The Integral Role of the Physical Therapist in the Pediatric Intensive Care Unit
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Disclosure
• I have no actual or potential conflict of interest in relation to this presentation, and no financial interest to disclose.

Objectives
• Identify those children who are most likely to be admitted to an oncology-based pediatric intensive care unit (PICU).
• Discuss the short-term and long-term implications of admission to the PICU.
• Describe the current rehabilitation literature related to the adult intensive care unit (ICU) and discuss how this information can be extrapolated to the PICU.
• Explain the current PICU early mobility program at Memorial Sloan Kettering Cancer Center.

PICU ADMISSIONS

PICU Admissions
• Cardiovascular
• Respiratory
• Neurological
• Surgical
• Other Medical
  – Oncology

Most Common Reasons for Admission in PICU Literature²–⁵
• Post-operative care
• Neurological failure
• Severe sepsis
• Metabolic disturbances
  – Tumor lysis syndrome
• Organ failure
• Mediastinal syndrome
• Respiratory failure

Most Common Reasons for Admission to MSKCC PICU
• Post-operative care
  – Thoraco-abdominal resection (TAR)
  – Neurosurgery
• Unstable neurologic status, and/or patients who require continuous EEG monitoring
• Unstable septic shock
• Tumor lysis syndrome
• Patients requiring mechanical ventilation

Oncology-Related Admissions
Neuroblastoma6–9

- Third most common pediatric cancer
  - Most common solid extracranial tumor
- Tumor of the sympathetic nervous system
- Stems from neural crest cells
- Characterized by overproduction of catecholamines and their metabolites
- Treatment with high-dose chemotherapy and gross total resection of tumor

Thoraco-abdominal Resection (TAR)6

<table>
<thead>
<tr>
<th>Complication</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Nephrectomy</td>
<td>3.5%</td>
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<tr>
<td>Excessive hemorrhage intraoperatively</td>
<td>2%</td>
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<tr>
<td>More than 7 days of mechanical ventilation</td>
<td>1%</td>
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<tr>
<td>Development of pelvic and sub-phrenic abscesses</td>
<td>&lt;1%</td>
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<td>Intraoperative or postoperative deaths</td>
<td>0%</td>
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<td>Total patients with at least one complication</td>
<td>8%</td>
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Thoraco-abdominal Resection (TAR)10

<table>
<thead>
<tr>
<th>Complication</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Normal organs removed with tumor</td>
<td>12%</td>
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<tr>
<td>Major hemorrhage intraoperatively</td>
<td>7%</td>
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<tr>
<td>Renal injury</td>
<td>8%</td>
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<tr>
<td>Bowel obstruction</td>
<td>1%</td>
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<td>Pulmonary complications</td>
<td>2%</td>
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<tr>
<td>Wound complications</td>
<td>1%</td>
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<tr>
<td>Other complications</td>
<td>5%</td>
</tr>
<tr>
<td>Total patients with at least one complication</td>
<td>33%</td>
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</table>


Cancers of the Central Nervous System11

- Gliomas
- Primitive neuroectodermal tumors (PNETs)
- Craniopharyngiomas
- Mixed glial and neuronal tumors
- Choroid plexus tumors
- Schwannomas
- Metastatic cancers

Neurosurgical Procedures

- Ommaya reservoir placement
- Ventriculoperitoneal shunt (VP shunt)
- Craniotomy
- Craniectomy

Neurologic Complications12-14

- Headache
- Neck or back pain
- Altered mental status
- Seizures
  - Leukoencephalopathy
  - Posterior reversible encephalopathy syndrome (PRES)
Indications for Continuous EEG Monitoring

- Status epilepticus
- Acute encephalopathy
- Acute brain injury (traumatic or atraumatic)
- Post-cardiac surgery
- Post-neurosurgery
- Intracranial pressure management
- Characterization of clinical events suspected to be seizures

Sepsis

- Systemic inflammatory response syndrome (SIRS)
  - Hypothermia or hyperthermia
  - Tachycardia or bradycardia
  - Tachypnea or mechanical ventilation
  - Elevated or depressed leukocyte count
- Sepsis is defined as the presence of SIRS in the presence of suspected or proven infection

Sepsis

- Along with respiratory failure, one of the most common non-surgical indications for admission to PICU
- Prognosis similar to that of children without cancer
  - Prognosis worse in children following hematopoietic stem cell transplant (HSCT)

Tumor Lysis Syndrome

- Caused by rapid breakdown of tumor cells, leading to metabolic derangement
  - Hyperkalemia
  - Hyperphosphatemia
  - Hyperuricemia
  - Hypocalcemia
  - Azotemia
- Can lead to acute renal failure, cardiac arrhythmias, or seizures

Tumor Lysis Syndrome

- Typically occurs within 12-72 hours following initiation of chemotherapy
- Usually asymptomatic to begin
- Associated with malignancy characterized by
  - High cell turnover rates
  - Large tumor burdens
  - High sensitivity to treatment

Organ Failure

- Cardiovascular
- Respiratory
- Neurologic
- Hematologic
- Renal
- Gastrointestinal
- Hepatic
Veno-Occlusive Disease (VOD)\textsuperscript{19,20}
- Hepatic complication following HSCT
- Third leading cause of death in pediatric HSCT patients in the immediate post-transplant period
- Characterized by
  - Bilirubin levels ≥ 2mg/dL (34µmol/L) or jaundice
  - Hepatomegaly or right upper quadrant pain
  - Sudden weight gain of >5% above baseline related to either fluid accumulation or ascites

Mediastinal Syndrome\textsuperscript{21}
- Superior vena cava syndrome (SVCS) defined as the signs/symptoms caused by obstruction of superior vena cava
- Mediastinal syndrome defined as SVCS with obstruction of the trachea
- Has both malignant and non-malignant causes
  - Treated with steroids and chemotherapy in malignant cases

Respiratory Admissions\textsuperscript{1}
- Progressive pulmonary disease of high severity with progression to respiratory failure
- High supplemental oxygen requirement of more than 50%
- Newly placed tracheostomy
- Endotracheal intubation
- Need for mechanical ventilation

Mechanical Ventilation in the PICU\textsuperscript{2,22,23}
- Indications
  - Severe respiratory failure
  - Septic or hypovolemic shock
  - Glasgow coma scale score <9 OR score ≤12 with concurrent abnormal respiratory function
- Use of mechanical ventilation in 9.8% of admissions (Ali, 2016)
- Use of mechanical ventilation has poor prognosis (mortality rates 25-65% in children with cancer)

Significance of PICU Admissions
- Delirium
- ICU-acquired weakness
- Poorer long term functional outcomes
- Post-intensive care syndrome (PICS)
- Greater psychological morbidity
- Diminished quality of life

PROLONGED CONSEQUENCES OF PICU ADMISSIONS
Delirium\textsuperscript{24,25}

- Acute onset with fluctuating course
- Disturbance of consciousness
  - Attention and awareness
- Change in cognition
  - Memory, orientation, language, perception
- Must be the result of a medical condition

Delirium\textsuperscript{9,24-27}

- Prevalence not well defined
  - In 5 studies reviewed, delirium prevalence of \textbf{13-28\%} in PICU (Daoud, 2014)
  - Prevalence of delirium is between \textbf{4.5-28\%} (Herrera, 2014)
  - Estimated incidence of pediatric delirium can be found in up to \textbf{29\%} of patients (Combs, 2014)
  - In pilot study, \textbf{29\%} prevalence rate (Silver, 2012)

Delirium\textsuperscript{9,24-27}

- Risk factors for developing delirium
  - High severity of illness upon admission to PICU
  - Use of opiates and/or sedatives
  - Administration of benzodiazepines
  - Developmental delay
  - Children aged 2-5 years old
  - Children on mechanical ventilation
  - Underlying malignancy

Delirium\textsuperscript{25,28}

- Gold standard to diagnose in pediatrics is assessment by child psychiatrist
- Screening tools
  - Delirium Rating Scale (DRS)
  - Pediatric Confusion Assessment Method for ICU (p-CAM-ICU)
  - Pediatric Anesthesia Emergence Delirium scale (PAED)
  - Cornell Assessment of Pediatric Delirium (CAPD)

Delirium\textsuperscript{25-27, 29-30}

- Consequences of delirium during PICU stay
  - Prolonged hospital stay
  - Increased length of mechanical ventilation
  - Increased mortality
  - Lasting perceptual-motor problems and long-term cognitive effects
  - Behavioral issues
  - Post-traumatic stress syndrome

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**ICU-Acquired Weakness**

- Defined as “clinically detectable weakness in ICU patients with no possible etiology other than critical illness” (Hashem, 2016)
- Typically occurs within the first 2-5 days after admission to PICU
  - Can occur within the first 48 hours

- Well recognized in adults
  - Up to 50% of adult patients in ICU develop varying severity of muscle weakness
- Under-recognized in children
  - In one study, suspected in 30% of children in PICU, confirmed in 6% (Choong, 2015)
  - Prevalence ICU-acquired weakness in children may be lower due to lack of appropriate tool to confirm diagnosis

**ICU-Acquired Weakness**

- Risk factors for developing ICU-acquired weakness
  - Admission to PICU based on respiratory issues or related to infectious disease
  - Need for mechanical ventilation
  - Need for additional invasive therapies, such as extra-corporeal life support (ECLS)
  - Older age

- Consequences of ICU-acquired weakness
  - Respiratory muscle weakness and greater likelihood of requiring tracheostomy
  - Prolonged weaning from mechanical ventilation
  - Longer PICU length of stay
  - Longer hospital length of stay
  - Higher level of care upon discharge from PICU
  - Increased morbidity

**Significance of PICU Admissions**

- Delirium
- ICU-acquired weakness
- **Poorer long term functional outcomes**
- Post-intensive care syndrome (PICS)
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**Long Term Functional Outcomes**

- Evidence in pediatrics is limited
- Review of 27 studies found at least one aspect of long term sequelae in PICU survivors (Knoester, 2007)
- Long term functional outcomes less clear than in adults and have not been studied prospectively to date (Cameron, 2015)
- PICU mortality is decreasing while morbidity increases
Long Term Functional Outcomes\(^{36-38}\)
- More than 67\% of children who stay in PICU for extended period of time (>28 days) had unfavorable outcome (Namachivayam, 2012)
- Three months following admission to PICU, 69\% had abnormal functional scores (Knoester, 2007)
- 24 months after discharge from PICU, 19\% of children had persistent functional impairments (Polic, 2013)

Significance of PICU Admissions
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Post-Intensive Care Syndrome (PICS)\(^{39}\)
- Defined as a collection of complications that exist beyond ICU admission
  - Muscle weakness or muscle wasting
  - Impaired ability to perform activities of daily living
  - Reduced functional capacity
  - Depression and anxiety
  - Post-traumatic stress disorder

Post-Intensive Care Syndrome (PICS)\(^{40}\)
- Can also affect family members of children admitted to PICU (PICS-F)
  - Acute stress disorder (33\%)
  - Post-traumatic stress disorder (up to 56\%)
  - Generalized or non-specific anxiety (up to 56\%)
  - Depression (up to 42\%)
  - Emotional distress
  - Complicated grief

Significance of PICU Admissions
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Psychological Considerations\(^{41-42}\)
- Children’s perceptions and recall of PICU experience
  - Some studies suggest amnesia regarding PICU stay
  - Children who can recall experience find it “anxiety-provoking” (Rennick, 2009)
  - Delusional memories during PICU stay reported by at least 1 in 3 children
Psychological Considerations

- Psychological outcomes following PICU discharge
  - Negative behavioral changes
  - Elevated anxiety levels
  - Increased fear
  - Less sense of control

Psychological Considerations

- PICU hospitalization and post-traumatic stress disorder may be associated with
  - Higher parental distress
  - Longer length of PICU stay
  - Recalling delusional memories
  - Emergent admission to PICU

Significance of PICU Admissions

- Delirium
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Quality of Life

- Health-related quality of life (HRQL) in children can be affected by
  - Ability to participate with peers
  - Ability to participate in developmentally appropriate activities
- Variety of ways to assess HRQL in children

Quality of Life

- Risk factors for impaired quality of life
  - Increasing severity of illness
  - Pre-existing chronic or complex conditions
  - Younger children
  - More invasive medical procedures during PICU stay

Quality of life

- Impairments in HRQL
  - Between 16-28% of children experience decline in emotional stability and well-being upon discharge from PICU
  - Lower self-esteem
  - Lower self-confidence
  - Medical fears
  - On-going post-traumatic stress responses
EVIDENCE FOR EARLY MOBILIZATION IN THE ADULT ICU

Early Mobilization

Within 2-5 days of critical illness or injury

“Physical activity sufficient to elicit acute physiological effects that enhance ventilation, central and peripheral perfusion, circulation, muscle metabolism and alertness and are countermeasures for venous stasis and deep vein thrombosis” (Cameron, 2015)

Key Points

• Deep sedation generally not necessary for patient comfort or tolerance of mechanical ventilation
• With change in sedation protocol and awakening trials, patients can have
  – Lower rates of ICU delirium
  – Increase in functional mobility
  – Decrease in length of hospital stay
• Patients who receive early rehabilitation spent more days without mechanical ventilation

Key Points

• Early rehabilitation is safe and well tolerated
  – Relatively minor events occurred, with most common adverse event cited as oxygen desaturation
  – Adverse events occurring in:
    • <4% of mobility sessions (Adler, 2012)
    • <1% of mobility sessions (Hopkins, 2007)
    • <1.1% of mobility sessions (Leditschke, 2012)
    • 0-3% of mobility sessions (Cameron, 2015)

Key Points

• Early rehabilitation can improve functional outcomes
  – Improved respiratory muscle strength
  – Mobility milestones achieved earlier
  – Patients ambulated more frequently
  – FIM scores improved at discharge from hospital
  – Physical functioning scores on SF-36 improved at discharge from hospital

EVIDENCE FOR EARLY MOBILIZATION IN THE PICU
<table>
<thead>
<tr>
<th>Choong, et al. 2014(^{48})</th>
<th>Wieczorek, et al. 2015(^{49})</th>
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<tbody>
<tr>
<td>Approximately 50% of children received some form of rehabilitation during hospital stay</td>
<td>Safety and feasibility of early mobility protocol</td>
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<tr>
<td>26% were mobilized</td>
<td></td>
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<tr>
<td>– Often preceded by a non-mobility intervention</td>
<td></td>
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<tr>
<td>9.5% of children received <strong>early mobilization</strong></td>
<td></td>
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<tr>
<td>Mobilization found to occur more often in older children</td>
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<th>Wieczorek, et al. 2015(^{49})</th>
<th>Parisien, et al. 2016(^{50})</th>
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</thead>
<tbody>
<tr>
<td>Functional outcomes</td>
<td>Early mobility defined as mobilization off of the bed surface while intubated</td>
</tr>
<tr>
<td></td>
<td>– Children with pectus excavatum surgery mobilized within 30 minutes of surgery demonstrated improved functional outcomes and ability to perform ADLs</td>
</tr>
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<td></td>
<td>– Use of Wii Boxing increased frequency of upper body activity daily</td>
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<thead>
<tr>
<th>Wieczorek, et al. 2016(^{51})</th>
<th>MSKCC Early Mobilization Definition</th>
</tr>
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<tbody>
<tr>
<td>Early mobility defined as active or passive activity within 3 days of PICU admission</td>
<td>Patients in PICU without mechanical ventilation are not considered to be early mobility candidates</td>
</tr>
<tr>
<td>No adverse events reported</td>
<td></td>
</tr>
<tr>
<td>– Safe and feasible in pediatric population</td>
<td>Early mobility is defined as mobilization of patients on mechanical ventilation once hemodynamically stable, usually within 24-48 hours of admission to PICU</td>
</tr>
<tr>
<td>Outcomes</td>
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IMPLEMENTING AN EARLY MOBILITY PROTOCOL: FROM RESEARCH TO ACTION

Eakin, et al. 2015\textsuperscript{52}

- Successful implementation in adult ICU
  - Buy-in from staff
  - Multidisciplinary, team-centered approach
  - Individual discipline champions
  - Staff education
  - Dedicated rehabilitation personnel

Wieczorek, et al. 2015\textsuperscript{49}

- Successful implementation in adult ICU
  - Defining current unit culture
  - Availability of necessary resources
  - Provider knowledge and competence
  - Early identification of potential barriers

Barriers to Early Mobility\textsuperscript{53}

- Physical barriers
  - Inappropriate referrals
  - Hemodynamic instability
  - Respiratory distress
  - Pain

Barriers to Early Mobility\textsuperscript{53-54}

- Neuropsychological and patient barriers
  - Oversedation and lack of sedation protocols
  - Delirium or agitation
  - Patient refusal
  - Fatigue

Barriers to Early Mobility\textsuperscript{53-55}

- Structural barriers
  - ICU-related equipment and availability of portable devices
  - Lack of equipment, such as age-appropriate seating and mobility devices
  - Limited staff
  - Limited time
  - Lack of mobility plan or protocol
  - Ineffective staff training
Barriers to Early Mobility

- Cultural barriers
  - Lack of mobility culture
  - Lack of staff knowledge
  - Lack of support or buy-in
  - Lack of patient or family knowledge
  - Belief in the need for bed rest
  - Perceptions regarding safety of mobilization

- Process-related barriers
  - Lack of planning
  - Lack of coordination
  - Unclear responsibilities
  - Delayed daily screening
  - Standing bed rest order
  - Need for physician orders

Plan-Do-Study-Act

- Planning phase
  - Appraise literature and summarize evidence
  - Create group of critical care and rehabilitation clinicians
    - Ensure team is interdisciplinary
  - Develop protocols
  - Identify goals and targets

Create Interdisciplinary Group

- Program champions from each of the following:
  - Critical care attending physicians
  - Critical care nurse practitioners
  - Clinical nurse leader
  - Critical care nursing staff
  - Respiratory therapy
  - Rehabilitation (physical and occupational therapy)
  - Child life

Develop Protocols

- Decision Algorithm
- Target Mobility Levels
- Pre-Mobilization Checklist
  - Defined responsibilities of all disciplines involved in early mobility program

Decision Algorithm
Exclusion Criteria

- RASS score ≤ -3 or ≥ +4
- Open lumbar drains
- Requiring FiO2>50%
- Requiring PEEP>8
- Hemodynamic instability as defined by requirement of up-titration of continuous vasoactive infusion within 2 hours OR signs of hypoperfusion including rising lactate OR uncontrolled arrhythmias
- EVD in patient with need for ongoing ICP management
- Known or suspected elevated ICP
- Uncontrolled seizures
- Open surgical sites
- Immobilization requested by surgical or orthopedic team
- Known active and/or uncontrolled bleeding
- Tracheostomy within the last 24 hours

Precautions

- Known history of difficult airway
- Tracheostomy within the last 1-5 days
- Decompression craniectomy without helmet
- RASS score ≥ +2

Signs of Activity Intolerance

- Oxygen saturation below 88%
- Increased work of breathing or use of accessory muscles
- Nasal flaring
- Development of any exclusion criteria

Target Mobility Levels

- Activities vary based on age
- General activities performed at each level
  - Level 1 – In bed activities
  - Level 2 – Edge of bed activities
  - Level 3 – Static activities performed out of bed
  - Level 4 – Dynamic activities performed out of bed
- Rehabilitation professional (PT/OT) progresses session based on patient tolerance

Role of Respiratory Therapist

- Maximize respiratory status prior to, during, and following mobility as needed
  - Manage ventilator settings as needed
  - Ensure the patient’s airway is clear of secretions
  - Ensure the inner cannula is patent and has been changed according to schedule
  - Ensure the patient receives bronchodilator treatment prior to mobilization
  - Encourage proper breathing techniques

Role of Nursing Staff

- Provide general care prior to and during mobilization
  - Manage pain medications as needed
  - Record CAPD and RASS scores prior to mobilization
  - Ensure IVs are secure and lines are untangled prior to mobilization
  - Monitor telemetry during mobilization
  - Help to manage patient lines and tubes during mobilization
Role of Rehabilitation Staff

• Evaluate patient’s functional status through PT and OT assessment
  – PT assess and treat physical performance and functional mobility
  – OT assess and treat delirium, cognitive status and functional performance in ADLs and play
  – PT/OT safely progress functional mobility through activity levels, up to established target activity level

Role of Rehabilitation Staff

• Ensure appropriate target activity levels are set through discussion with PICU team
• Prepare room to allow for optimal mobilization
• Coordinate timing with all members of the mobility team (PT, OT, RN, and RT)
• Educate patient’s families regarding the early mobility program and role of rehabilitation

Role of Child Life Therapist

• Provide support to patient and family
  – Help to manage potential psychosocial complications of PICU stay
  – Provide calming strategies before, during, and/or after mobility
  – Reinforce the importance of early mobility program
  – Assist with communication strategies
  – Carry over target mobility level activities outside of early mobility sessions
  – Provide early mobility team with information regarding patient/family interests and needs

Identify Goals and Targets

• Phase I (12 months):
  – Literature review of relevant early mobility articles
  – Rehabilitation department inservice
  – First appropriate PICU early mobility patient identified
  – Discipline champions nominated
  – Multidisciplinary group formed

Plan-Do-Study-Act

• Doing phase
  – Market culture and practice changes
  – Remind clinicians of changes
  – Ongoing data collection and analysis of that data

• Phase II (12 months):
  – Rehabilitation discipline champions take the lead
  – Interdisciplinary meeting
  – Protocols created and program developed
  – Inservice to critical care nursing staff and to pediatric rehabilitation staff
  – Early mobility orders go live
Measuring Outcomes

- Pain and RASS scores pre-mobilization session
- Duration of mobility session
- Individuals present during mobility session
- Activities performed during mobility session
- Discussion of adverse effects (if applicable)
- Pain, RASS and CAPD scores post-mobilization session
- Family feedback

MOVING FORWARD

Plan-Do-Study-Act\textsuperscript{54}

- Studying phase
  - Analyze barriers, effectiveness of protocols, effectiveness of physician referrals
  - Re-evaluate protocols
  - Obtain feedback from critical care clinicians, rehabilitation clinicians, patients, families

The 4Es Strategy\textsuperscript{58}

- Applies to whole initiative
- Cyclical, rather than linear
  - Takes additional factors into consideration
- More emphasis on primary goal
- Additional points added
  - Extend
  - Endure

• Sustainability of an early mobilization program
  – Program champion who oversees day-to-day implementation
  – Ongoing staff education
  – Early mobilization becomes standard of care
  – Enhanced nursing support through training and education
  – Periodic chart audits/reviews

Cameron, et al. 2015

Questions

References


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