Evaluation of an Early Mobilization Program in a Pediatric Intensive Care Unit

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Abstract

Introduction: The focus of care in a pediatric intensive care unit (PICU) is on resuscitation, stabilization, management of critical disease processes, and reversal of organ failure. As a result, the child is often sedated, restrained and confined to bed for prolonged periods of time for perceived needs of safety, comfort and hemodynamic stability. Multi-system anatomic and physiologic alterations are known to occur in response to critical illness and may be compounded by immobility. These sequelae may have long-term implications for the patient and the patient’s family. A robust body of literature has showed that early mobilization in the intensive care unit can decrease these sequelae and reduce length of stay for the critically ill adult, but little has been published in regards to the pediatric population.

Objective: To determine the safety and feasibility of an early rehabilitation and progressive mobilization program in a pediatric intensive care unit.

Method: A before/after retrospective design was used for this QI project that focused on evaluating an early mobility program as it became routine care for the children hospitalized in this PICU. Data was collected and analyzed from July to August 2014 (pre-implementation phase) and July to August 2015 (post-implementation). Program implementation was completed in April to May 2015.

Setting: Pediatric intensive care unit (PICU) in a tertiary academic hospital in the US.

Results: Analysis of 200 children aged 1 day through 17 years admitted to a Pediatric Intensive Care Unit with a length of stay of at least three days demonstrated a significant increase in occupational and physical therapy consultations after implementation of the early mobility program ($p < 0.05$). In addition the number of mobilization activities increased post-
implementation ($p < 0.05$). No adverse events, such as unplanned extubations, occurred as a result of early mobilization.

**Conclusions:** Implementation of a structured and stratified early mobilization program in a pediatric intensive care unit resulted in an increase in occupational and physical therapy consultations, increased patient activity, without adverse events.

**Background**

The focus of care in a pediatric intensive care unit (PICU) is on resuscitation, stabilization, management of critical disease processes, and reversal of organ failure. As a result, the child is often sedated, restrained and confined to bed for prolonged periods of time due to perceived needs of safety, comfort and hemodynamic stability. Multi-system anatomic and physiologic consequences such as delirium and alterations in skin integrity are known to occur in response to critical illness and may be compounded by immobility (Desai, Law, & Needham, 2011; King, 2012. These sequelae may have long-term implications for the patient and the patient’s family (Desai et al., 2011; Knoester, Bronner, & Bos, 2008).

The prevalence of delirium in the critically ill child is reported to be between 13% and 30% (Silver et al., 2012; Smith et al., 2011). Pediatric delirium (PD) is associated with an increased PICU length of stay (LOS), independent of severity of illness, age, gender, mechanical ventilation and admitting diagnosis (Smeets et al., 2010). Additionally critically ill children can experience residual perceptual-motor, psychiatric and behavior problems (Silver et al., 2012).

The development of pressure ulcers is a second example of physiologic changes associated with pediatric critical illness. Schluer and colleagues reported a prevalence of pressure ulcers of 26.5% in children over one year of age hospitalized in an acute care setting; children in the PICU were at greatest risk for developing a pressure ulcer (Schluer et al., 2014). Children
over 12 years of age developed more pressure ulcers related to ineffective positioning and limited mobility (Schluer et al., 2014).

Data originating in adult intensive care units where critically ill adults are mobilized early in a structured and interdisciplinary fashion indicate that early mobilization is associated with reduced intensive care and hospital (LOS), improved muscle strength, improved self-perception of functional status, decreased rates of delirium, decreased use of sedative agents, and a reduction in the number of ventilator days (Engel, Needham, Morris, & Gropper, 2013; Kayambu, Boots, & Paratz, 2013; Morris et al., 2008; Needham & Korupolu, 2010). While pediatric literature regarding the practice of early mobilization is just emerging, the data available indicates that early mobilization activities for the critically ill child are safe and feasible with benefits for short and long term outcomes (Abdulsatar, Walker, Timmons, & Choong, 2013; Cameron et al., 2015; Hollander et al., 2014; Jacobs, Salman, Cotton, Lyons, & Brilli, 2001; Wieczorek, Burke, Al-Harbi, & Kudchadkar, 2015).

The purpose of this scholarly project was to evaluate a structured and interdisciplinary early rehabilitation and progressive mobility protocol, PICU UP!, for all children hospitalized in a pediatric intensive care unit and to make recommendations for program modification. For the purposes of this project, early mobilization is defined as any activity, passive or active, that occurs within the first 2 to 5 days of critical illness or injury intended to maintain or restore musculoskeletal strength and function (Hodgson, Berney, Harrold, Saxena, & Bellomo, 2013). The practice setting was a tertiary academic hospital where, previously, the referral of children for therapy and mobilization of the child is at the discretion of the medical providers without standardization or guidelines. The objectives of implementation of the PICU UP! Protocol were to provide a standardized mechanism to increase the child's activity level safely and thus attempt
to lower the rates of immobility associated complications. The decision to begin the PICU UP! program was evidence based and interprofessional in origin. This project was intended to evaluate the program, determine effectiveness, and through data analysis, offer recommendations for improvement or change.

**Theoretical Framework**

Key to the success of the PICU Up! implementation project is interdisciplinary collaboration (Balas et al., 2013; King, 2012). Collaboration in healthcare is a complex process that brings together two or more individuals, often from different disciplines, working together to achieve shared aims and goals with the intended goal of improved patient outcomes (Houldin, Naylor, & Haller, 2004). Interdisciplinary collaboration is elucidated by Imogene King’s Theory of Goal Attainment; the theoretical framework for this project. Often King’s theory is applied to interactions between the nurse and patient dyad but the applicability of the theory small groups and organizations is strength of the conceptual system (Fewster-Thuente & Velsor-Friedrich, 2008).

King’s conceptual theory of the person consists of three interacting systems: personal, interpersonal and social (King, 1997). The personal system involves humans interacting with their environment. The interpersonal system involves individuals interacting with each other in a variety of environments. Societal systems are groups of two or more individuals, each working in their role, toward a collective goal. The interdisciplinary team will work together with the child and family to achieve the goal of safe and early mobilization.

King’s Theory of Goal Attainment includes the concepts of communication, interaction, and transaction. Through effective communication and interaction, the interdisciplinary team, the child, and family mutually define and set goals. During the transaction phase interventions
are implemented that achieve the identified goals; the PICU UP! Protocol will be the intervention.

**Review of the Literature**

A review of the literature was conducted to critically evaluate the evidence regarding (1) the safety and feasibility of early mobilization, (2) the outcomes associated with early mobilization of critically ill patients, and (3) the recommendations for the development of early mobilization programs. The primary focus is on activities in the PICU but the search is broadened to include the adult ICU where documentation of this process has been in place for a longer period of time. Evidence regarding mobilization activities in critically ill children is just recently emerging and while adult protocols cannot always be directly applied in the pediatric setting many pediatric critical care practices evolve from evidence in adult intensive care patients (Munkwitz, Hopkins, Miller, & Luckett, 2010).

**Early Mobilization Outcomes**

Jacobs et al (2001) published the first large retrospective study on mobilization of critically ill children which has been referenced by pediatric critical care experts and highlights multiple factors that should be considered in designing a program (Jacobs et al., 2001). Children who underwent single stage laryngotracheal reconstruction were assigned to one of two groups: (1) the intervention group of children were allowed graduated liberal activities as tolerated while intubated post-operatively (n=54) and (2) the control group of children received standard post-operative interventions, intubation, restraints, sedation with or without neuromuscular blockade (n=79). The children were grouped based on chronological and developmental age, past medical history, and parental report of the child’s ability to cooperate (N=133). Fewer post-operative events were reported in children post laryngotracheal reconstruction who were allowed
liberal activities compared to the standard post-operative care group: atelectasis (p = 0.001),
post-extubation stridor (p = 0.001) and withdrawal syndromes (p = 0.001). Children who were
allowed liberal activity after laryngotracheal reconstruction had a shorter PICU LOS (p = 0.007)
and shorter hospital LOS (p = 0.01) than children who were managed with the standard post-
operative approach (Jacobs et al., 2001). In regards to adverse events there were no differences
in the incidence of unplanned extubations between groups. Selection bias and non-equivalent
groups were noted limitations of this study as there was an age difference between the two
groups of children. The single patient population limits generalizability to the heterogeneous
group of children cared for in PICUs. The study highlights the importance of stratifying
activities based on physiologic and developmental patient characteristics and progressive
liberalization of activity.

**Safety and Feasibility**

In a prospective pilot study, Abdulsatar, Walker, Timmons & Choong (2013) evaluated
the safety and feasibility of a virtual reality (VR) exercise, Nintendo Wii™ Boxing in a PICU.
Children, whose ages ranged from three to eight years, meeting inclusion criteria (N = 8)
participated in the VR exercise at least twice a day for up to two days. Fifty percent of the
children were able to participate in the VR activity while intubated with no adverse events
reported. The frequency of upper body activity was significantly greater during play time
(p=0.049); there was no significant change in grip strength.

In a retrospective, descriptive study, Hollander and colleagues (2014), investigated the
safety and feasibility of standardized family-centered inpatient rehabilitation care paths initiated
in the PICU for children requiring paracorporeal assist devices (PAD) (N=14); 12 of the children
survived to transplantation. The children aged six months to 14 years were assigned to one of
two groups based on their age (less than one year of age or one year of age or greater). The outcome measure was the number of age-specific phases achieved by each child. Eleven of the 14 children achieved all goals; reasons for not meeting goals included cannula infection, repeated pulmonary infections and intolerance of handling. No activity associated adverse events were reported. While not a primary outcome measure, the median time to extubation post-cardiac transplantation for the group of children requiring PAD who participated in the therapy program was similar to children transplanted during the study period. Children who required PAD and participated in a therapy program approached surgery in a state conducive to rapid post-operative recovery.

The sample size in each of the three studies reviewed was small and the studies were single center studies, factors that limit generalizability. Hollander et al. (2014) and Jacobs et al. (2001) incorporated the developmental needs of the child and invited family input into program activities. Unlike the studies by Jacobs et al (2001) and Abdulsatar et al. (2013), the study by Hollander et al (2014) included younger children, suggesting that early mobilization may be reasonable intervention to consider in this population as well. Jacobs et al. (2001) allowed children to participate in graduated activities of their choice, however, the children who participated in the study by Hollander et al. (2014) engaged in a standardized and structured therapy program developed and implemented by child life specialists, occupational therapists and physical therapists.

Recommendations for Programs

Mobilization of the critically ill patient is a culture shift for the ICU and requires a cultural transformation (Munkwitz et al., 2010). Factors that have been found to affect the successful implementation of early mobility programs in the adult critical care setting include:
(1) consideration of the unit culture, (2) early identification of barriers and facilitators to mobilization, (3) provider knowledge and competence, (4) interdisciplinary communication and collaboration, and (5) development of protocols that stratify patients based on severity of illness and contraindications to therapy (Balas et al., 2013; Engel, Tatbe, Alonzo, Mustille, & Rivera, 2013; Hodgson et al., 2014; Morris et al., 2008; Needham et al., 2010). Safety and feasibility of use are the first concerns when designing early mobility programs in the intensive care unit. Given the heterogeneous nature of the PICU population, the feasibility of early mobility may be more challenging than the integration of early mobility into the adult critical care setting. The unique anatomical and physiologic features of the child, as well as the chronological and developmental age of the child will impact the design of early PICU mobility programs (Choong et al., 2014; Choong et al., 2013; Choong, Tran, Clark, Cupido, & Corsi, 2012; Hollander et al., 2014; Jacobs et al., 2001; Munkwitz et al., 2010).

Literature addressing early activity and mobilization of the critically ill child, while limited in volume and with noted sample and design limitations, suggest that the practice is safe and feasible with the potential for improved patient outcomes. Findings are consistent with those regarding early mobilization of critically ill adult where the literature is more robust. Comparatively, findings from the pediatric and adult literature offer valuable recommendations for designing, implementing, and evaluating early mobility programs in a pediatric intensive care unit.

**Methods**

**Study Design**

A pre/post design was utilized for this quality improvement (QI) project evaluating the PICU Up! mobility program as it became routine care for the child in the intensive care unit.
The quality improvement model chosen for implementation was the Plan-Do-Study-Act (PDSA) cycle (Colquhoun et al., 2013).

**Setting**

The setting for this QI project was a 40 bed tertiary care PICU in an academic teaching institution providing care for children from ages 1 day to 21 years of age. The PICU is a combined medical-surgical unit admitting critically ill children with trauma and burns, transplant, and oncology diagnoses as well as children requiring extracorporeal membrane oxygenation (ECMO) therapy. The PICU is staffed with attending physicians, fellow physicians in training, nurse practitioners, rotating residents, registered nurses, respiratory therapists, child life specialists, social workers, pharmacists, and nutritionists. Pediatric occupational and physical therapy (OT, PT) and speech/language pathology (SLP) consultations and treatment are available when ordered by a medical provider.

**Procedures**

**Program development.** An interdisciplinary team, led by this DNP student, was formed to review the literature regarding early mobilization of critically ill children and adults. Team composition was open to all interested parties. Active participants have included physicians, nurse practitioners, nurses, OT, PT, child life specialists, and respiratory therapists. The first meeting took place in January 2014. The PICU Up! Guidelines for Early Rehabilitation and Progressive Mobility were developed by this group and approved by senior PICU leadership. The components of the PICU Up! guidelines include a tiered activity plan based on clinical parameters as well as exclusion criteria (Appendix A). The program included triggers for OT and PT consults. Included in the guidelines are criteria for pausing activity and re-assessing (Appendix B). Associated with each activity level are a set of interventions, written to promote
individualization based on the child’s unique needs (Appendix A). A written procedure was available to the staff via the institutions Policies on Line (Appendix C). Educational materials included an on-line learning module (Appendix D). A pocket card that summarized the levels and activities was distributed to all staff members (Appendix E). Education took place in April and May 2015 and the program was officially launched July 2015.

**Process.** Each morning on rounds the bedside nurse reported the child’s activity level based on the established criteria. The interdisciplinary team considered the activity level and activity goal for the day. This information was recorded by the bedside nurse in the electronic record daily goals note and was accessible to all providers. The appropriateness of the activity level was assessed throughout the day by the bedside nurse and the team conferred on an as needed basis.

**Sample**

A non-probability, convenience sampling strategy was used to evaluate the program. Charts of the first 100 children meeting inclusion criteria were reviewed before implementation of the mobility protocol in the months of July through August 2014. The charts of the first 100 children meeting inclusion criteria who had the intervention were reviewed after implementation during the months of July through August 2015. The same time of year was chosen to decrease seasonal variance between samples. Inclusion criteria were children aged one day to 17 years of age requiring hospitalization in the PICU for greater than or equal to three days. The day of admission to the PICU was day zero. Children 18 years of age and older and children hospitalized in the PICU for less than three days were excluded from data collection.

**Human Subjects**
Throughout the chart review process all patient data was kept confidential and patient identifiers were removed. Each chart was assigned a unique study identifier and only the study ID was recorded in the database. A link between the study ID and the child’s medical record number and the data collection forms were kept in a locked cabinet, accessible only to persons directly involved in the study. Computer systems that require institution authorized passwords for access housed the data; there was a unique login and password specifically for that database. The login and password was accessible only to the principle investigator and study team members. An application to the Internal Review Board (IRB) was submitted both at the University of Maryland School of Nursing and institution where the project was implemented. The study was approved as a quality improvement project (Appendix F).

**Outcome Measures**

Primary outcome measures of this project were the (1) documentation of the activity level in the daily goals of care note, (2) the number of OT and PT consultations, (3) the number and types of activities performed, (4) barriers to activities and (5) adverse events. Secondary outcome measures were the number of (1) pressure ulcers, (2) contractures, (3) delirium, and (4) non-catheter related deep vein thrombosis developed.

**Data Collection and Analysis**

Charts were reviewed in the before and after groups retrospectively. Data was extracted manually and recorded on the data form. Demographic data was obtained. The Pediatric Logistic Organ Dysfunction (PELOD) score was used to record the child’s physiologic status on admission and to compare the groups (Leteurtre et al., 2003). The PELOD score describes the severity of organ dysfunction. Demographic data, the PELOD score, pertinent clinical information and outcome data were recorded on the Case Report Tool (Appendix G).
Demographic statistics were used to describe the characteristics of the children included in the study: age, gender, weight, admission category and pre-existing processes such as intellectual or motor disabilities. Categorical primary and secondary outcome measures were analyzed using descriptive statistics and chi-square analysis. For continuous data independent group t-tests were utilized for analysis. Outcome measures were analyzed for PICU day 3 for all children and the day prior to transfer or discharge for children with a PICU LOS of greater than 5 days, unless otherwise specified. For all analyses, a two-tailed p- of less than 0.05 was considered statistically significant. Stata 12 was used for statistical analysis.

Results

Patient Characteristics

The pre- and post-implementation groups were similar in regards to age, weight, premorbid processes, and PELOD scores. The average age was 92 months. The physiologic status of the children, as measured by the PELOD score, was similar. There was not a difference in the PICU Up! level at PICU day 3, $X^2(1, N=200) = 1.056$, p= 0.788. There was not a difference in the PICU Up! level 24 hours before discharge/transfer from the PICU $X^2(1, N=116) = 1.944$, p= 0.584. There was a difference between the numbers of males in the pre and post-implementation groups. Table 1 describes the patient characteristics of the sample.
Table 1

Baseline patient characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Pre-Implementation (N=100)</th>
<th>Post-Implementation (N=100)</th>
<th>P-Value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in months, mean (SD)</td>
<td>92.94 (68.06)</td>
<td>92.92 (65.81)</td>
<td>0.99</td>
</tr>
<tr>
<td>Weight in kg, mean (SD)</td>
<td>26.78 (19.19)</td>
<td>27.32 (22.03)</td>
<td>0.86</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td>0.021*</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>67 (67%)</td>
<td>51 (51%)</td>
<td></td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>33 (33%)</td>
<td>49 (49%)</td>
<td></td>
</tr>
<tr>
<td>Admission Categories</td>
<td></td>
<td></td>
<td>0.256</td>
</tr>
<tr>
<td>Medical, n (%)</td>
<td>58 (58%)</td>
<td>50 (50%)</td>
<td></td>
</tr>
<tr>
<td>Surgical, n (%)</td>
<td>42 (42%)</td>
<td>50 (50%)</td>
<td></td>
</tr>
<tr>
<td>Pre-existing conditions present</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor impairment, n (%)</td>
<td>29 (29%)</td>
<td>26 (26%)</td>
<td>0.63</td>
</tr>
<tr>
<td>Intellectual disability, n (%)</td>
<td>32 (32%)</td>
<td>27 (27%)</td>
<td>0.44</td>
</tr>
<tr>
<td>PELOD score, mean (SD)</td>
<td>2.8 (5.23)</td>
<td>4.29 (7.83)</td>
<td>0.12</td>
</tr>
<tr>
<td>PICU LOS, mean (SD)</td>
<td>6.75 (5.39)</td>
<td>7.6 (6.89)</td>
<td>0.34</td>
</tr>
</tbody>
</table>

<sup>a</sup> Descriptive, T-test and Chi-squared tests used for analysis
<sup>*</sup> p-value <0.05

Outcome Measures

**Documentation of Activity Levels.** Forty-eight percent of the children had a level of activity documented in the daily goals of care note by the nurse on day three. Forty-seven percent of the children had a level of activity documented in the daily goals of care note the day prior to transfer/discharge (Table 2).

Table 2

Documentation of Activity Level in Daily Goals of Care Note

<table>
<thead>
<tr>
<th></th>
<th>PICU Day 3 (N = 100)</th>
<th>Day prior to PICU transfer (N = 60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No daily goals note written, n (%)</td>
<td>40 (40%)</td>
<td>28 (47%)</td>
</tr>
<tr>
<td>Level noted in daily goals note, n (%)</td>
<td>48 (48%)</td>
<td>28 (47%)</td>
</tr>
<tr>
<td>Level not noted in daily goals note, n (%)</td>
<td>12 (12%)</td>
<td>4 (6%)</td>
</tr>
</tbody>
</table>

**Occupational and Physical Therapy Consultations.** There was an increase in the number of occupational therapy consultations from the pre- to post-implementation phase for
PICU day 3, $X^2(1, N=200) = 4.50, p = 0.034$. There was not an increase in the number of physical therapy consultations for PICU day 3, $X^2(1, N=200) = 3, p= 0.08$. There was an increase in the number of physical therapy consultations 24 hours before discharge/transfer for children who were able to ambulate pre-morbidly, $X^2(1, N=60) = 5.658, p= 0.017$; occupational therapy consultations remained significant for this same population at 24 hours before discharge/transfer from the PICU $X^2(1, N=60) = 7.186, p= 0.007$.

**Activities.** For analysis purposes activities were categorized as in-bed therapies or mobility therapies. In-bed therapies included passive range of motion (PROM), active range of motion (AROM), active or passive bed positioning and splinting. Mobility activities included sitting at edge of bed (EOB), sit to stand, transfer, pre-gait activities, mobility device, ambulation and play. For PICU day three, there was an increase in the number of children who had at least on bed activity, $X^2(1, N=143) = 45.368, p < 0.000$. For PICU day 3 there was an increase in the number of children who transitioned from sit to stand, $X^2(1, N=47) = 10.04, p= 0.002$ and the number of children who ambulated, $X^2(1, N=35) = 5.85 , p= 0.016$. Table 3 describes the activities on PICU day three.
Table 3

Activities: PICU Day Three

<table>
<thead>
<tr>
<th>Activity</th>
<th>Pre-Implementation N = 100</th>
<th>Post-Implementation N = 100</th>
<th>P – Value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>In bed activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive range of motion, n (%)</td>
<td>9 (9%)</td>
<td>10 (10%)</td>
<td>0.809</td>
</tr>
<tr>
<td>Passive bed positioning, n (%)</td>
<td>28 (28%)</td>
<td>41 (41%)</td>
<td>0.053</td>
</tr>
<tr>
<td>Splinting, n (%)</td>
<td>2 (2%)</td>
<td>8 (8%)</td>
<td>0.051</td>
</tr>
<tr>
<td>Active range of motion, n (%)</td>
<td>2 (2%)</td>
<td>1 (1%)</td>
<td>0.561</td>
</tr>
<tr>
<td>Active bed positioning, n (%)</td>
<td>17 (17%)</td>
<td>51 (51%)</td>
<td>0.000 *</td>
</tr>
<tr>
<td>At least one bed activity, (%)</td>
<td>50 (50%)</td>
<td>93 (93%)</td>
<td>0.000 *</td>
</tr>
<tr>
<td>Mobility activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit edge of bed, n (%)</td>
<td>2 (2%)</td>
<td>8 (8%)</td>
<td>0.052</td>
</tr>
<tr>
<td>Sit to stand, n (%)</td>
<td>14 (14%)</td>
<td>33 (33%)</td>
<td>0.002 *</td>
</tr>
<tr>
<td>Transfer, n (%)</td>
<td>35 (35%)</td>
<td>41 (41%)</td>
<td>0.382</td>
</tr>
<tr>
<td>Ambulate, n (%)</td>
<td>11 (11%)</td>
<td>24 (24%)</td>
<td>0.016 *</td>
</tr>
<tr>
<td>Play, n (%)</td>
<td>5 (5%)</td>
<td>1 (1%)</td>
<td>0.097</td>
</tr>
<tr>
<td>Other, n (%)</td>
<td>3 (3%)</td>
<td>1 (1%)</td>
<td>0.312</td>
</tr>
<tr>
<td>At least one mobility activity, n (%)</td>
<td>55 (55%)</td>
<td>45 (45%)</td>
<td>0.120</td>
</tr>
</tbody>
</table>

<sup>a</sup> Descriptive and Chi-squared tests used for analysis.

* p-value <0.05 for significance

In the pre-implementation phase of the program, 56 children remained in the PICU for five or more days. In the post-implementation phase, 53 children remained in the PICU for five or more days. Following implementation of the PICU Up! program more children received passive range of motion, $X^2(1, N=7) = 4.316$, $p= 0.037$ and passive bed positioning, $X^2(1, N=42) = 4.82$, $p= 0.028$. There was an increase in reporting of active bed positioning post-implementation phase, $X^2(1, N=34) = 9.54$, $p= 0.002$. In the post-implementation phase there more children were reported to have at least one bed activity, $X^2(1, N=79) = 24.718$, $p= 0.000$.

Table 4 describes the activities the day prior to transfer/discharge from the PICU.
Table 4

Activities: Day Prior to Transfer/Discharge from PICU

<table>
<thead>
<tr>
<th>Activity</th>
<th>Pre-Implementation N = 56</th>
<th>Post-Implementation N = 53</th>
<th>P – Valuea</th>
</tr>
</thead>
<tbody>
<tr>
<td>In bed activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive range of motion, n (%)</td>
<td>1 (2%)</td>
<td>6 (11%)</td>
<td>0.037 *</td>
</tr>
<tr>
<td>Passive bed positioning, n (%)</td>
<td>16 (29%)</td>
<td>26 (49%)</td>
<td>0.028</td>
</tr>
<tr>
<td>Splinting, n (%)</td>
<td>3 (6%)</td>
<td>3 (6%)</td>
<td>0.944</td>
</tr>
<tr>
<td>Active range of motion, n (%)</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Active bed positioning, n (%)</td>
<td>10 (18%)</td>
<td>24 (45%)</td>
<td>0.002 *</td>
</tr>
<tr>
<td>At least one bed activity, (%)</td>
<td>29 (52%)</td>
<td>50 (94%)</td>
<td>0.000 *</td>
</tr>
<tr>
<td>Mobility activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sit edge of bed, n (%)</td>
<td>3 (6%)</td>
<td>4 (8%)</td>
<td>0.641</td>
</tr>
<tr>
<td>Sit to stand, n (%)</td>
<td>14 (25%)</td>
<td>17 (32%)</td>
<td>0.208</td>
</tr>
<tr>
<td>Transfer, n (%)</td>
<td>29 (52%)</td>
<td>32 (60%)</td>
<td>0.366</td>
</tr>
<tr>
<td>Ambulate, n (%)</td>
<td>13 (23%)</td>
<td>14 (26%)</td>
<td>0.699</td>
</tr>
<tr>
<td>Play, n (%)</td>
<td>3 (3%)</td>
<td>2 (4%)</td>
<td>0.692</td>
</tr>
<tr>
<td>Other, n (%)</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>At least one mobility activity, n (%)</td>
<td>33 (60%)</td>
<td>36 (68%)</td>
<td>0.330</td>
</tr>
</tbody>
</table>

a Descriptive and Chi-squared tests used for analysis.  
* p-value <0.05 for significance

There were no reported adverse events related to mobility in either phase of the program.

Barriers to Activities: On PICU day 3, the reported barriers to activities included (1) patient or parent refusal to participate for reasons of fatigue or sleeping, (2) procedures, (3) change in patient condition and (4) lack of equipment (Table 5). In the pre-implementation phase the most frequently reported barrier to activities was performing a procedure and in the post-implementation phase the most frequently reported barrier to activities was lack of equipment, specifically an appropriate seating devices and positioning materials.
Table 5

**Barriers to Activities: PICU Day Three**

<table>
<thead>
<tr>
<th></th>
<th>Pre-Implementation (N = 7)</th>
<th>Post-Implementation (N = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient or parent refusal</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Procedure or test</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Patient condition</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Lack of equipment</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

**Immobility Associated Morbidities.** Immobility associated complications included the number of pressure ulcers, contractures, delirium and non-catheter related deep vein thrombosis (DVT). In the pre-implementation phase of the program delirium was reported two children and delirium was reported for one child post-implementation. There were otherwise no immobility associated complications.

**Discussion**

The PICU Up! program was designed to be interdisciplinary, structured and stratified. These factors have been shown to increase the success of a mobility program and increase patient activity through standardization of work flow, increasing discussions regarding mobility during work rounds and identification of safe activities for patients (Engel et al., 2013; Honiden & Connors, 2015). In this retrospective, pre-post quality improvement study evaluating the impact of an early mobilization program of 200 PICU admissions, an increase in bed and mobilization activities was reported in the post-implementation phase; specifically there was a significant increase in active bed positioning, transitioning from sit to stand and ambulation. Approaching significance was an increase in passive bed positioning and splinting on PICU day three. Data for children who remained in the PICU for more than five days revealed a significant increase in bed activities 24 hours before transfer or discharge from the PICU. The bed activities
that increased during this phase were passive range of motion, passive and active bed positioning. While there was a percentage increase in the number of children who participated in mobility activities 24 hours before discharge/transfer post-implementation of the PICU Up! program, the Chi-square difference did not reach significance. Even though the children were designated as level three the day prior to discharge, since they had a longer length of stay it is possible that they were more ill, more sedated and more debilitated requiring additional recovery time and resources for mobilization.

Barriers to mobility were recorded to assist in determining what factors needed to be addressed to enhance the program. The literature review indicated that lack of equipment could be a barrier to early mobilization of the adult patient and is magnified in the pediatric population because of the heterogeneous nature of the child’s height and weight, factors that often determine the size of the equipment. This was a finding in the PICU Up! QI program and impacted the ability of the team to transfer children who required special sitting systems because of pre-existing or new on-set head and trunk instability. Lack of equipment was identified more frequently in the post-implementation phase likely because of increased awareness of the problem. Purchase of additional equipment was not part of this pilot study.

While the chart review did identify barriers, the PICU Up! committee suspected there were barriers that were not identified in the chart review. An addition to this study included a Likert scale survey with area to text comments sent to the entire staff of the PICU and the rehabilitation department. The survey was voluntary and responses were anonymous; there were 98 responses (N = 250). Specifically, the team was asked to answer the following question: ‘The resources needed to increase the activity and mobility of the critically ill child in the PICU were readily available’. Eight percent of the respondents strongly disagreed, 36% disagreed,
51% agreed and five percent strongly agreed. The themes that emerged as barriers included lack of appropriate equipment, inadequate personal to assist with mobilization of the child and to continue care of other patients, coordination of provider efforts, and safety concerns.

Consistent with the literature regarding early mobility in the critically ill population, there were no adverse events, such as extubation, reported with the increased activities in this program. There were no reports of needing to stop activities early because of a decline in the child’s physiologic status or behavior; likely related to the design of the mobility levels based on physiologic as well as the developmental level of the child. Respecting the parent’s assessment of the child’s ability to cooperate with the task and incorporating the child-life specialist into the therapy efforts are two additional factors that likely enhanced the child’s ability to participate in the therapy activity safely. Interestingly, the staff did not express concern regarding the safety of mobilizing critically ill children during the pilot phase or in the survey, but rather expressed concern regarding the safety and monitoring of the other assigned patients. Early mobilization programs in the adult critical care units included increased staffing to minimize coordination of time barrier. The PICU Up! program did not include additional staffing, which, may have negatively impacted the reported mobility activity of the children in this phase of the program.

Post-implementation, there was a significant increase in the occupational therapy consultations, which was consistent with prior pre-post implementation mobility studies investigating early activity in intensive care units. Unlike programs that demonstrated an increase in mobility activities as measured by billable PT units (Clark, Lowman, & Griffin, 2013), there was not a significant increase in PT referrals on PICU day three, yet there was a significant increase in the children who ambulated. In this institution, PT provides airway clearance therapies and therapies related to ambulation; splinting, range of motion, seating and
positioning are shared activities with OT but generally are the purview of OT. Children able to ambulate on day three did not require PT services, therefore addressing the insignificance in PT referrals at PICU day three. Over 25% of the children had premorbid diagnoses that rendered them wheelchair dependent and non-ambulatory, so along with the varied age group of the study population the number of children able to ambulate at baseline was limited. Excluding children who did not have ambulation potential, there was a significant increase in PT referrals post-implementation of PICU Up! on the day before transfer/discharge suggesting appropriate referral to PT.

The ability to communicate among team members facilitates early mobility in the critically ill (Bakhru, Wiebe, McWilliams, Spuhler, & Schweickert, 2015). The goals of care note, which was the communication tool, was not always written and when it was, it did not always include the PICU Up! level.

A secondary outcome measure was the incidence of mobility associated complications. There were no reports of pressure ulcers, contractures, or DVT. The data revealed only isolated cases of delirium. However, the reports of delirium may be under reported since the screening tool that this institution utilizes can only be used to screen children who are developmentally minimally at a five year old level.

**Implications for Clinical Practice**

Early mobilization has the potential to improve outcomes for the critically ill patient. Based on this project, the PICU Up! program is an effective method for improving the mobility of critically ill children in this PICU. The staff’s enthusiasm for the program and commitment to problem solving has added to the positive outcomes. Several areas for improvement in the program exist based on the study results.
Ongoing education of staff. The importance of ongoing education cannot be underestimated given the number of interdisciplinary staff members. Pocket cards and on-line educational modules will continue to be available to support the policy. As more complex, critically ill children are ambulated the need for simulation experiences will be considered.

Resources. It is unlikely that the program will continue to flourish without staffing modifications and additional equipment. The rehabilitation therapists and PICU Clinical Nurse Specialist are actively evaluating alternate seating and positioning devices. Telemetry during ambulation is being piloted to minimize the equipment that is needed during ambulation. Alternate solutions to restraints, infant/pediatric mitts, are being considered. Concurrent collection of data to further elucidate the equipment and personal barriers will assist in developing a business plan directed toward acquiring additional resources.

Communication: The activity level is presented during morning rounds, however the level is not being consistently recorded in the daily note and specific activities for the day are not being discussed in rounds.

ABCDEF Bundle (Society for Critical Care Medicine, n.d.). Increasing the activity and mobility of the critically ill child has the potential to improve patient outcomes. However, increased mobility is only one piece of puzzle to improving patient outcomes. As highlighted by the studies in adult intensive care unit, bundling a mobility program with strategies to assess and treat pain, minimize sedation, assess readiness for extubation, and assess and treat delirium can exponentially improve patient outcomes. To achieve improved outcomes in this PICU and to enhance mobility efforts, delirium assessment, sedation practices, and readiness for extubation strategies will be incorporated in the PICU Up! Program.

Limitations
A limitation of this project was a convenience sample from a single academic pediatric hospital, limiting the generalizability. Secondly, the retrospective nature of data collection is limited by the quality of documentation. Temporal changes that occurred between the pre- and post-implementation phases, such as the influence of planning the program on changing the culture during the pre-implementation phase, could not be controlled in this pilot.

**Conclusion**

The purpose of this quality improvement project was to evaluate an interdisciplinary mobility program as it became standard of care in the PICU. The guidelines for mobility were designed to be structured and activities stratified based on physiologic and developmental measures. In this retrospective pre/post comparison, there was an increase in activities post-implementation of the PICU Up! guidelines without adverse events. The lessons learned from this project can serve as a foundation to revise the program in this institution as well serve as an example to other pediatric intensive care units as they design a program.
References


mobilization of mechanically ventilated critically ill adults. Critical Care, 18, .

http://dx.doi.org/10.1186/s13054-014-0658-y


## Appendix A

### Tiered Activity Plan

**Excluded from PICU UP! Levels and Activities**
- ECMO
- Open chest
- Open abdomen
- Unstable fracture
- Medical orders specifying alternate activity

<table>
<thead>
<tr>
<th>PICU UP! Level</th>
<th>Parameters for Inclusion</th>
<th>Activities</th>
</tr>
</thead>
</table>
| **Level 1**    | • Intubated with FiO2 >60% or  
• Intubated with PEEP > 8 or  
• Intubated difficult airway or  
• New tracheostomy or  
• Acute neurological event or  
• Sedated and SBS -3 to -2 or  
• Vasopressor  
  ○ other than Milrinone |  
• Lights on/shades up by 0900  
• Bed/bath/weight by 2300  
• Lights dimmed/out by 2300  
  ○ increase lighting as needed for cares/interventions  
• TV limited to 30 minutes at a time and a goal of < 2 hours per day for children >2 years of age  
• HOB elevated ≥ 30°  
• Turn q2h during the day and q4h at night  
• Positioned in developmentally supportive position or as recommended by OT/PT  
• OT consult by PICU day 3  
• PT consult as needed |

| **Level 2**    | • Intubated or tracheostomy with FiO2 ≤ 60% +/-or PEEP ≤8 and SBS -1 to +3  
• Non-invasive support with FiO2 > 60% or  
• Dialysis/Renal Replacement Therapy or  
• Femoral access |  
• Level 1 activities plus  
• Positive touch for infants/toddlers  
• Sitting up in bed TID  
• Team to consider OOB to chair +/- or ambulation  
• OT/PT consult by PICU day 3  
• Assess for difficulty with communication or phonation and consult SLP  
• Assess for swallowing readiness in high risk children and consult SLP  
• Assess need for daily schedule  
• pCAM-ICU BID |

| **Level 3**    | • Non-invasive pulmonary support with FiO2 ≤ 60% or  
• Baseline pulmonary support or  
• EVD cleared by NUS and SBS-1 to +3 |  
• Level 1 and 2 plus  
• OOB to chair TID or sitting up in bed TID if appropriate chair is not available  
• Ambulate BID if trunk control present |
Appendix B

Criteria to Pause, Rest and Reassess

- Change in HR 20%
- Change in BP 20%
- Change in RR 20%
- Decrease SaO2 15%
- Increase FiO2 20%
- Increase ETCO2 20%
- Ventilator asynchrony
- CPAP/BiPAP asynchrony
- Respiratory distress
- New arrhythmia
- Hemodynamic concerns
- Change in mental status
- Concern for airway device, vascular access or EVD integrity
- Behavior interfering with safe activity
Appendix C

**TITLE:** PICU Up! Promoting Early Rehabilitation and Progressive Mobilization

**Objectives**

The purpose of this protocol is to guide the practitioner in the progressive mobilization of children in the pediatric intensive care unit.

**Indications for Use**

This protocol applies to all children in the pediatric intensive care unit with the exception of children on ECMO, open chest, open abdomen, unstable fractures, or medical orders specifying alternate activities.

**Definitions**

1. **Activity level:** The child’s activity based on physiologic criteria (Appendix A). The levels are associated with permitted actions.
   
   a. **Level 1**
      
      i. Intubated with FiO2 > 60% and/or PEEP > 8 or
      
      ii. Intubated difficult airway child or
      
      iii. New tracheostomy or
      
      iv. Acute neurologic event or
      
      v. Sedated and SBS – 3 to -2 or
      
      vi. Vasopressors (other than milrinone)
   
   b. **Level 2**
      
      i. Intubated or tracheostomy with FiO2 ≤ 60% and/or PEEP ≤ 8 and SBS -1 to +3 or
      
      ii. Non-invasive support with FiO2 > 60% or
      
      iii. Dialysis/renal replacement therapy or
      
      iv. Femoral access
   
   c. **Level 3**
      
      i. Non-invasive pulmonary support with FiO2 ≤ 60% or
      
      ii. Baseline ventilator support or
      
      iii. External ventricular drain cleared by neurosurgery for ad lib activity and SBS -1 to +3

1. **Developmental activity:** Developmentally appropriate activities are defined as activities and sensory stimulation that are designed to promote achievement of developmental milestones, normalize the hospital environment, facilitate family attachment and patient coping. (Appendix C)
2. Positioning: Techniques and strategies to optimize joint/postural alignment, promote development, optimize pulmonary status, and avoid contractures and skin breakdown.
3. Progressive mobilization: Developmentally age appropriate activities undertaken while the child remains hospitalized in the PICU with the intent of increasing physical activity.
4. Range of motion: Exercises that optimize and promote joint and muscle flexibility. These can be active or passive depending on medical status and level of function. (Appendix D)

Responsibility

A. Authorized Prescriber
   a. In collaboration with the child’s team determine the activity level of the child each day during morning rounds. Refer to appendix A for activity levels and suggested activities for each level.
   b. Prescribe an OT consult by PICU day 3 on for all children.
   c. Prescribe a PT consult by PICU day 3 for children level 2 and 3 or when children are at level 2 or 3.
   d. Prescribe a Speech/Language consult for feeding/swallowing and communication as needed. Refer to appendix E for reasons to refer.
   e. Discuss the importance of activity and mobility with the child and family.

B. Nurse
   a. Participate in determining the child’s activity level according to guidelines noted in appendix A during morning rounds and document activity level in summary of daily rounds note.
   b. Implement recommended interventions as appropriate based on determined activity level (Appendix A).
   c. Discuss the importance of activity and mobility with the child and family.

C. Respiratory Therapy
   a. Participate in determining the child’s activity level according to guidelines noted in appendix A during morning rounds.
   b. As appropriate participate in the implementation of recommended interventions (Appendix A).
   c. Discuss the importance of activity and mobility with the child and family.

D. Occupational and Physical Therapist
   a. Participate in determining the child’s activity level according to guidelines noted in appendix A.
   b. As appropriate participate in the implementation of recommended interventions (Appendix A)
   c. Communicate recommendations for ongoing interventions, such as call bell adaptations, positioning, range of motion and splinting and activity status, to the child’s team (Appendices D and F).
d. Discuss the importance of activity and mobility with the child and family.

E. Speech-Language Pathologist
   a. Evaluate the child’s ability to establish developmentally appropriate communication and feeding and swallowing function with caregivers.
   b. Collaborate with the child’s family and medical team to develop communication systems and feeding and swallowing function that are developmentally, culturally, and linguistically appropriate.
   c. Anticipate and respond to the child’s communication and feeding/swallowing needs as they arise during the hospitalization.

F. Child Life Specialist
   a. Participate in determining the child’s activity level according to guidelines noted in appendix A.
   b. As appropriate participate in the implementation of recommended interventions Appendix A.
   c. Communicate recommendations for ongoing interventions, such as developmental play, to the child’s team.
   d. Discuss the importance of activity and mobility with the child and family.

Procedure

A. Prior to initiation of mobilization activity the treating team will determine if there have been any changes in the child’s condition that would warrant a change in the activity level.

B. Patient monitoring:
   a. The child will be monitored throughout the activity.
   b. If any of the conditions occur the activity will be halted (appendix B).
      Depending on the child’s response activity can resume, be modified or stopped.
      The medical provider should be notified if the child is not able to continue activity.
      i. Change in HR, BP, RR by 20%
      ii. Decrease SaO2 by 15%
      iii. Increase oxygen requirement of 20%
      iv. Increase ETCO₂ by 20%
      v. Ventilator/PAP asynchrony
      vi. Respiratory distress
      vii. Hemodynamic concerns
      viii. Change in neurological status
      ix. Concern for airway device, vascular access or drain/tube integrity
      x. Behavior interfering with safe activity
c. While ambulating children must be monitored by telemetry and pulsoxmetry. Pulsoxmetry may be deferred with an order from the attending, fellow or nurse practitioner.
d. The child must wear shoes, non-skid slippers or non-skid socks when ambulating.
e. The nurse will be present during ambulation.
f. The nurse will notify her ‘buddy’ that she is with the patient and ambulating so that the ‘buddy’ can monitor for alarms.
g. The ‘buddy’ will notify the patient’s nurse of alarms.

Reportable Conditions

1. The nurse will report to the child’s prescriber loss of airway device, vascular access or external ventricular drains that occurs during the mobilization activity.
2. The nurse will report to the child’s prescriber changes in vital signs and clinical status that occur during the mobilization activity that requires halting of the activity.
3. Report patient adverse events associated with mobility in the event reporting system (Patient Safety Net).
5. Decline in the child’s level of mobility.

Documentation

1. Document the activity level in the summary of am rounds note.
2. Document the intervention and child’s response to intervention in the electronic medical record.

References


EVALUATION OF AN EARLY MOBILIZATION PROGRAM IN A


Sponsor: PICU UP Mobilization Committee, Pediatric Intensive Care Unit
Appendix D:

PICU Up! On Line Learning Module: Outline

Objectives: At the completion of the learning module the participant will be able to:

1. State the PICU UP! Early Rehabilitation and Progressive Mobilization program as a component of the ABCDE Bundle.
2. Discuss the negative consequences of immobility in the critically ill child.
3. State the goal of the PICU UP! program.
4. Define progressive mobilization.
5. Apply the screening process for the PICU UP! program to a case study.
6. Develop an activity program for the child based on the activity level.

Outline:

I. ABCDE Bundle
   A. Evidence based approach
   B. Improves patient outcomes
   C. Components
      1. Awakening and breathing trial coordination
      2. Delirium assessment and management
      3. Early mobilization

II. Negative Consequences of Immobility
   A. Physical
   B. Psychosocial

III. Goal of PICU UP! Program
   A. Increase safe age-appropriate activities to
      1. reduce the risk and incidence physical consequences of immobility
      2. reduce the risk and incidence of psychosocial consequences of immobility
      3. increase family involvement

IV. Progressive Mobilization
   A. Defined
   B. Screen
      1. Level 1
      2. Level 2
      3. Level 3
   C. Activity Progression
      1. Level 1
      2. Level 2
      3. Level 3
   D. Criteria to Pause, Rest and Reassess
E. Case Studies

Appendix E

Tri-fold Pocket Card

### PICU UP! LEVELS

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intubated with FiO2 &gt; 60% or PEEP &gt; 8 cmH2O</td>
<td>Intubated or trach’d with FiO2 ≥ 60% or PEEP ≥ 8 cmH2O</td>
<td>Non-invasive support with FiO2 &gt; 80% or PEEP ≥ 8 cmH2O</td>
</tr>
<tr>
<td>Newly transfused</td>
<td>Non-invasive support with FiO2 ≥ 60% or PEEP ≥ 8 cmH2O</td>
<td>Baseline pulmonary support ≥ 80%</td>
</tr>
<tr>
<td>Acute neurological event</td>
<td>Non-invasive support with FiO2 ≥ 60%</td>
<td>EVD cleared by NUS and SBS ≥ 1 to +3</td>
</tr>
<tr>
<td>Sedated and SBS 3 to ≤ 2</td>
<td>Renal Replacement Therapy/Dialysis</td>
<td>Femoral lines</td>
</tr>
<tr>
<td>Vasopressors (other than MIHr/min)</td>
<td>Non-invasive support with FiO2 &lt; 60% or PEEP ≥ 8 cmH2O</td>
<td>Exclusion Criteria</td>
</tr>
</tbody>
</table>

#### Level 1 Activities
- Lights on and shades up by 0700
- Bed/bath/weight by 2300
- Lights dimmed/out by 2300
  (increase lighting as needed for assessment and interventions)
- TV limited to 30 minutes at a time & goal ≤ 2 hours per day for children over 2 years
- Hob elevated ≥ 30°
- Turn q2h during the day & q4h at night
- Positioned in developmentally supportive position or as recommended by OT/PT
- OT consult by PICU day 3
- PT consult as needed

#### Level 2 Activities
- Positive touch for infants/toddlers
- Sitting up in bed tid
- Team to consider OOB to chair/ambulation
- OT/PT consult by PICU day 3
- Assess for difficulty with communication or phonation and consider a speech language pathologist consult
- Speech language pathologist for feeding and swallowing readiness in high risk children
- Assess need for daily schedule
- PCAM-ICU Delirium Assessment BID if SBS ≥ 1 to +3

#### Level 3 Activities
- Positive touch for infants/toddlers
- Sitting up/oob to chair tid if appropriate chair available
- Ambulate bid if trunk control present

---

### CRITERIA TO PAUSE ACTIVITY, REST AND REASSESS

- Change in HR ≥ 20%
- Change in BP ≥ 20%
- Change in RR ≥ 20%
- Decreased SO2 ≥ 15%
- Increase FiO2 ≥ 20%
- Increase ETCO2 ≥ 20%
- Ventilator asynchrony
- Respiratory distress
- New arrhythmia
- Hemodynamic concerns
- Change in mental status
- Concern for airway device, vascular access or EVD integrity
- Behavior interfering with safe activity

March 2015
Appendix F

IRB Approval

**Not Human Subjects Research (NHSR) Confirmed**

To: Beth Wieczorek  
Link: [HP-00064344](#)

An IRB Analyst has reviewed the information provided and has determined that the project meets the definition of *Not Human Subjects Research* (NHSR). IRB oversight is not required and no further actions are required.

**Description:**

*Submission Title:* Evaluation of an Early Mobilization Program in a Pediatric Intensive Care Unit

*POC:* Catherine Haut

Please contact the HRPO at 410-706-5037 or [HRPO@umaryland.edu](mailto:HRPO@umaryland.edu) if you have any questions.

<table>
<thead>
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<th><strong>eIRB:</strong> FYI - Do not reply</th>
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<td>Evaluation of an Early Mobilization Plan in a Pediatric Intensive Care Unit</td>
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<tr>
<td><strong>PI:</strong></td>
<td>Sapna Kudchadkar</td>
</tr>
<tr>
<td><strong>Link to Workspace:</strong></td>
<td>IRB00064972</td>
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</tbody>
</table>

The Application referenced above has been approved by the IRB. No action by the PI or study team member is required at this time.

Thank you,
Appendix G

PICU Up! Case Report Form

1. Demographic Data

<table>
<thead>
<tr>
<th>1.1</th>
<th>Age in months</th>
<th>1.2</th>
<th>Weight</th>
<th>1.3</th>
<th>Race</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gender</td>
<td></td>
<td>Male</td>
<td></td>
<td>Female</td>
</tr>
<tr>
<td>1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.5 PICU admit date (MM/DD/Year)

1.6 PICU discharge date (MM/DD/Year)

1.7 Discharge disposition from PICU

<table>
<thead>
<tr>
<th>General Care</th>
<th>Rehab</th>
<th>Home</th>
<th>Death</th>
</tr>
</thead>
</table>

1.8 Primary dx leading to PICU admission
(circle the single most appropriate dx)

- Respiratory failure
- Sepsis
- Shock
- Surgery (admitting service):
  - Neurosurgery
  - Orthopedics
  - GPS
  - Cardiac
  - GU
  - Plastic
  - ENT
  - Transplant
  - Other:
    - Cardiac
    - Neurological
    - Endocrine
    - Metabolic
    - Hematology
    - GI
    - Toxins/Overdose
    - Nephrology
    - Trauma with TBI
    - Trauma without TBI
    - Burn
    - Pulmonary
    - Other:

1.9 Pertinent chronic underlying conditions: present at the time of admission but not the primary reason for admission (circle)

- Motor impairment (note assistive devices used)
- Intellectual disability
- Tracheostomy with/without ventilator
2. **PELOD score**

<table>
<thead>
<tr>
<th>Organ system and variable</th>
<th>Points assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neurologic*</td>
<td></td>
</tr>
<tr>
<td>Glasgow coma score</td>
<td>12–15</td>
</tr>
<tr>
<td>Pupillary reaction</td>
<td>7–11</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>4–6</td>
</tr>
<tr>
<td>Heart rate, beats/min</td>
<td>3</td>
</tr>
<tr>
<td>&lt; 12 years</td>
<td>≤ 195</td>
</tr>
<tr>
<td>≥ 12 years</td>
<td>&gt; 195</td>
</tr>
<tr>
<td>Systolic blood pressure, mm Hg</td>
<td></td>
</tr>
<tr>
<td>&lt; 1 mo</td>
<td>≤ 65</td>
</tr>
<tr>
<td>≥ 1 mo–&lt; 1 yr</td>
<td>&gt; 65</td>
</tr>
<tr>
<td>≥ 1 yr–&lt; 12 yr</td>
<td>35–65</td>
</tr>
<tr>
<td>≥ 12 yr</td>
<td>&lt; 35</td>
</tr>
<tr>
<td>Renal</td>
<td></td>
</tr>
<tr>
<td>Creatinine, μmol/L (mg/dL)</td>
<td></td>
</tr>
<tr>
<td>&lt; 7 d</td>
<td>≤ 140 (&lt; 1.59)</td>
</tr>
<tr>
<td>≥ 7 d–&lt; 1 yr</td>
<td>&gt; 140 (≥ 1.59)</td>
</tr>
<tr>
<td>≥ 1 yr–&lt; 12 yr</td>
<td>≥ 55 (≥ 0.62)</td>
</tr>
<tr>
<td>≥ 12 yr</td>
<td>≥ 55 (≥ 0.62)</td>
</tr>
<tr>
<td>Respiratory</td>
<td></td>
</tr>
<tr>
<td>PaO₂:FiO₂ ratio, mm Hg</td>
<td></td>
</tr>
<tr>
<td>&lt; 70</td>
<td>≤ 70</td>
</tr>
<tr>
<td>≥ 70</td>
<td>≥ 70</td>
</tr>
<tr>
<td>PaCO₂, mm Hg (kPa)</td>
<td></td>
</tr>
<tr>
<td>&lt; 90 (&lt; 11.7)</td>
<td>≥ 90 (≥ 11.7)</td>
</tr>
<tr>
<td>Hematologic</td>
<td></td>
</tr>
<tr>
<td>Leukocyte count, × 10⁹/L</td>
<td></td>
</tr>
<tr>
<td>≥ 4.5</td>
<td>1.5–4.4</td>
</tr>
<tr>
<td>≥ 35</td>
<td>&lt; 1.5</td>
</tr>
<tr>
<td>Platelet count, × 10⁹/L</td>
<td></td>
</tr>
<tr>
<td>≥ 35</td>
<td>&lt; 35</td>
</tr>
<tr>
<td>Hepatic</td>
<td></td>
</tr>
<tr>
<td>Glutamic oxaloacetic transaminase, IU/L</td>
<td></td>
</tr>
<tr>
<td>&lt; 950</td>
<td>≥ 950</td>
</tr>
<tr>
<td>≥ 950</td>
<td>≥ 950</td>
</tr>
<tr>
<td>Prothrombin time, % of standard (international normalized ratio)</td>
<td></td>
</tr>
<tr>
<td>&gt; 60 (&lt; 1.40)</td>
<td>≤ 60 (≥ 1.40)</td>
</tr>
</tbody>
</table>

**Note:** FIO₂ = fraction of inspired oxygen, PaCO₂ = partial pressure of carbon dioxide in arterial blood, PaO₂ = partial pressure of oxygen in arterial blood.

*For the Glasgow coma score, use the lowest value. If the patient is sedated, record the estimated coma score before sedation. Assess the patient only with known or suspected acute central nervous system disease. For pupillary reactions, nonreactive pupils must be > 3 mm; do not assess after iatrogenic pupillary dilatation.

†The use of mask ventilation is not considered to be mechanical ventilation.
3. Rehabilitation Consultations

<table>
<thead>
<tr>
<th>Service</th>
<th>Order date</th>
<th>Date of Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational Therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Therapy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Morbidities acquired during PICU Admission

<table>
<thead>
<tr>
<th>Description (include site)</th>
<th>Date Noted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure area (≥ grade 2)</td>
<td></td>
</tr>
<tr>
<td>Pressure area (≥ grade 2)</td>
<td></td>
</tr>
<tr>
<td>Joint contracture</td>
<td></td>
</tr>
<tr>
<td>Joint contracture</td>
<td></td>
</tr>
<tr>
<td>Non-catheter related DVT</td>
<td></td>
</tr>
<tr>
<td>Non-catheter related DVT</td>
<td></td>
</tr>
<tr>
<td>Delirium</td>
<td></td>
</tr>
</tbody>
</table>
## 5. Activities

<table>
<thead>
<tr>
<th>Date</th>
<th>Intervention (note all)</th>
<th>Reason for aborting intervention</th>
<th>Barriers to activities</th>
<th>SBS @ 0800</th>
<th>pCAM-ICU @ 0800</th>
<th>PICU Up! Level</th>
<th>PICU Up! Level documented in daily goals note</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 = passive range of motion</td>
<td>1 = hemodynamic changes</td>
<td>1 = child refused</td>
<td>1 = NA</td>
<td>1 = level 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 = passive bed positioning</td>
<td>2 = respiratory changes</td>
<td>2 = parent refused</td>
<td>2 = negative</td>
<td>2 = level 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 = splinting</td>
<td>3 = neurological changes</td>
<td>3 = diagnostic study/test or procedure</td>
<td>3 = positive</td>
<td>3 = level 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 = active range of motion</td>
<td>4 = uncontrollable pain</td>
<td>4 = deferred because of patient condition (specify)</td>
<td>4 = meets exclusion criteria</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 = active bed positioning</td>
<td>5 = concern for device integrity</td>
<td>5 = lack of staff</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 = mobility device</td>
<td>6 = patient behavior</td>
<td>6 = lack of equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 = sitting at edge of bed</td>
<td>7 = other (specify)</td>
<td>7 = other (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 = sit to stand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9 = transfer bed to chair, mat, caregiver arms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 = pre-gait activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11 = ambulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 = therapeutic play/activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13 = other (specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Definition of Interventions

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In-Bed Therapies</strong></td>
<td></td>
</tr>
<tr>
<td>Passive range of motion</td>
<td>Exercises that optimize and promote joint and muscle flexibility; child doesn’t assist</td>
</tr>
<tr>
<td>Passive bed positioning</td>
<td>Techniques and strategies to optimize joint/postural alignment, promote development, optimize pulmonary status, and avoid contractures and skin breakdown, child doesn’t assist.</td>
</tr>
<tr>
<td>Splinting</td>
<td>Devices used to maintain range of motion</td>
</tr>
<tr>
<td>Active range of motion</td>
<td>Exercises that optimize and promote joint and muscle flexibility with the child’s participation.</td>
</tr>
<tr>
<td>Active bed positioning</td>
<td>Techniques and strategies to optimize joint/postural alignment, promote development, optimize pulmonary status, and avoid contractures and skin breakdown with the participation of the child – ie: active or active-assisted positioning, rolling, bridging.</td>
</tr>
<tr>
<td><strong>Mobility Therapies</strong></td>
<td></td>
</tr>
<tr>
<td>Ambulation</td>
<td>Gait training exercises with or without an assistive device.</td>
</tr>
<tr>
<td>Mobility device</td>
<td>Activities performed with a device that facilitates movement of the limbs – ie: bike</td>
</tr>
<tr>
<td>Pre-gait activities</td>
<td>Patient exercises that occur prior to ambulation – ie: weight shifting, stepping in place.</td>
</tr>
<tr>
<td>Sit edge of bed</td>
<td>Movement from lying position to upright with legs dangling over bed, may be assisted to this position</td>
</tr>
<tr>
<td>Sit to stand</td>
<td>Position change from sitting to standing, may be assisted to this position</td>
</tr>
<tr>
<td>Therapeutic play/activities</td>
<td>Developmentally appropriate activities are defined as activities and sensory stimulation that are designed to promote achievement of developmental milestones, normalize the hospital environment, facilitate family attachment and patient coping.</td>
</tr>
<tr>
<td>Transfers</td>
<td>Active movement from one surface to another; level of nurse/therapist assistance may vary – ie: bed to chair, mat, caregivers arms.</td>
</tr>
</tbody>
</table>
## Summary Table: Pediatric Specific

<table>
<thead>
<tr>
<th>#/ Author Date</th>
<th>Purpose</th>
<th>Sample</th>
<th>Results Recommendations</th>
<th>Limitations</th>
<th>Strength/Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Abdulsatar, Walker, Timmons, &amp; Choong, 2013</td>
<td>Pilot trial to evaluate the safety and feasibility of a virtual reality exercise – Nintendo Wii™ Boxing at least 2 times a day for a maximum of 2 days.</td>
<td>Tertiary Canadian PICU. N= 8. Anticipated PICU admission ≥ 48 hours; 3-8 years of age Normal to moderate cognitive and functional disability.</td>
<td>Safety: no adverse events. 50% of the children were able to participate while intubated. Feasibility: enrollment rate slower than anticipated due to provider comfort with intervention in critically ill children and the limited number of children who met inclusion criteria. Secondary outcomes: Upper body activity – increased during intervention ( p= 0.049 ); No change in grip strength</td>
<td>Pilot study. Single center study – limits generalizability. Limited sample and patient population – limits generalizability. Descriptive nature – no controls.</td>
<td>III/Low</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Setting</td>
<td>Participants</td>
<td>Results</td>
<td>Study Design</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>---------</td>
<td>--------------</td>
<td>---------</td>
<td>--------------</td>
</tr>
<tr>
<td>#2 Choong, Tran, Clark, Cupido, &amp; Corsi, 2012</td>
<td>To evaluate acute rehabilitation practices and potential barriers to mobilization.</td>
<td>Tertiary PICU in Canada. N = 91. Children &lt;18 years with PICU LOS &gt;24 hours. Mean age 6.4 ± 6.4 years.</td>
<td>39.6% children received some form of therapy. 17.6% received non-mobility therapy only – passive repositioning and/or chest physiotherapy. 22% received some form of mobility therapy. 6.6% received both non-mobility and mobility therapy. Increased severity of illness, mechanical ventilation, baseline disability, and young age were identified barriers. PT was often delayed until the child was considered “stable”. Mobility therapy was considered for less sick, older and non-mechanically ventilated children.</td>
<td>Single center descriptive study.</td>
<td>Retrospective data collection is limited by the quality of documentation. Sample size.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#3</td>
<td>Choong et al. 2013</td>
<td>To evaluate the knowledge, perceptions, and practices regarding early mobilization in critically ill children among physicians and PTs.</td>
<td>Canadian providers practicing in PICUs. N = 102 physicians and 35 PTs; response rate 64.2% representing 59.8% invited physicians and 77.1% invited PTs.</td>
<td>Knowledge and skills: 66.7% reported having adequate knowledge and skills to provide early mobility in the PICU. 76.1% perceived early mobility as important or very important in the child’s care. Institutional barriers: no practice guidelines, lack of champion or clinical advocate for practice; PTs reported lack of physician order as a barrier. Patient barrier: medical stability, risk of device dislodgement, presence of endotracheal tube. Provider barrier: safety concerns, conflicting views regarding stability, slow to recognize when child was ready to start therapy, limited staffing, communication. Timing to start early mobility: when cardiorespiratory status stable – definition of stable varied. Chest physiotherapy and passive range of motion were the most frequent intervention;</td>
<td>Response bias. Purposive sampling method. Sample size.</td>
</tr>
<tr>
<td>#4 Choong et al., 2014</td>
<td>To evaluate the nature and timing of pediatric critical care unit rehabilitation practices.</td>
<td>Six Canadian, tertiary care PICUs. N = 600 children &lt;17 years of age admitted to a PICU with a LOS &gt;24 hours.</td>
<td>Practice patterns: Therapy consult requested on 37% of patients (222/600). PT most frequently requested therapy – 29%. Non-mobility therapy 19.2% (115/600). Mobility therapy 26.3% (158/600). Combination 17.2% (103/600). Early mobilization (any mobility therapy within 48 hours of admission) 9.5% (57/600). Time to consult varied on therapy: PT – 1 day (IQR 0-3); OT – 2 days (IQR 0-6); Speech/Language – 6 days (IQR 1-15). Two of six sites had written</td>
<td>Retrospective data collection is limited by the quality of documentation. Selection bias. History threat.</td>
<td>III/Good</td>
</tr>
</tbody>
</table>
Variation among sites in respect to frequent of any PT ($p<0.0001$) and mobility therapy ($p<0.0001$). The rate of PT was not significantly greater in the two centers with guidelines.

Independent predictors of mobilization: increasing age, winter admission, neuromuscular blockade and sedative infusions. Increasing age predictive of early mobilization ($p<0.0001$) and neuromuscular blockade associated with delays ($p=0.0006$). Mechanical ventilation and sedative infusions not significantly associated with delays to mobility therapy.

Patient Outcomes:
Overall mortality 4.7% - no significance difference among mobilized versus not mobilized.

There were no statistical differences in adverse events during mobility compared to
### Table: Evaluation of an Early Mobilization Program in a Pediatric Setting

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Setting</th>
<th>Participants</th>
<th>Results</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hollander et al., 2014</td>
<td>To determine the safety and feasibility of acute rehabilitation for children using a standardized, age-appropriate, family-centered pathway after paracorporeal ventricular assist</td>
<td>Pediatric Cardiac Intensive Care Unit. Age range 0.5 to 14.4 years</td>
<td>N= 14. Children requiring paracorporeal assist devices; seven required biventricular devices. n= 8 children participated in an infant standardized therapy pathway; &lt;1 year of age.</td>
<td>Eleven of twelve children achieved all of the goals of the age appropriate standardized pathway goals – 6/6 children achieved all goals and 5/6 infants achieved all goals (2 of the 8 children died). No adverse events were reported related to interventions. Median time to extubation 2</td>
<td>Single institution study – limits generalizability. Limited patient population – limits generalizability. Retrospective data collection is limited by the quality of documentation.</td>
</tr>
<tr>
<td>Study</td>
<td>Objective</td>
<td>Design</td>
<td>Sample</td>
<td>Outcomes</td>
<td>Limitations</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
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<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>#6 Jacobs et al. 2001</td>
<td>To evaluate the safety and efficacy of a postoperative approach that limits pharmacologic and physical restraints and sedation and permits liberal activity.</td>
<td>Tertiary PICU. N = 133 children – postoperative single-stage laryngotracheal reconstruction. 2-336 months of age (mean 66 ± 5). Assigned to one of two groups based on past medical history, parent.</td>
<td>PICU LOS &lt; group 1: 11.2 ± 0.5 days versus 13.7 ± 0.6 days; p= 0.007. Hospital LOS &lt; group 1: 16.7 ± 1 day versus 21.1 ± 1.1 day; p=0.01. Fewer adverse events group 1: Atelectasis p&lt;0.001; Post-extubation stridor p&lt;0.001;</td>
<td>A dated article but the first article in the pediatric literature that discusses liberalization of activity for the critically ill child and outcomes. Single center study – limits generalizability.</td>
<td>II/ Low</td>
</tr>
</tbody>
</table>

Retrospective. Consecutive sampling. Descriptive. | n= 6 children participated in the child pathway; ≥1 year of age. | days (range 1-8) – time to extubation similar to children at that institution who were transplanted without ventricular assist devices. | Age appropriate, family centered, structured rehabilitation program is safe and feasible in children with ventricular assist devices waiting transplantation. Multidisciplinary approach facilitates program. Importance of therapist teaching parents and other staff members interventions for carry-over of activities. | Therapists not blinded to interventions – measurement bias. Subjective nature of determining pathway achievements. Mortality threat. Descriptive nature – no controls. | |
| Retrospective. Consecutive sampling. Quasi-experimental. | nursing and physician judgment of the child’s ability to cooperate: Group 1: liberal therapy (tracheal intubation, no sedation and restraints) n= 54; 113 ± 8 months or/ Group 2: standard activity (tracheal intubation, restraints and sedative medications) n= 79; 33 ± 3 months. | Withdrawal syndrome $p<0.001$ | Limited patient population and sample size – limits generalizability. Selection bias. Non-equivalent groups making it difficult to separate the contribution of sedation and activity from age and size. |

Importance of assessment of the child’s developmental level. Inclusion of provider and parent assessment is important.

<table>
<thead>
<tr>
<th>#/Author Date</th>
<th>Purpose</th>
<th>Sample and Sample Size</th>
<th>Results</th>
<th>Limitations</th>
<th>Strength/Quality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Balas et al., 2013</td>
<td>Using a structured implementation framework, CFIR, (1) identify facilitators and barriers to the adoption of the ABCDE bundle and (2) identify which bundle implementation was effective, sustainable and conducive to dissemination.</td>
<td>Interprofessional providers in 5 adult ICUs, 1 stepdown unit and 1 special care unit in an academic hospital. N= 328 Over 18 month period, all ICU providers were invited to participate in multimodal educational opportunities – on-line module, grand rounds, 8 hour nursing education day, inservices, policy statement. Three focus group sessions, on line surveys administered at three intervals to assess knowledge and impediments, and one educational evaluation were administered to identify facilitators and barriers to bundle adoption.</td>
<td>100% completed the online education module and evaluation: participants reported the ABCDE bundle was relevant, beneficial and of high quality – 92% indicated they would make a change in their clinical practice after viewing the module. 11% attended focus group sessions: stakeholders perception of the value of the bundle changed substantially postimplementation. 30% completed the knowledge and impediments survey: at 4 months 29% agreed or strongly agreed with statement “the ABCDE bundle improves patient outcomes” and 50% agreed at 8 months after adoption. Facilitators to bundle adoption: (1) daily, interdisciplinary rounds, engagement of leadership, sustained and</td>
<td>Single institution – limits generalizability. Low participation in focus groups session and survey. Selection bias.</td>
<td>III/good</td>
</tr>
</tbody>
</table>
diverse educational strategies, bundle’s quality and strength.

Barriers to adoption: intervention related issues (ie: fear of adverse events), communication and coordination challenges, knowledge deficit, workload concerns, and documentation barrier.

Staff recommendations: continue educational efforts, simplify the process (make policy shorter, merge documentation), add to daily rounds sheet, create mobilization teams, unit champion.

Prospective. Convenience sampling. Mixed-methods

Implementation requires clear, consistent and timely communication across providers.

Multidisciplinary rounds may improve interprofessional communication and compliance.

Importance of engaging leadership in development.
| #2 Engel, Tatbe, Alonzo, Mustille, & Rivera, 2013. | To reduce the patient’s ICU length of stay by increasing the number of ICU patients receiving PT and to decrease the time from ICU admission to PT initiation by establishing an inter-professional ICU early mobilization group to establish and implement guidelines for mobilizing critically ill adults. | 16 bed combined medical and surgical ICU at an academic medical center.  
N = 473 critically ill adults who met criteria (both intubated receiving mechanical ventilation and not intubated breathing spontaneously; medical and surgical population)  
n= 179 pre-implementation group  
n= 294 implementation group | Baseline characteristics similar between groups.  
60% increase in number of patients receiving therapy after implementation.  
Decrease in number of days to PT from median of 3 pre-implementation to 1 (p = 0.001).  
Functional improvements in distance walked with program implementation (p = 0.002).  
Shorter ICU LOS implementation phase (p = 0.011).  
% patients discharged to home implementation phase (p = 0.001). | Single center study - limits generalizability.  
Measurement bias – outcomes not evaluated in a blinded manner.  
Retrospective analysis from 6 data collectors.  
Unable to control for confounding variables that may have influence LOS – history threat | II/Good |
<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
<th>Findings</th>
<th>Methodology</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3 Hodgson et al., 2014</td>
<td>To develop consensus recommendations on safety parameters prior to mobilizing adult, mechanically ventilated,</td>
<td>Consensus was achieved on all criteria for mobilization except for levels of vasoactive medications – group able to agree that vasoactive medications were not a contraindication to mobilization.</td>
<td>Retrospective Convenience sampling. Quasi-experimental QI project</td>
<td>IV/High</td>
</tr>
</tbody>
</table>

No medically detrimental events resulting from early mobility. No change in adverse event reporting with addition of early mobility.

Establishment of interprofessional early mobility group.

Importance of interdisciplinary education.

Contextual assessment of barriers and facilitators with strategies to minimize barriers and maximize facilitators.

Establish guidelines for mobilization versus strict protocol to increase patients able to participate.

Rounds to determine patient eligibility.

Sample size and criteria used to mobilize patients varied between studies.

Recommendations primarily based on experts.
<table>
<thead>
<tr>
<th>Intensive Care Patients</th>
<th>Endotracheal intubation was not a contraindication to early mobilization.</th>
<th>Interpretation of literature and clinical practice.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FiO₂ ≤ 60% with SaO₂ ≥ 90% and respiratory rate ≤ 30 breaths/minute were considered safe criteria for both in/out of bed mobilization activities if there were no other contraindications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extreme agitation or combative behaviors identified as contraindication for both in/out of bed mobility activities.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active management of intracranial hypertension contraindicated for in/out of bed mobilization.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spinal precautions, uncontrolled seizures, uncontrolled bleeding contraindication for in/out of bed mobilization.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open chest, open abdomen, unstable fractures, VA ECMO contraindication for out of bed mobilization.</td>
<td></td>
</tr>
</tbody>
</table>
## Systematic Literature Review and Meeting of Experts

A systematic literature review was followed by a meeting of 23 multidisciplinary ICU experts involved in early mobilization research to achieve consensus. At an international meeting, 94 multidisciplinary ICU clinicians concurred with recommendations.

Future research is needed to validate each of the safety considerations discussed. The context of the unit needs to be considered in relation to implementing these guidelines. Safety criteria for mobilizing patients in ICU is recommended using a system of rating activity as low risk, moderate or high risk to standard process.

### Study Design and Population

<table>
<thead>
<tr>
<th>Study Design</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>#4 Morris et al., 2008</td>
<td>To assess the frequency of PT, site of therapy initiation, and patient outcomes comparing respiratory failure patients who received usual care to those who received PT from a Mobility Team (critical care)</td>
</tr>
<tr>
<td></td>
<td>Medical intensive care service in several ICUs in a university hospital. N = 330 critically ill adults requiring intubation who met criteria</td>
</tr>
<tr>
<td></td>
<td>n = 165 usual care n = 165 Mobility Team intervention</td>
</tr>
<tr>
<td></td>
<td>Baseline characteristics similar between groups. Team patients received at least one PT session than did usual care (p = 0.001). Team patients were out of bed earlier (p = 0.001). Team patients had therapy initiate more frequently in the ICU (p = 0.001).</td>
</tr>
</tbody>
</table>

**II/Good**
<table>
<thead>
<tr>
<th>nurse, nursing assistant, PT) using a mobility protocol.</th>
<th>Team patient ICU LOS shorter than usual care ($p = 0.025$) and hospital LOS shorter as well ($p = 0.006$).</th>
<th>No adverse events with Team. No cost difference between the two groups – including the Mobility Team cost.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prospective Convenience sampling. Quasi – experimental QI approach</td>
<td>Dedicated mobility teams may improve outcomes. A mobility protocol with levels can direct interventions. Important to develop criteria to limit or withhold interventions.</td>
<td></td>
</tr>
<tr>
<td>#5 Munkwitz, Hopkins, Miller, &amp; Luckett, 2010</td>
<td>To summarize the evidence for early mobilization programs in critically ill children and adults with respiratory failure. No studies of early mobilization in children were found. Five adult studies were identified for review: two RCT and three observational studies.</td>
<td>Early mobilization in critically ill adults is safe, feasible and well tolerated. Functional outcomes: early mobilization was associated with enhanced exercise capacity, improved muscle strength, increased self-perceived functional status as well as increased number of ventilator free days, and decreased duration of ICU delirium. Heterogenous study design, sample size, interventions, and outcome measures. Possible author bias in article selection.</td>
</tr>
</tbody>
</table>
Components of a successful early mobilization program include a change in culture that supports modification of sedation regimens.

<table>
<thead>
<tr>
<th>Study</th>
<th>Objective</th>
<th>Setting</th>
<th>Participants</th>
<th>Findings</th>
<th>Study Design</th>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>#6 Needham et al., 2010</td>
<td>To reduce deep sedation and delirium to allow for mobilization of critically ill patients, to increase therapy consultations and treatments to improve functional mobility and to evaluate the impact of interventions on LOS.</td>
<td>Tertiary MICU.</td>
<td>N=57 patients mechanically ventilated for ≥4 days. Pre-intervention n = 27. Intervention n = 30.</td>
<td>Patients in the intervention group had fewer days receiving benzodiazepines (p = 0.002); improved sedation and delirium status – days alert (p=0.001); days not delirious (p=0.003). Patients in intervention group received more therapy treatments (p&lt;0.001) with a higher level of functional mobility (p=0.03).</td>
<td>Single center study.</td>
<td>Small sample size. Limited patient population. Measurement bias – outcomes not evaluated in a blinded manner. History threat.</td>
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<tr>
<td>Prospective. Convenience sample. Quasi-experimental. QI project</td>
<td>Importance of contextual assessment. Enlisting all stakeholders to identify problems and solutions.</td>
<td>I/Good</td>
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To evaluate the efficacy of combining daily interruption of sedation with OT and PT on the functional outcomes in mechanically ventilated critically ill adults.

Two tertiary hospital settings.

Sedated adults, ≥ 18 years, mechanically ventilated for < 72 hours, expected to be ventilated for at least 24 additional hours, baseline functionally independent were computer generated block randomized to one of two groups. N = 104.

Intervention group – early exercise and mobilization during periods of daily sedation interruption. n = 49.

Control group – daily sedation interruption with therapy as ordered by primary treating team.

More patients in the intervention group returned to functional independence at discharge than in the control group (p = 0.02).

Patients in the intervention group had a short duration of delirium (p = 0.02).

Patients in intervention group had more ventilator free days at 28 day follow up than did control group (p = 0.05).

One serious adverse event in 498 therapy sessions was reported – SaO₂ <80%.

Therapy discontinued in 4% of all sessions – most often for ventilator asynchrony.

Mortality threat.

Limited patient population.

I/High
EVALUATION OF AN EARLY MOBILIZATION PROGRAM IN A

| Prospective. RCT. | n = 55. | Coordinated effort of a multidisciplinary team that focuses on whole-person rehabilitation can be associated with better outcomes. |