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## Development and implementation of an early mobility program for mechanically ventilated pediatric patients



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### ABSTRACT

**Purpose:** Early mobility (EM) is being used in adult ICUs in an effort to treat and prevent intensive care unit acquired weakness (ICU-AW) and Post-Intensive Care Syndrome (PICS). Data supports children suffer from ICU-AW and PICS as well. Our objective was to create and implement an EM protocol for pediatric patients receiving invasive mechanical ventilation.

**Methods:** A multidisciplinary EM committee was formed to create and implement an EM protocol in a quaternary care PICU. A quality database was used to prospectively monitor patient tolerance of EM sessions and for serious adverse events, defined as unplanned extubation, hemodynamic instability, loss of central venous line, loss of arterial line, displacement of ECMO cannula, or cardiopulmonary arrest.

**Results:** Between December 2013 and October 2016, 74 patients received EM for a total of 130 unique sessions. No serious adverse events occurred. Two patients had an oxygen desaturation episode during mobility that resolved with ventilator modifications, and one patient had nasogastric tube displacement during mobility.

**Conclusions:** Early mobility is attainable in a quaternary care PICU population without serious adverse events, using a multidisciplinary approach and appropriate staff education. Further research is needed to understand the physical and neurocognitive benefits of EM in children.

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### 1. Introduction

Critical illness is associated with long-lasting negative outcomes after intensive care unit (ICU) discharge [1,2]. ICU acquired weakness (ICU-AW) [3–6] and Post-Intensive Care Syndrome (PICS) [7] are well described in the adult literature. Interest in treating and preventing ICU-AW and PICS has prompted work towards early rehabilitation in ICU patients [8]. “Early mobility” (EM) is a term used to describe physical activity and rehabilitation early on in critical illness [9,10].

ICU-AW exists in children [11–13], and pediatric ICU (PICU) patients may be at even higher risk for prolonged deficits, as they are often

admitted with pre-existing rehabilitation needs [14]. Outcomes studies have demonstrated that children discharged from the ICU have long-term functional deficits [15–17] similar to PICS [18]. In a multicenter Canadian study of critically ill children, only 26% of patients received mobility therapies, with only 9.5% occurring during the first 48 h of admission [19].

Several pilot studies and case reports have favored EM as feasible in the PICU population [20–23]. Due to many challenges, EM has yet to become the standard of care in pediatric critical care medicine [18]. The varied stages of development in PICU patients require developmentally specific activities. With growing emphasis on preventing serious safety events, there is hesitance to mobilize mechanically ventilated pediatric patients due to fear of unplanned extubations (UEs). PICUs are known to have higher rates of UEs compared to adult ICUs, and UEs are correlated to younger patient age and agitation [24]. Such knowledge has led to a culture of heavy sedation in PICUs [18]. To date, no studies have proven or disproven improved outcomes with EM in the PICU population, and there is a paucity of data regarding EM use in mechanically ventilated pediatric patients.

In 2013, Children's Healthcare of Atlanta at Egleston formed a multidisciplinary Early Mobility Committee to develop and institute an EM

*Abbreviations:* ICU-AW, ICU acquired weakness; PICS, Post-Intensive Care Syndrome; EM, early mobility; PICU, pediatric intensive care unit; UE, unplanned extubation; PT, physical therapist; OT, occupational therapist; RT, respiratory therapist; CPAP, continuous positive airway pressure; ECMO, extracorporeal membrane oxygenation; PEEP, positive end expiratory pressure; FiO<sub>2</sub>, fraction of inspired oxygen; CAPD, Cornell Assessment for Pediatric Delirium.

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protocol specifically for PICU patients receiving invasive mechanical ventilation. We aim to describe the creation and initiation of the EM protocol; and elaborate on the barriers associated with implementation.

## 2. Materials and methods

### 2.1. Overview

We performed a retrospective review of prospectively collected data on all patients receiving EM in the PICU at Children's Healthcare of Atlanta at Egleston between December 2013 and October 2016. Egleston is a quaternary care, 278-bed, freestanding children's hospital affiliated with Emory University. The PICU is a 36-bed medical-surgical ICU caring for patients 0–21 years of age. It serves as a regional center for solid organ transplantation, continuous renal replacement therapies, and extracorporeal life support. The institutional review board at Emory University approved the retrospective review as a quality initiative.

### 2.2. Definition

In adult literature, EM lacks a consensus definition. Most sources refer to early mobility as active rehabilitation exercises, engaging the patient and requiring patient participation. Timing of mobility events differs across studies. A recent systematic review of fourteen adult studies showed the first mobility event occurring between day one and eight of admission [25]. At our institution, EM was defined as active mobility of any mechanically ventilated patient, requiring patient participation, and occurring irrespective of duration of time in the PICU. Given the inherent challenges associated with implementing a new protocol, our protocol did not exclude any patients based on time since admission. Physicians and staff were encouraged to screen for EM candidacy each day during rounds, to ensure EM occurred as early as possible during the patient's PICU stay.

### 2.3. Protocol development

Prior to the EM protocol implementation, invasively ventilated patients in the Egleston PICU routinely received passive rehabilitation, such as range of motion exercises and splinting. Once extubated, physical therapists (PTs) and occupational therapists (OTs) engaged patients with active exercises.

In 2013, the Early Mobility Committee, comprised of PTs, OTs, respiratory therapists (RTs), PICU nurses, rehabilitation staff, child life specialists and PICU physicians, was assembled to address EM for patients receiving invasive mechanical ventilation. The committee's first meeting occurred on July 9, 2013, and monthly meetings were held thereafter. The EM protocol was generated as part of a PICU quality improvement initiative. Using information learned through EM webinars (Institutes of Health Mobility in the Intensive Care Unit) and conferences (Institutes of Health Conference November 2013, Johns Hopkins Critical Care Rehabilitation Conference November 2015), the committee created a consensus age-specific pediatric protocol. Age-specific mobility goals were created with developmentally appropriate tasks (Appendix I). Additionally, a pre-mobility checklist was developed to ensure that staff had all necessary equipment prepared prior to mobilizing a patient (Appendix II). Fig. 1 depicts the EM algorithm.

### 2.4. Patient selection

Definitive exclusion criteria, and potential exclusions, were created by the EM committee and approved by the attending physician group. Patients are evaluated for EM candidacy on a case-by-case basis using these guidelines, and require final approval by the attending or fellow physician caring for the patient. Physicians and staff are encouraged to screen all mechanically ventilated patients for EM within 72 h of

admission and to continue screening daily. Patients excluded from EM receive passive rehabilitation per unit standards.

Definitive exclusions:

- 1) Patients on high frequency oscillator ventilation
- 2) Patients with a critical airway
- 3) Patients receiving neuromuscular blockade
- 4) Unstable traumatic brain injury patients

Potential exclusions<sup>1</sup>:

- 1) Fraction of inspired oxygen (FiO<sub>2</sub>) > 50% (or escalating rapidly)
- 2) Positive end expiratory pressure (PEEP) > 8
- 3) Current sedation level < 2 on sedation scale (Appendix III)
- 4) Patients with spinal precautions
- 5) Hemodynamically unstable patients requiring active resuscitation

### 2.5. Protocol implementation

The EM protocol was implemented in December 2013, and the first patient was mobilized on December 10, 2013. Once a patient is determined to be an EM candidate, an EM order is placed by the physician caring for the patient. PT and OT coordinate with the patient's nurse and RT to schedule an optimal time to mobilize the patient that day. Parents are briefed on the procedure by PT and OT, and encouraged to be present and participate as possible to help minimize patient anxiety. Child life specialists assist in preparing patients and families before the EM session.

Prior to each EM session, the pre-mobility checklist is reviewed (Appendix II). All patient vascular access lines, endotracheal tubes and nasal/oral gastric tubes are secured. Mobility goals are determined based on developmental level (Appendix I) and how the patient has tolerated mobility in the past. Once the nurse, RT, OT, and PT are available, the patient is moved to the planned position, and each provider is assigned specific tasks as outlined in the pre-mobility checklist. Vitals signs, strength, and tolerance are assessed during EM sessions. Duration of mobility and activities performed are contingent on patient tolerance. For example, an initial EM session may be as simple as transitioning from a supine to seated position, while the second attempt may involve seating the patient on the edge of the bed. Through subsequent EM attempts, and as a patient's muscle strength and coordination increased, the patient can be assisted to a chair, to use a stationary bike, or to ambulate.

#### 2.5.1. Identifying EM candidates

In an effort to capture all eligible patients, a prompt for EM candidacy was included in the existing daily quality checklist. The daily quality checklist is a computer-based composite of 22 items completed by the provider on each patient during morning rounds. It reviews adherence to existing protocols, patient safety measures, and quality bundles. Additionally, an EM order panel was created for computerized physician order entry. The order panel consists of an EM specific consult to PT, OT, and RT.

#### 2.5.2. Special considerations

When developmentally appropriate, the highest level of early mobility anticipated is ambulation. To facilitate ambulation, and depending on patient ventilator needs, the patient's endotracheal tube can be connected to continuous positive airway pressure (CPAP) via a flow-inflating bag and portable oxygen tank or to a portable ventilator. Patients without intrinsic lung disease generally tolerate CPAP via a flow-inflating bag, but children requiring more than minimal ventilator settings with lung disease should use a portable ventilator to allow a higher level of support during the session.

<sup>1</sup> Potential exclusions should be discussed during rounds to assess safety of EM.

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