severity of his ICU-acquired weakness and for safe management of his medical devices, he required assistance of 3 staff members for transition from a supine to a sitting position. The patient tolerated sitting at the edge of bed for 10 minutes with maximal assistance and demonstrated difficulty raising his head against gravity. By day 52, the patient continued to require maximum assistance to sit at the edge of the bed, but was able to hold his head upright without assistance. He experienced increased pain with prolonged periods of sitting due to his sacral wound. In order to minimize his pain and continue his physical therapy, position changes and intravenous narcotics were utilized. Although the patient was severely deconditioned, dependent transfers to a cardiac chair were performed to promote upright posture, allow hemodynamic assessment with postural changes, and improve respiratory mechanics. During this time, his respiratory status improved, and he was transitioned off mechanical ventilation, receiving oxygen via tracheostomy collar, by day 55. For upper-extremity strength training, he performed active range of motion exercises, and by day 58, he used Nintendo Wii (tennis and boxing) (Nintendo of America Inc, Redmond, Washington), requiring...
occasional assistance to hold up his right upper extremity and primarily using his forearm and wrist to use the interactive video game. In addition, he was able to participate in basketball throwing with the physical therapy team.

His lower-extremity strength improved as well, and by day 80, he was performing active in-bed cycling and standing with maximal assistance of 2 staff members, requiring tactile cues to prevent bilateral knee buckling. By day 101, using the parallel bars in the hospital gymnasium, he ambulated 4 steps and 3 steps with 1 seated rest break, requiring minimal assistance of 1 person. He progressed to ambulating 6.2 m (20 ft) with 1 rest break, requiring minimal assistance of 1 person. On day 112, he was discharged to an acute rehabilitation facility.

**Outcomes**

At an acute rehabilitation facility, the patient’s physical function continued to improve. After 16 days, he ambulated 45.7 m (150 ft) with a walker and was discharged to home with continued outpatient rehabilitation. Although his physical function improved during his rehabilitation course, we believe the duration of his ICU stay and time to ambulation were prolonged because of 40 days of immobility while he was receiving ECMO. Furthermore, the significant muscle weakness that developed while critically ill put him at risk for persistent impairment in physical function. Given the evidence that implementing rehabilitation interventions early after ICU admission results in improved physical function and shorter ICU stays, we were interested in delivering physical therapy much earlier for patients requiring ECMO for severe respiratory failure.

### Case 2

**Patient History and Systems Review**

A 37-year-old woman with a remote history of lymphoma post-chemotherapy, mediastinal radiation, and autologous stem cell transplant, complicated by pulmonary fibrosis and recurrent right pneumothorax with bronchopleural fistula, was admitted to our inpatient medicine service with worsening dyspnea and persistent right pneumothorax despite chest tube placement.

**Clinical impression 1.** The patient’s functional status prior to this hospitalization was impaired secondary to multiple complications following her lymphoma treatment. At baseline, she reported being “bed bound 9 out of 10 days.” When she would ambulate, she did not require an assistive device but mostly remained within her home. Her physical therapy goals included walking, doing laundry, and cooking for her children. This history made our team aware of her baseline state and high risk for worsening weakness and functional impairment. In order to prevent further physical decline, the physical therapy team evaluated her functional capacity to develop a rehabilitation strategy.

**Examination**

The patient’s initial physical therapist evaluation occurred on hospital day 8. She was positioned supine in bed with her head elevated and a right chest tube *in situ* and was receiving supplemental oxygen via nasal cannula. During the examination, the patient participated in range of motion, strength, and mobility testing (Tab. 2). Overall, she required supervision for dynamic standing balance activities and had limited ambulation distances due to her chest tube being on wall suction.

**Clinical impression 2.** Prior to this hospitalization, her worsening dyspnea on exertion due to recurrent pneumothoraces placed her at high risk for further worsening of her respiratory and functional status. Her physical examination revealed 4/5 strength in all muscle groups evaluated. As a result, the physical therapy team developed an early and intensive rehabilitation program to prevent further functional decline and improve her strength.

### Intervention/Hospital Course

Given the refractory nature of the patient’s pneumothoraces despite chest tube placement, the thoracic surgery team was consulted and recommended decortication to allow for lung expansion and repair of her

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**Table 2.**

Physical Therapist Assessment of the Patient in Case 2 by Organ System

<table>
<thead>
<tr>
<th>Organ System</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognition</td>
<td>Awake and oriented to person, place, and time. Able to follow 3-step commands.</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>Within functional limits with the exception of bilateral shoulder flexion. Left peripherally inserted central catheter in place and clean, dry, and intact. Right chest tube in place and clean, dry, and intact.</td>
</tr>
<tr>
<td>Neuromuscular</td>
<td>4/5 strength throughout all extremities Sensation: grossly intact</td>
</tr>
<tr>
<td>Cardiopulmonary</td>
<td>Tachycardia, regular rhythm. Normal S1, S2. No audible murmurs, rubs, or gallops. Dry inspiratory crackles bilaterally.</td>
</tr>
<tr>
<td>Integumentary</td>
<td>Skin intact. No edema.</td>
</tr>
</tbody>
</table>
Rehabilitation in Patients Receiving ECMO

bronchopleural fistula. The day after her initial physical therapist assessment, she underwent decortication with her postoperative course complicated by cardiogenic shock due to massive pulmonary embolus requiring intubation, mechanical ventilation, vasopressor support, and surgical embolectomy. She subsequently was admitted to our MICU with her course complicated by sepsis and ARDS that prevented ventilator weaning. On day 5 of her MICU course, she was reassessed by the physical therapy team. The patient was positioned supine in bed, intubated, and received mechanical ventilation via an oral endotracheal tube. She was alert, oriented, and able to follow commands. She required minimal assistance to roll and required moderate assistance to move from a supine to a sitting position.

Our interprofessional team had daily discussions regarding safe implementation of interventions to improve the patient’s strength and physical function, which had further declined due to her critical illness. By day 26, she began participating in physical therapy with AAROM and passive in-bed cycling. By day 30, she progressed to transferring from chair position in bed to sitting unsupported at the edge of the bed with maximum assistance. Other interventions included upper-extremity and lower-extremity exercises and bed mobility. She began active in-bed cycling by day 35 and standing with assistance to promote lower-extremity strengthening and weight bearing by day 39. She subsequently transferred to a chair with maximum assistance of 1 person plus an additional person for line management. She continued intensive rehabilitation, but on day 63 developed pneumomediastinum with widespread subcutaneous emphysema. By day 71, she had worsening hypercarbia and was initiated on ECMO as a bridge to lung transplantation given the refractory nature of her pulmonary disease. In order to avoid femoral vein cannulation, a single internal jugular bicaval dual lumen cannula was used.

The patient continued intensive rehabilitation while receiving ECMO with the assistance of an interprofessional team including physicians, nurses, physical therapists, and a perfusionist, and she was able to perform supine therapeutic exercises, active in-bed cycling, and sitting at the edge of the bed with the assistance of 4 staff members. She required assistance of 2 people for static sitting balance. On day 82, she underwent right orthotopic lung transplantation, with discontinuation of ECMO the following day. However, she required continued mechanical ventilation throughout her hospitalization due to right phrenic nerve injury. While receiving mechanical ventilation, she continued physical therapy interventions within 3 days of transplantation with AAROM, progressing to sitting at the edge of the bed by day 86, active in-bed cycling by day 93, standing exercises using parallel bars by day 116, upper-extremity exercise using Nintendo Wii boxing while seated by day 132, and walking several steps with moderate assistance by day 141. On day 158, she ambulated 24 steps with minimal assistance and only 1 rest break.

Outcomes
Given this patient’s baseline functional impairment and the development of critical illness, she was at extremely high risk for worsening debilitation. Early in her course, we instituted an interprofessional rehabilitation program that allowed her to participate even as her pulmonary function declined and she required ECMO as a bridge to lung transplantation. This case suggests that instituting an active physical therapy regimen is safe and feasible while a patient receives ECMO. Unfortunately, on day 163 of her MICU course, she had a large spontaneous intracranial hemorrhage and died despite emergent neurosurgery. Although she had an unfortunate outcome, the experience with this patient encouraged our interprofessional team to perform early rehabilitation with patients requiring ECMO.

Case 3
Patient History and Systems Review
A 25-year-old woman with cystic fibrosis and severe obstructive pulmonary physiology (forced expiratory volume in 1 second 32% predicted) presented to an outside hospital with multidrug resistant pneumonia and subsequently was transferred to our MICU.

Clinical impression 1. In addition to her severe pulmonary disease, this patient had developed a multidrug-resistant pneumonia resulting in ARDS. Initially, she received adequate oxygenation via a non-rebreather facemask with a fraction of inspired oxygen of 1.0. She was treated with broad-spectrum antibiotics and intensive airway clearance techniques to manage her secretions. We were interested in implementing an early physical therapy regimen to prevent atelectasis and physical functional impairment during her critical illness.

Examination
The patient had minimal impairment in her physical functional capacity prior to her critical illness. She reported full independence with functional mobility and activities of daily living without any assistive devices. In addition, she was capable of exercising several times per week. Her initial complete physical therapist evaluation occurred on day 2. The patient was sitting upright in bed and was alert and oriented to

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person, place, and time. She engaged in appropriate conversation. During the examination, she participated in range of motion and strength testing (Tab. 3) that demonstrated no evidence of weakness. The patient deferred mobility assessment due to a headache. She was educated on the plan for airway clearance treatments and physical therapy interventions to prevent progressive weakness.

**Clinical impression 2.** Despite her critical illness, our assessment (Tab. 3) did not demonstrate any significant functional impairment, although she deferred assessment of ambulation. The physical therapy focus was preventing significant muscle atrophy and weakness, as well as airway clearance. Although critically ill, the patient was receiving adequate oxygenation via a non-rebreather facemask, required no sedation, and was able to interact with her care providers. Consequently, early in her critical illness, we had the opportunity to begin an intensive, interprofessional rehabilitation regimen focused on prevention of ICU-acquired weakness.

**Intervention/Hospital Course**

On day 3, due to continued hypoxemia and hypercapnea refractory to noninvasive positive pressure ventilation, the patient required orotracheal intubation and initiation of mechanical ventilation. On day 7, after hemodynamic and respiratory stabilization, sedation was reduced, and she received twice-daily physical therapy sessions involving airway clearance via percussion and vibration, therapeutic exercises, and mobilization. Clinical judgment regarding medical appropriateness for physical therapy interventions was based on prior studies demonstrating that early mobilization after cardiopulmonary stabilization is safe and improves outcomes in patients who are critically ill.1,5–9

Mobilization of this patient while intubated and mechanically ventilated required coordination of physical therapists, nurses, and ICU physicians who together ensured she was medically appropriate for ambulation with a focus on hemodynamic stability and adequate gas exchange, as well as respiratory therapists who managed the portable ventilator to ensure appropriate respiratory support. By day 8, she began ambulating with a rolling walker. By day 12, she walked 24.4 m (80 ft) while ventilated (assist-control mode, tidal volume 400 cc, PEEP 8 cm H2O, FiO2 0.6). On day 13, due to persistent respiratory failure, she underwent tracheotomy. On day 14, she ambulated a total of 73.2 m (240 ft), with 1 seated rest break and several standing breaks, while ventilated with an increase in supplemental oxygen delivery to support exercise (assist-control mode, tidal volume 400 cc, PEEP 8 cm H2O, FiO2 1.0). Given her end-stage lung disease and persistent respiratory failure, she was listed for lung transplantation. On day 22, prior to identification of a donor, her respiratory status worsened with refractory impairment in gas exchange despite maximal support from the mechanical ventilator. Consequently, she was initiated on ECMO as a bridge to lung transplantation.

In order to support continued mobilization, femoral vein cannulation for ECMO was avoided, and a single internal jugular bicaval dual lumen cannula was used. On day 24, while on ECMO, she performed 30 minutes of active, in-bed cycling with a physical therapist, under the guidance of the ICU physician, bedside nurse, respiratory therapist, and perfusionist. Our team initiated a plan to continue mobilization while the patient was receiving ECMO. However, on day 25, physical therapy interventions were deferred due to refractory hypoxemia secondary to right heart failure while on ECMO. Interventional cardiology performed an urgent atrial septostomy with subsequent improvement in oxygenation. On day 26, she underwent bilateral orthotopic lung transplantation with decannulation from ECMO. On day 28, she resumed physical therapy, performing AAROM exercises, and progressed to sitting at the edge of the bed and standing. By day 45, she began ambulating with assistance.

**Outcomes**

The patient continued to make progress with her respiratory and physical functional status. Unfortunately, her subsequent hospital course was complicated by septic shock, disseminated intravascular coagulation, and liver failure, and she expired 166 days after MICU admission. Despite this outcome, we believe that her progressive, functional recovery postoperatively was due to receiving physical therapy interventions.

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**Table 3.** Physical Therapist Assessment of the Patient in Case 3 by Organ System

<table>
<thead>
<tr>
<th>Organ System</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognition</td>
<td>Awake and oriented to person, place, and time. Able to follow 3-step</td>
</tr>
<tr>
<td></td>
<td>commands</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>Full range of motion throughout all extremities</td>
</tr>
<tr>
<td>Neuromuscular</td>
<td>5/5 strength throughout all extremities</td>
</tr>
<tr>
<td></td>
<td>Sensation: patient denied numbness or tingling</td>
</tr>
<tr>
<td>Cardiopulmonary</td>
<td>Tachycardia, regular rhythm. Normal S1, S2. No audible murmurs, rubs,</td>
</tr>
<tr>
<td></td>
<td>or gallops. Coarse breath sounds throughout bilateral lung fields with</td>
</tr>
<tr>
<td></td>
<td>bibasilar crackles.</td>
</tr>
<tr>
<td>Integumentary</td>
<td>Skin intact. No edema.</td>
</tr>
</tbody>
</table>
Rehabilitation in Patients Receiving ECMO

Discussion

Recently, there has been growing interest in using ECMO in patients with severe, acute respiratory failure.\(^1\)\(^-\)\(^4\,\)\(^1\)\(^5\,\)\(^9\) Given the evidence that early rehabilitation in ICU patients improves outcomes,\(^1\)\(^5\,\)\(^9\) approaches to implementing rehabilitation in patients requiring ECMO are needed. We describe 3 patients with refractory respiratory failure who required ECMO and subsequent lung transplantation to discuss the feasibility and safety of rehabilitation in this complex and severely ill patient population.

In case 1, 2 factors limited rehabilitation therapy on ECMO. First, the patient was deeply sedated, which has traditionally been considered necessary for comfort, hemodynamic stability, ventilator synchrony, and prevention of device dislodgement. However, there is growing evidence of the safety, feasibility, and benefits of avoiding deep sedation, even in ICU patients who are severely ill.\(^1\)\(^4\,\)\(^1\)\(^5\,\)\(^9\) Increased patient wakefulness allows for participation in rehabilitation and decreases the duration of mechanical ventilation and ICU stay.\(^1\)\(^6\,\)\(^-\)\(^1\)\(^9\) In the 2 subsequent cases, patients were alert on ECMO and participated in active physical therapy, illustrating feasible rehabilitation techniques for these patients. Second, the patient described in case 1 was cannulated via the femoral veins, restricting mobility.\(^1\)\(^1\) The recent availability of intrajugular placement of a single bicaval dual lumen ECMO cannula avoids this mobility limitation and allowed for active physical therapy in cases 2 and 3. In planning for intensive rehabilitation during ECMO, careful consideration is needed regarding the type and location of cannulae.

Patient safety is a critical issue in implementing physical therapy interventions for patients requiring ECMO. In these case studies, deciding that a patient was safe to undergo physical therapy interventions was a collaborative process among the physical therapist, physicians, bedside nurse, and perfusionist, all of whom typically monitored the patient, directly at the bedside, throughout the physical therapy session. Factors that were discussed prior to initiating a physical therapy session and monitored throughout the session included the patient’s mental status, hemodynamics (including heart rate and blood pressure, which were monitored continuously with an arterial catheter), and respiratory status (including respiratory rate and oxygenation, which were monitored continuously). We believe that the key to safely implementing physical therapy interventions in these complex patients with high acuity of illness is an interdisciplinary team approach with advanced planning and open communication, and having all relevant members of the critical care and rehabilitation team being present, as needed, during rehabilitation interventions. With such an approach, there were no safety-related events during or shortly after the physical therapy interventions in this case series. More specifically, there was no acute worsening of cardiovascular or respiratory status associated with these interventions. Each patient’s progression to ECMO was not due to any clinical deterioration temporally related to the physical therapy interventions, but rather progressive worsening of the patient’s condition consistent with ARDS on top of chronic lung disease. The patient’s lung disease was felt to be irreversible and, as a result, required lung transplantation.

Thiagarajan and colleagues\(^2\)\(^0\) have recently described physical therapy and rehabilitation issues for pediatric patients receiving ECMO, including appropriate precautions when performing early mobilization of these patients. As mentioned above, no safety events occurred during any physical therapy sessions while the patients in cases 2 and 3 received ECMO. Similar safety data have been reported with a separate series of 3 patients who progressed to ambulation while receiving ECMO.\(^1\)\(^5\) While greater experience is needed to more fully demonstrate the safety of rehabilitation on ECMO, these initial cases are encouraging. We recommend systematically and prospectively tracking safety events during rehabilitation on ECMO to create greater evidence in this important area. As utilization of ECMO grows, we must understand the feasibility and safety of active physical therapy in patients requiring ECMO.

Dr Rahimi, Dr Reddy, Dr Zanni, Dr Stephens, and Dr Needham provided concept/idea/project design. Dr Rahimi, Ms Skrzat, Dr Reddy, and Dr Needham provided writing. Dr Rahimi, Ms Skrzat, and Dr Reddy provided data collection. Dr Rahimi, Ms Skrzat, Dr Fan, and Dr Needham provided data analysis. Dr Needham provided project management. Dr Fan, Dr Stephens, and Dr Needham provided patients. Dr Rahimi, Dr Zanni, Dr Fan, Dr Stephens, and Dr Needham provided consultation (including review of manuscript before submission).

An oral presentation of this case series was given at the Fifth International Meeting of Physical Medicine & Rehabilitation (PM&R) in the Critically Ill; May 19, 2011; San Francisco, California.

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

References


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Originally published online October 25, 2012