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Occupational and Physical Therapy in the PICU

Gracie Brinck OTD, OTR/L

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Disclosures

- No significant financial disclosures

Objectives

- Define Early Mobility and review benefits and existing literature
- Discuss implementation of Early Mobility protocol
- Discuss an age/developmental based approach to EM & Communication
- Introduce functional outcomes measures utilized in Pediatric ICU
- Discuss diagnosis-specific considerations for ICU mobility
- Discuss future directions for continued improvements in care for PICU patients

Poll

- Do you work in a pediatric acute setting? If so, where?
- If you answered yes to the last question, does your facility have a protocol for rehab in the intensive care unit(s)?

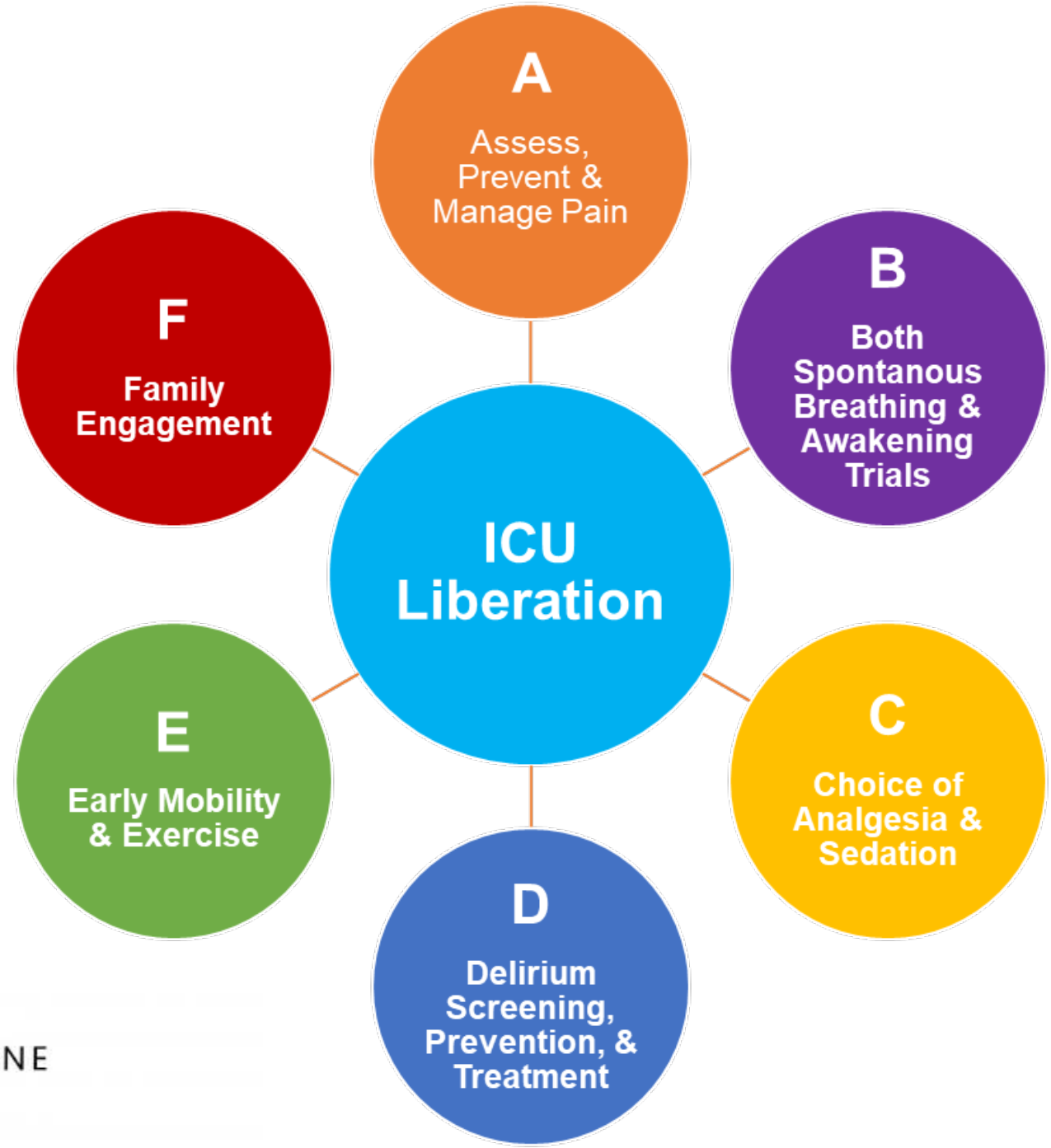
What is the role of therapy in the intensive care unit?

Early Mobility

- A preventative form of physical and cognitive rehabilitation, engaging the critically ill person in activity that assists with recovery of the cardiopulmonary system, prevents muscle deterioration and joint contractures, and begins restoration of autonomy
- Adult studies have shown improved outcomes
  - Decreased delirium
  - Decreased mechanical ventilation days
  - Decreased ICU length of stay
- Peds data is still emerging

Benefits of Early Mobility (in Adults)

- Decreased time requiring respiratory support
- Delayed muscle atrophy and deterioration
- Decreased incidents of skin breakdown and joint contractures
- Improved reports of functional mobility and independence
- Decreased delirium
- Decreased ICU and total hospital length of stay
- Greater likelihood of discharge to home > rehab facility
- Decreased incidents of chronic complications from ICU stay and prolonged immobilization
- Improved reported quality of life



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Caring for Critically Ill Patients with the ABCDEF Bundle: Results of the ICU Liberation Collaborative in Over 15,000 Adults

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- Data collected at 68 adult ICUs over 20 month period (academic and community)
- 15,226 adults with ICU stay of at least one day
- ABCDEF bundle compliance monitored

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Pun BT, Balas MC, Barnes-Daly MA, Thompson JL, Aldrich JM, Barr J, et al. Caring for Critically Ill Patients with the ABCDEF Bundle. Crit Care Med [Internet]. 2018;1.

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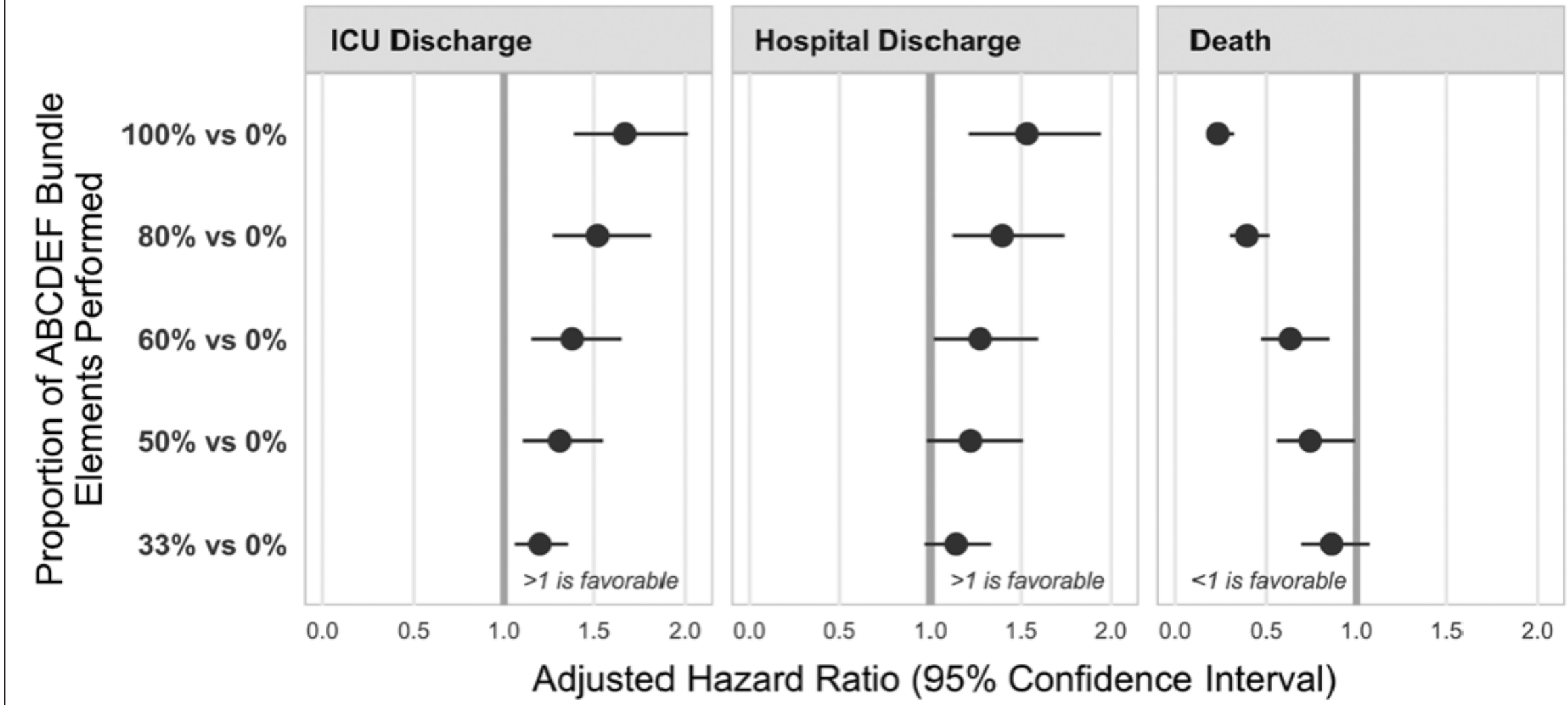

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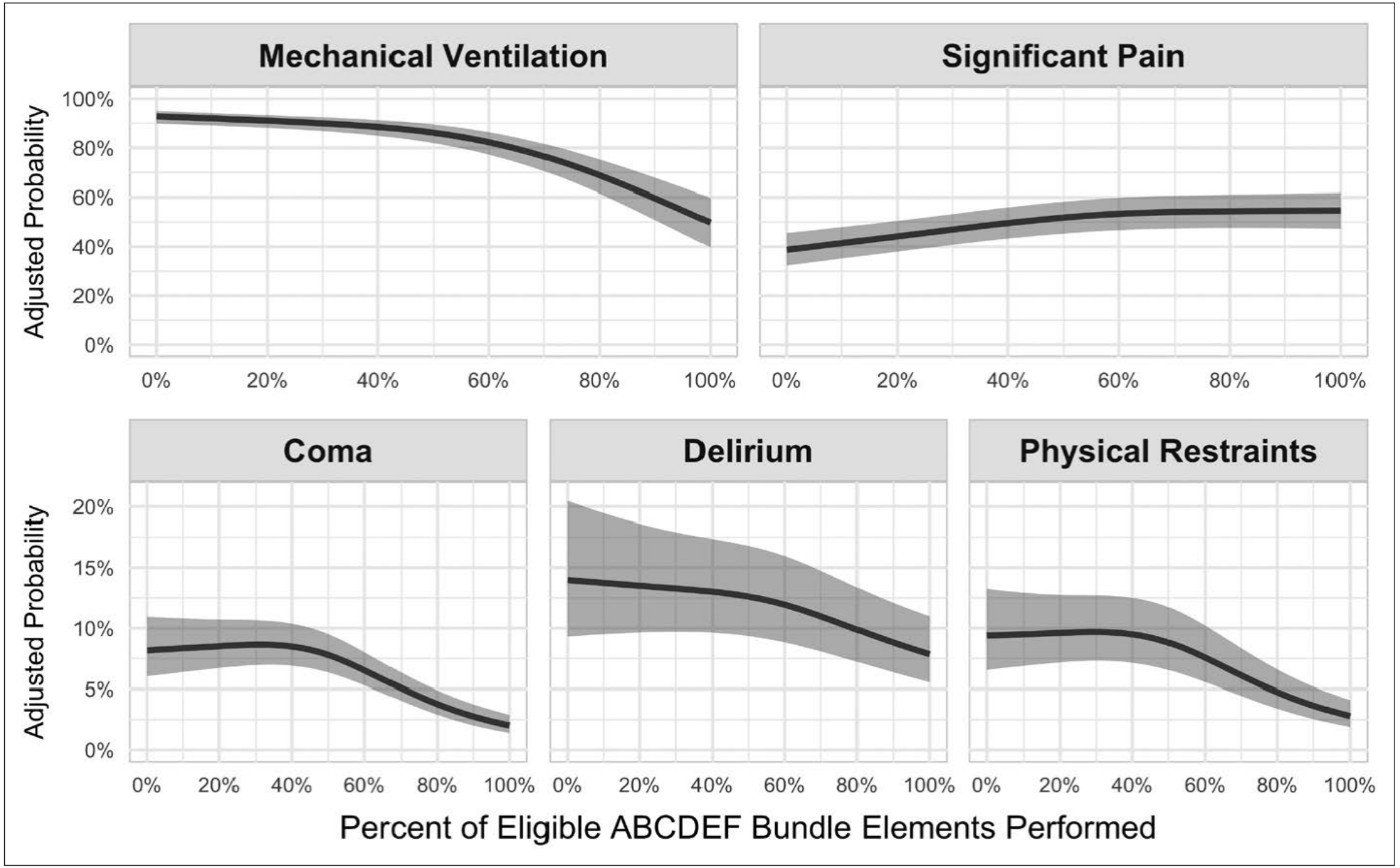

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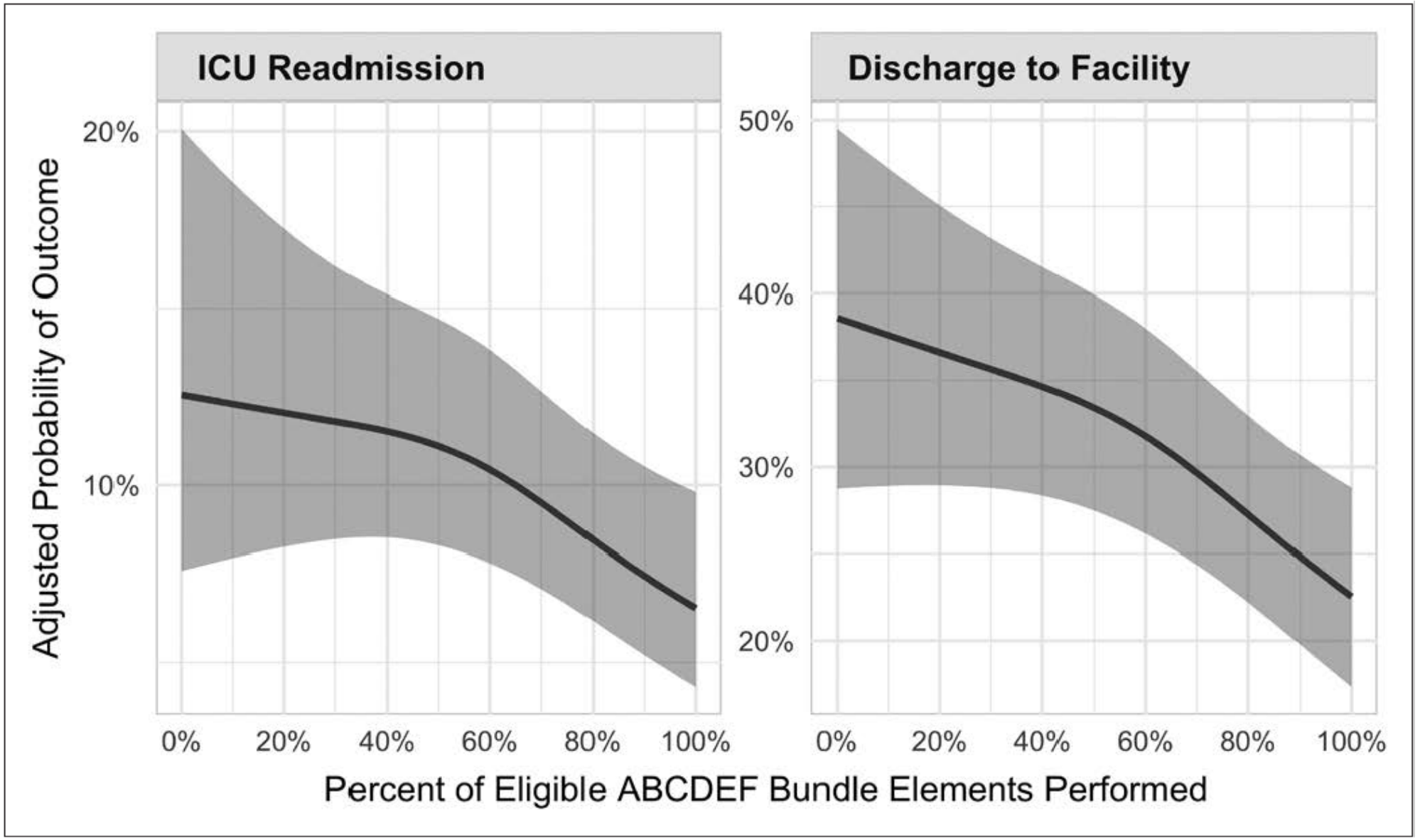

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Early mobility in pediatrics is SAFE!

- Mobilized 74 intubated patients with no serious adverse events (one NG dislodgement and 2 desaturations)
- Systematic review of 11 studies reporting on 1178 children, only 13 patients (1.1%) experienced an adverse event

Characteristic	N = 130 sessions, 74 patients
Age, median (mos, 25th-75th)	53 (22-154)
Sex (male)	40%
PEEP[1], median, (cm H_20, 25th-75th)	6 (5 - 8)
FiO_2[2], median (25th-75th)	0.30 (0.30- 0.40)
Duration of mobility, mean (min)	35

[1] *Positive end expiratory pressure*
[2] *Fraction of inspired oxygen*

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Betters KA, Hebbar KB, Farthing D, Griego B, Easley T, Turman H, et al. Development and implementation of an early mobility program for mechanically ventilated pediatric patients. J Crit Care. 2017;41

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Early mobility in pediatrics is SAFE!

Journal of Critical Care 41 (2017) 303–308

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

Kristina A. Betters, MD [a,b,*], Kiran B. Hebbar, MD, FCCM [a,b], David Farthing, OTR/L [b], Brittany Griego, DPT [b], Tricia Easley, OTR/L [b], Hartley Turman, MPT [b], Lauren Perrino, BSN [b], Stephanie Sparacino, RRT [b], Mary L. deAlmeida, MD [a,b]

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ARTICLES | MARCH 30 2022

Mobilization Safety of Critically Ill Children

Jessica M. LaRosa, MD; Archana Nelliot, MD; Munfarid Zaidi, MD; Dhananjay Vaidya, PhD; Ronke Awojoodu, MPH, RN; Sapna R. Kudchadkar, MD, PhD, FCCM on behalf of the Pediatric Acute Lung Injury and Sepsis Investigators (PALISI) Network and the U.S. PARK-PICU Investigators

CONFLICT OF INTEREST DISCLOSURES: The authors have indicated they have no potential conflicts of interest to disclose.

Address correspondence to Jessica M. LaRosa, MD, Division of Pediatric Anesthesiology and Critical Care Medicine, Department of Anesthesiology and Critical Care Medicine, Johns Hopkins University School of Medicine, 1800 Orleans St, Suite 6349, Baltimore, MD 21287. E-mail: jlarosa4@jhmi.edu

Pediatrics (2022) 149 (4): e2021053432.
https://doi.org/10.1542/peds.2021-053432 **Article history**

THE JOURNAL OF PEDIATRICS • www.jpeds.com

ORIGINAL ARTICLES

Early Mobilization in Critically Ill Children: A Systematic Review

Carlos A. Cuello-Garcia, MD, PhD[1], Safiah Hwai Chuen Mai, PhD[1], Racquel Simpson, MA[1], Samah Al-Harbi, MD[2], and Karen Choong, MD, BCh, MSc[1]

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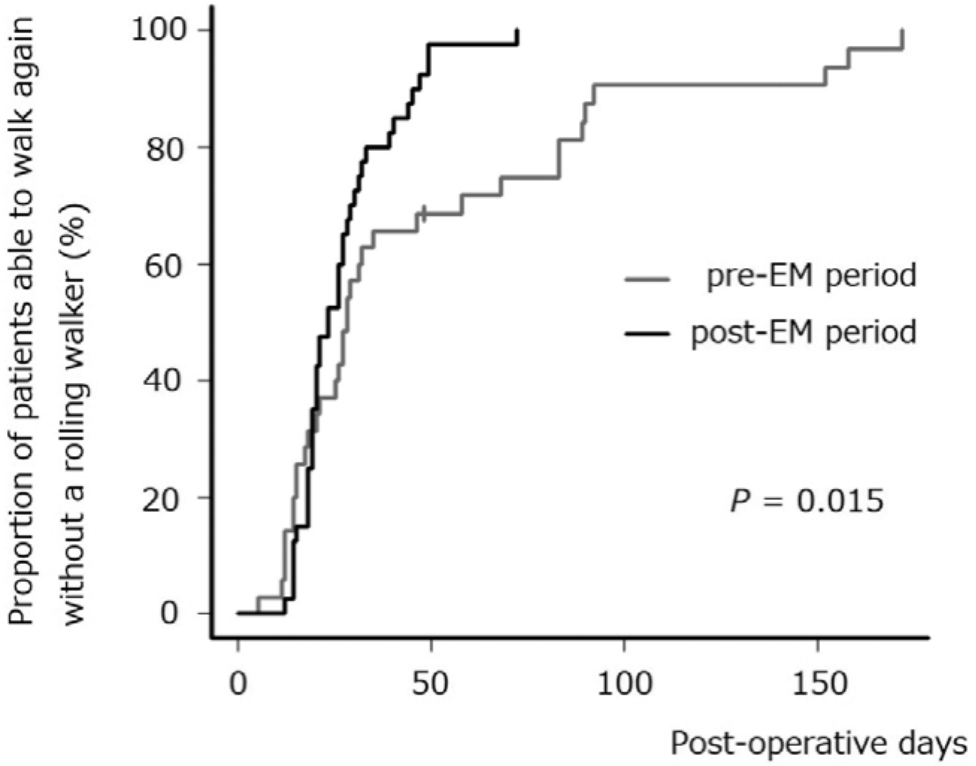
Early mobility outcomes data in children



Tsuboi N, Hiratsuka M, Kaneko S, Nishimura N, Nakagawa S, Kasahara M, Kamikubo T. Benefits of Early Mobilization After Pediatric Liver Transplantation. Pediatr Crit Care Med. 2019 Feb;20(2):e91-e97. doi: 10.1097/PCC.0000000000001815. PMID: 30489487.

Another QI study in PICU showed post-intervention group with decreased length of stay

- **Hospital LOS decreased by 35%**
- **PICU LOS decreased by 34%**

Herbsman JM, D'Agati M, Klein D, O'Donnell S, Corcoran JR, Folks TD, Al-Qaqaa YM. Early Mobilization in the Pediatric Intensive Care Unit: A Quality Improvement Initiative. Pediatr Qual Saf. 2020 Jan 31;5(1):e256. doi: 10.1097/pq9.0000000000000256. PMID: 32190800; PMCID: PMC7056284.

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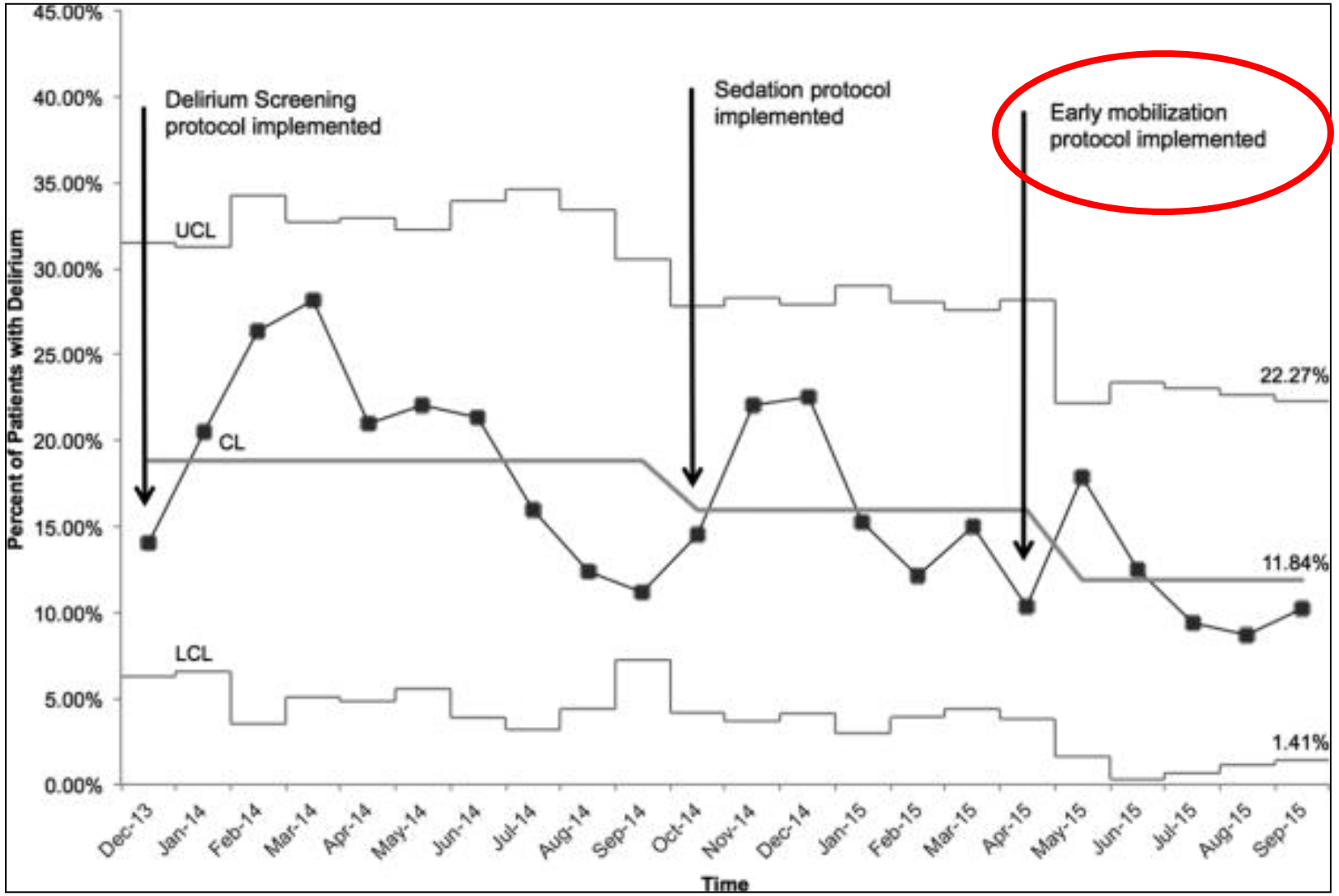

Figure 3 . Delirium prevalence with the implementation of ICU bundle over 22-mo study period. CL = center line.

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Simone S, Edwards S, Lardieri A, Walker LK, Graciano AL, Kishk OA, et al. Implementation of an ICU Bundle: An Interprofessional Quality Improvement Project to Enhance Delirium Management and Monitor Delirium Prevalence in a Single PICU. Pediatr Crit Care Med. 2017;18(6):531–40.

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Utilization of ICU Rehabilitation Services in Pediatric Patients With a Prolonged ICU Stay*

Kristina A. Betters, MD[1]
Truc M. Le, MD[1]
Wu Gong, MS, MD[2]
Chris J. Lindsell, PhD[2]
Heidi AB Smith, MD, MSCI[3]
Andrew H. Smith, MD, MSCI, MMHC[1,4]

OBJECTIVES: To describe rehabilitation practice patterns among critically ill children with prolonged ICU stays and explore the association between institution-level utilization of rehabilitative services and patient outcomes.

DESIGN: Retrospective cohort study using an administrative database of inpatient clinical and resource utilization data from participating pediatric hospitals in the United States. Center-level utilization of physical therapy and occupational therapy among critically ill patients was used to divide hospitals by quartile into high utilization centers or standard utilization centers.

SETTING: Fifty-one pediatric hospitals in the United States.

PATIENTS: Critically ill pediatric patients with prolonged critical illness (defined as an ICU length of stay of at least 7 d) discharged from July 2016 to June 2017.

INTERVENTIONS: Not applicable.

MEASUREMENTS AND MAIN RESULTS: Seventeen thousand four hundred seventy encounters met criteria for study inclusion. Of those, 6,040 (35%) were not charged for either physical therapy or occupational therapy services. There was wide variability in center-level utilization of rehabilitative services while in the ICU, ranging from 81% utilization of physical therapy or occupational therapy services among high utilization centers to 46% utilization among centers within the lowest quartile. In univariate analyses, children cared for at an high utilization center were less likely to require discharge to an inpatient rehabilitation facility (1.7% vs 3.5%; $p < 0.001$) and less likely to incur a new pressure injury (2.2% vs 3.1%; $p = 0.001$). In multivariable analyses, the direction and magnitude of effects remained similar, although the effect was no longer statistically significant (discharge to inpatient rehabilitation facility: odds ratio, 0.64; 95% CI, 0.18–2.26; pressure injury: odds ratio, 0.77; 95% CI, 0.48–1.24).

CONCLUSIONS: Institutional use of rehabilitative services for children with prolonged critical illness varies greatly in the United States. Further research is needed into the potential benefits for patients cared for at centers with high usage of rehabilitation services in the ICU during prolonged critical illness.

Figure 1. Hospital-level variation in physical therapy (PT)/occupational therapy (OT) utilization in encounters with PICU stay of 7 d or greater.

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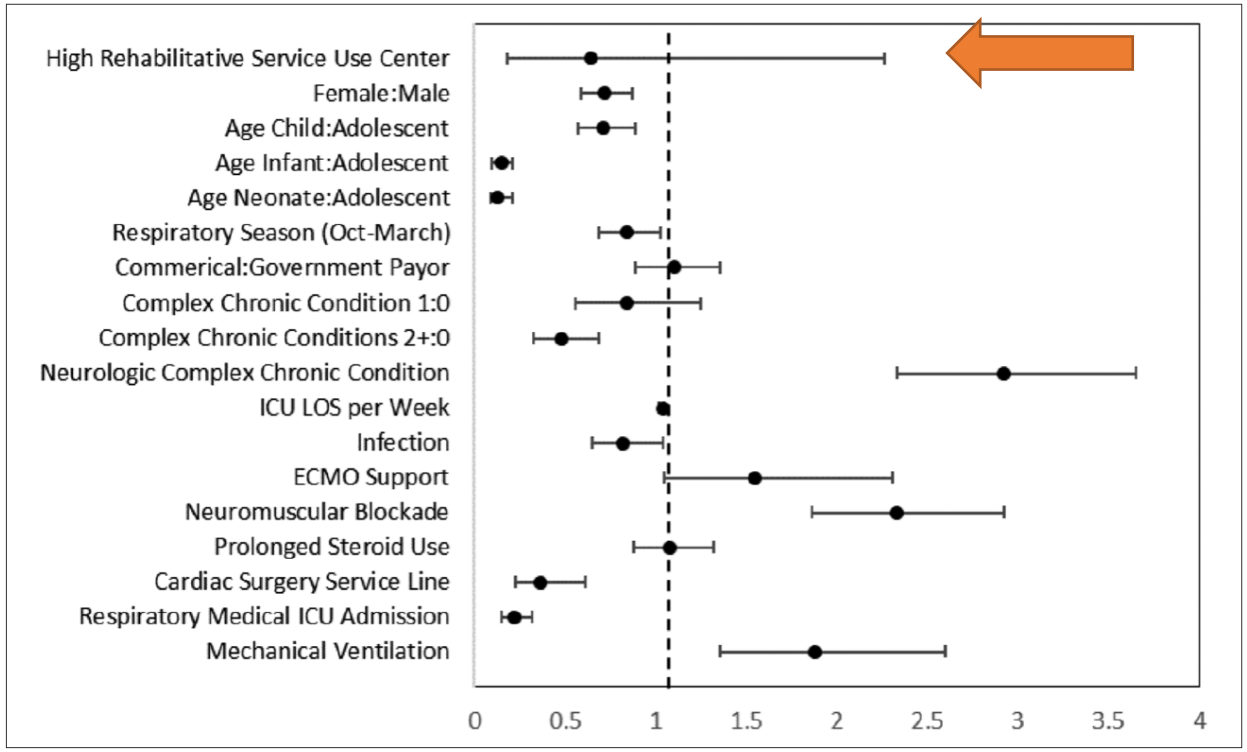

Figure 2. Variables associated with the outcome of discharge to inpatient rehabilitation facility (vs discharge home). *Ethnicity included in statistical model but not displayed in figure due to lack of statistical significance. ECMO = extracorporeal membrane oxygenation, LOS = length of stay.

Discharge to Inpatient Rehab

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Pressure Injury

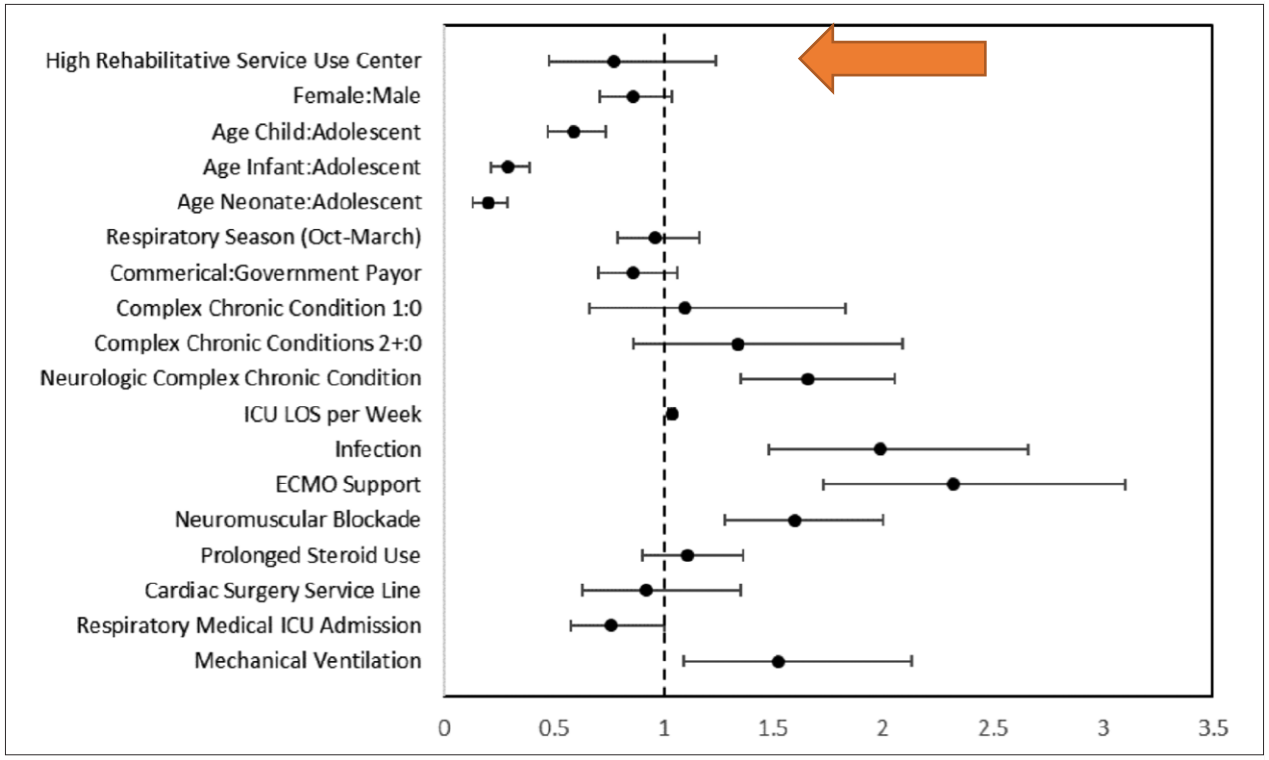

Figure 3. Variables associated with diagnosis of new pressure injury. *Ethnicity included in statistical model but not displayed in figure due to lack of statistical significance. ECMO = extracorporeal membrane oxygenation, LOS = length of stay.

Early Mobility on ECMO

Mayer KP, Pastva AM, Du G, Hatchett SP, Chang M, Henning AN, Maher B, Morris PE, Zwischenberger JB. Mobility Levels With Physical Rehabilitation Delivered During and After Extracorporeal Membrane Oxygenation: A Marker of Illness Severity or an Indication of Recovery? Phys Ther. 2022 Mar 1;102(3):pzab301. doi: 10.1093/ptj/pzab301. PMID: 34972871.

› Ann Am Thorac Soc. 2022 Jan;19(1):90-98. doi: 10.1513/AnnalsATS.202102-151OC.

Early Mobilization during Extracorporeal Membrane Oxygenation for Cardiopulmonary Failure in Adults: Factors Associated with Intensity of Treatment

Darryl Abrams [1], Purnema Madahar [1], Christina M Eckhardt [1], Briana Short [1], Natalie H Yip [1], Madhavi Parekh [1], Alexis Serra [1], Richard L Dubois [2], Danial Saleem [3], Cara Agerstrand [1], Peter Scala [4], Luke Benvenuto [1], Selim M Arcasoy [1], Joshua R Sonett [5], Koji Takeda [6], Anne Meier [1], James Beck [7], Patrick Ryan [8], Eddy Fan [9] [10], Carol L Hodgson [11] [12], Matthew Bacchetta [13], Daniel Brodie [1], MORE-PT Investigators

Collaborators, Affiliations + expand

PMID: 34077700 DOI: 10.1513/AnnalsATS.202102-151OC

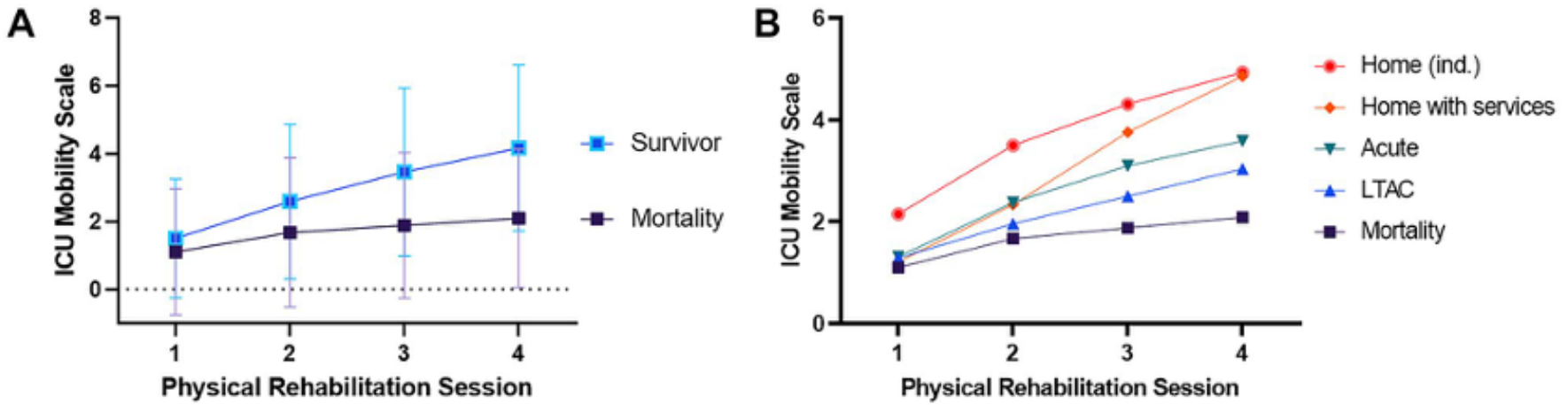

Figure 1. A positive change in mobility as an indicator of a response to physical rehabilitation is associated with improved survival and discharge disposition. (A) Individuals discharged alive achieved higher mobility levels and had a steeper, more positive rate of change in mobility in the first 4 sessions than individuals who died in the hospital (2.8 vs 0.38; $t_{199} = 8.24$; $P < .001$). (B) Individuals who were discharged to home had the highest rate of change in mobility (3.5 [SD = 2.3]) compared with individuals discharged to acute care rehabilitation (2.3 [SD = 1.5]) and long-term care/nursing home (1.8 [SD = 1.5]) ($P < .001$). LTAC = long-term acute care facility.

Table Patient characteristics and disposition (N = 9)

Characteristic	ECMO type: Venovenous[a]	ECMO type: Venovenous/venoarterial[b]
Cannulation		
Internal jugular	2	1
Internal jugular/femoral	0	3
Femoral	2	1
Airway while receiving ECMO		
Tracheostomy	1	3
Extubated	3	2
Reason for decannulation		
Received transplant	3	4
Died	1	1
Therapy sessions, No.	78	164
Days receiving ECMO, No.	62	184
Disposition		
Discharged	3	2
Died	1	3

Abbreviation: ECMO, extracorporeal membrane oxygenation.
[a] All venoarterial cases were originally venovenous but were revised to provide the patient additional support.
[b] Venovenous transitioned to venoarterial.

Patrick K, Adams A. Mobilization of Patients Receiving Extracorporeal Membrane Oxygenation Before Lung Transplant. Crit Care Nurse. 2021 Aug 1;41(4):39-45. doi: 10.4037/ccn2021689. PMID: 34333616.

Discipline-Specific Considerations

Role of Physical Therapy

- Gross Motor Development
- LE strength and positioning
- Tone Management
- Postural strengthening
- Head shaping recommendations
- Caregiver Education
- Promotion of physical fitness
- Endurance and Aerobic Capacity
- Respiratory Coordination
- Equipment Recommendations

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ROM, Positioning, Massage

- Provide family with handouts and daily recommendations of ROM and splint wear dosage
- Massage
  - Promote positive touch and sensory development
  - Caregiver bonding/coping
  - Prevention of sensory/vascular impairments
  - Infant massage certifications and additional training
- Appropriate signage in rooms to promote carryover
- Attention to lines and precautions
- Empower the caregiver as safely able

Infant Positioning Considerations

***ENCOURAGE*:** flexed position with support from blankets/ boundaries, rotate baby in different positions to promote head shaping, gross motor strengthening, self-calming, and ability to participate in fine motor and developmental activities


Supervised Tummy Time

Side Lying


Supine

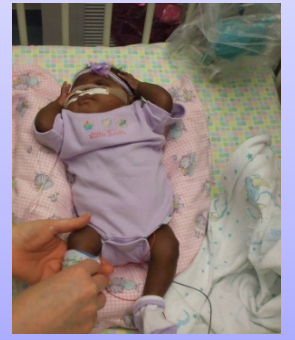
***AVOID*:** positioning without support/boundaries which can result in asymmetrical postures, skull deformations, delayed fine and gross motor development

"W" Position of Arms

"M" Position of Legs

No Boundaries

Preferential Head Turning

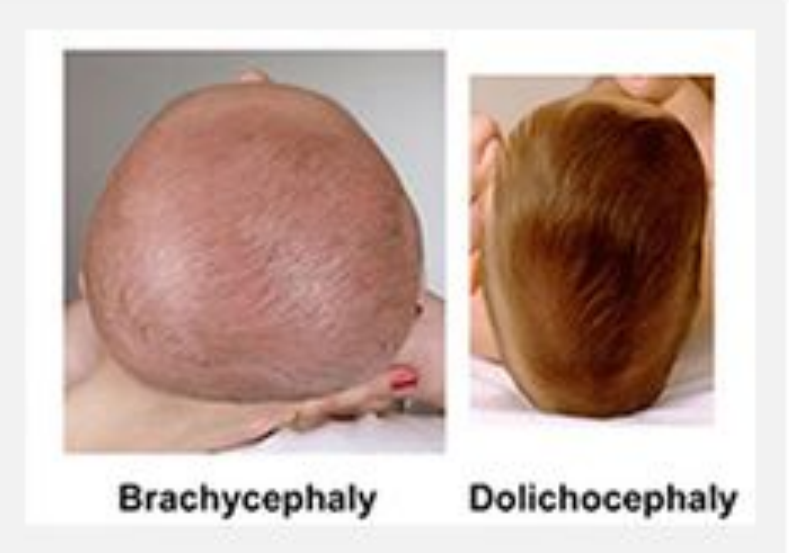


Boundaries Too Small

D. Powers & E. Williamson 2008

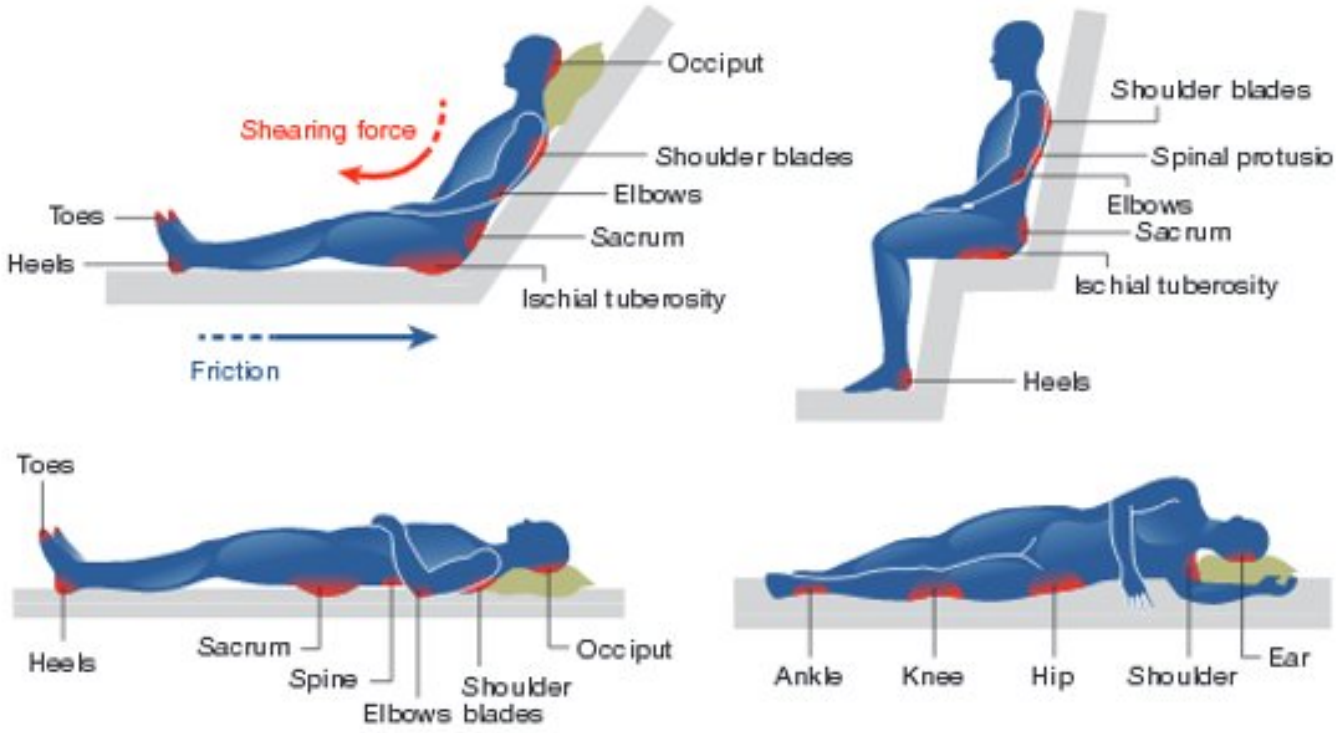
Head Shaping

- Head shaping anomalies arise from sustained positioning of malleable, undeveloped skull
  - Brachycephaly
  - Dolichocephaly
  - Plagiocephaly
- Respond well to intentional positioning changes
  - Head shaping posters placed at crib side
  - Mobiles on opposite side of head preference
  - Care and handling on opposite side of head preference
- If untreated, can impact skull, facial, spinal, and brain development
  - May require cranial orthotic at 4-6 months if untreated
  - Orthotic ineffective if initiated after 12 months
  - Long term cognitive and academic implications
    - School-aged children with moderate to severe PPB scored lower than controls on cognitive and academic measures; associations were negligible among children with mild PPB



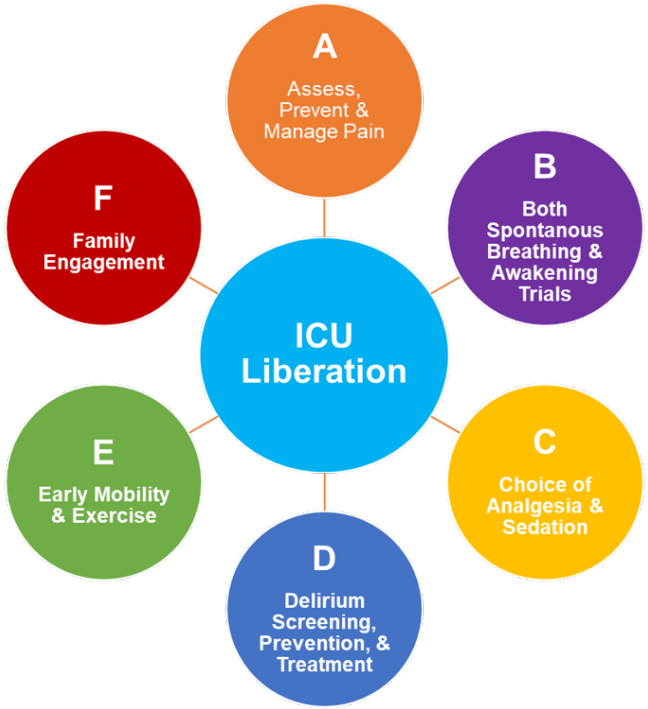
Prevention of Secondary Impairments

- Contracture
- Critical Illness Myopathy/Neuropathy
- Pressure injuries
  - Neutral positioning equipment
  - Zflos
  - Pressure relief mattress/bed
  - Attention to bony prominences in all positions
- Delirium
- Further deconditioning
- Falls



Pediatric ICU Delirium Management

- Most often related to use of pain and sedation medications
- Concerns for ICU delirium can result in prolonged intubation times and excessive use of PRN sedation medication
- Risk factors for Pediatric ICU delirium:
    - younger age, male, preexisting cog impairment, dev delay, previous delirium, preexisting emotional and behavioral problems
- Types of Delirium:
    - Hypoactive, hyperactive, and mixed-type
- Objective tools to assess and communicate concerns about delirium
    - Richmond Agitation Sedation Scale (RASS)
    - Pediatric Confusion Assessment Method for the ICU (pCAM-ICU)
    - Pediatric Anesthesia Emergence Delirium (PAED)
    - Cornell Assessment of Pediatric Delirium (CAPD)
- Delirium is NOT a reason to decline therapies!



Importance of Upright Positioning

- Postural strengthening and endurance
  - If unable to sit, unable to participate in functional activities
- Pulmonary Toileting
- Improved respiratory quality and coordination
  - Improved global rib expansion
- Improved engagement with environment and ability to participate in ADLs and play
  - Assists with delirium management
- Advance to dynamic skills for greater aerobic challenge and activity

Upright positioning strategies

- Elevate head of crib/bed
- Bouncy seat
- Tumbleform chair
- Neurochair
- Size-wise Neurochair
- Caregiver's lap
- Personal Wheelchair
    - Encourage caregivers to bring personal wheelchairs/ equipment to the hospital early in hospitalization
    - Provides most custom spinal support and optimal positioning
    - Allows more efficient use of hospital equipment for pts who require seating device

Gross Motor Developmental Positions

- **Supine**
  - Antigravity trunk and hip strengthening
  - Overhead reaching
  - Midline play with postural fixation
  - Visual fixation and tracking
  - Neutral alignment of shoulders/hips

- **Sidelying**
  - Lateral truncal strengthening
  - Antigravity strengthening of hip and glutes
  - Crossbody reaching and integration
  - First steps toward independent rolling

- **Supported Sitting**
  - Head and trunk strengthening against gravity
  - Hip stabilization strengthening
  - Exploration of environment with UEs

- **Prone**
  - Cervical extension strengthening
  - Proximal hip extension strengthening against bed
  - UE weightbearing

ECMO Advantage

Transitional Mobility

- Children with prolonged hospitalizations in infancy get very good at maintaining positions and postures, however have delayed abilities to obtain postures
- Postural strengthening through a range of movement while controlling center of gravity
- Promote independent exploration
- Neurocognitive development through movement

ECMO Advantage

Role of Occupational Therapy

- Fine motor & visual motor skills
- Self-care skills
- Functional mobility
- UE strength and positioning
- Tone management
- Splinting
- Sensory processing & integration
- Caregiver education

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The Importance of “Doing”

- Participation in everyday activities:
  - Vital part of children's development
    - Directly related to their quality of life and future outcomes
  - Provides opportunities to improve strength, endurance, coordination, and progress developmental skills
- Research indicates that children with disabilities are at risk for lower participation in ordinary daily activities at home and in the community.
  - Opportunities to teach patients with disabilities and their families adaptive strategies to maximize engagement
- Therapeutic play in the hospital setting has been proven to positively impact physical and emotional recovery!

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Daily Routine

- Conservative management of delirium and hospital-acquired disturbance of daily schedules and routines
- Created with patient/family actively involved, as able
- Establish element of control in midst of chaos
- Implementation of daily schedules:
  - Coordination of multidisciplinary care
  - Improved expectations of therapy services
    - Anticipatory preparation (family present, nursing care, etc)
  - Preservation of “patient time”
  - Age- and diagnosis-appropriate rest breaks

Occupational Therapy throughout Childhood and Adolescents

- Infants:
  - Facilitate age-appropriate development
  - Promote sensory development and self-soothing
  - Provide/fabricate splints
  - Provide caregiver education
    - Infant massage
    - Assistance in positioning recommendations/head shaping
    - Implementation of calming strategies

- Toddlers/Early Childhood and Middle Childhood/Adolescents:
  - Facilitate age-appropriate play/leisure
  - Promote functional mobility and self-care within precautions
  - Instruct and provide adaptive techniques and equipment to promote independence with ADLs
  - Promote general strengthening and endurance
  - Provide caregiver education

Control the Environment!

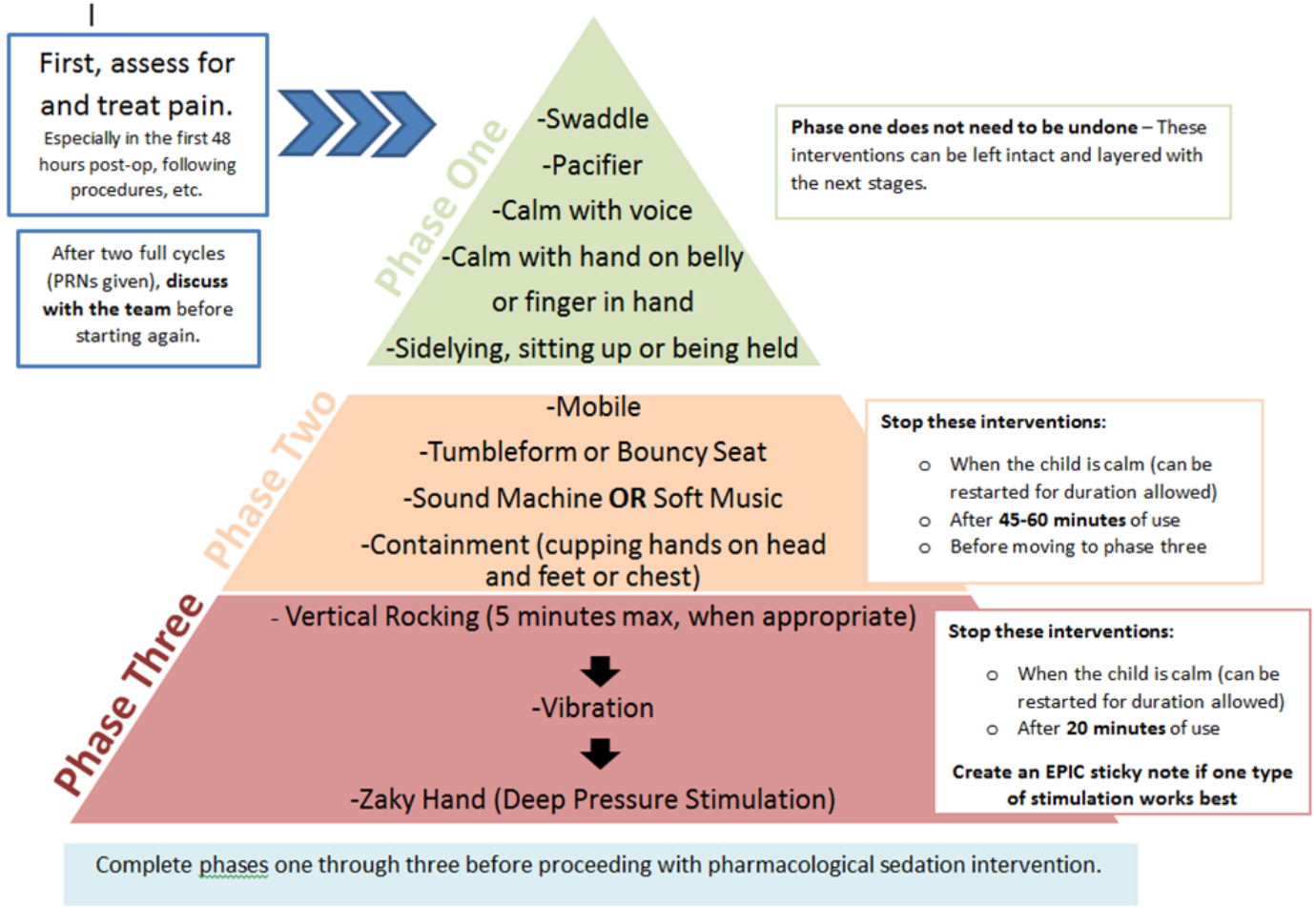
- Age-appropriate stimulation throughout the course of the day
  - Developmentally appropriate light, sound
  - Implementation of SENSE protocol
- Day-night cycling
- Respect of sleep cycles and daily routines with family and nursing
- Attention to agitating factors that may result in need for medication changes
- Minimize necessary personnel in room

Sensory Development Considerations in PICU

- PICU protocols working to reduce sedation medications to facilitate greater mobility/alertness
- Incorrect use of sensory equipment (vibration tools, weighted blankets, auditory stimulation, etc.) can result i:
  - Patient habituation
  - Suffocation
  - Decreased mobility
  - Poor self-soothing skills and state regulation
- Infants learn and develop by habituation to sensory input- but too much of a good thing can be detrimental to a child's sensory system
  - Especially important in first year of life
- Children with CHD often have neurobehavioral deficits and are more likely to have difficulty feeding and calming

Sensory Development Considerations in PICU

- **The new approach:**
- Progressive sensory pyramid
- Increases level of sensory support to provide calming while being mindful of infant cues and developmental needs
- Provides guidelines for appropriate use and duration of sensory resources
- Creates pathway for communication with the team regarding pharmacological needs



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Role of Speech Language Pathologists

- SLP screening for all patients in ICU >12 months of age in ICU >72 hours
  - Communication impairment as developmental, acquired, and/or **IATROGENIC**
  - Augmentative and Alternative Communication (**AAC**)
  - Assessment of communication vulnerability with provision of age-appropriate communication strategies
- Feeding/Swallowing assessment after prolonged intubation, acute deterioration, or neurologic incident

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Communication impairment has consequences

- **Developmental and psychosocial consequences** (e.g., PICS, ICU-AWS, lack of enriching home/school environment)
- **Medical consequences** (e.g., sentinel events linked to communication – reaching hand to throat to indicate throat deemed as attempt at self-extubation, able to report pain or changes in status)
- **Financial consequences** (e.g., patients are able to communicate with providers and prevent adverse events)
- **Recovery consequences** (e.g., early intervention for new-onset impairment may lead to better outcomes)
- **Dignity consequences** (e.g., identifying toileting needs, sharing close messages with loved ones)

AAC is a major means to combat communication vulnerability in acute care

Enhanced communication efficiency, improved ventilator weaning trials, and increased patient engagement were cited in Radtke, Baumann, Garrett, & Happ, 2011 in adults with varying forms of AAC

Communication boards were described as decreasing frustration for adults in Patak et al., 2006

- AAC may alleviate fear in pediatric patients per Costello, 2000
- AAC may allow for lower sedation levels (?)

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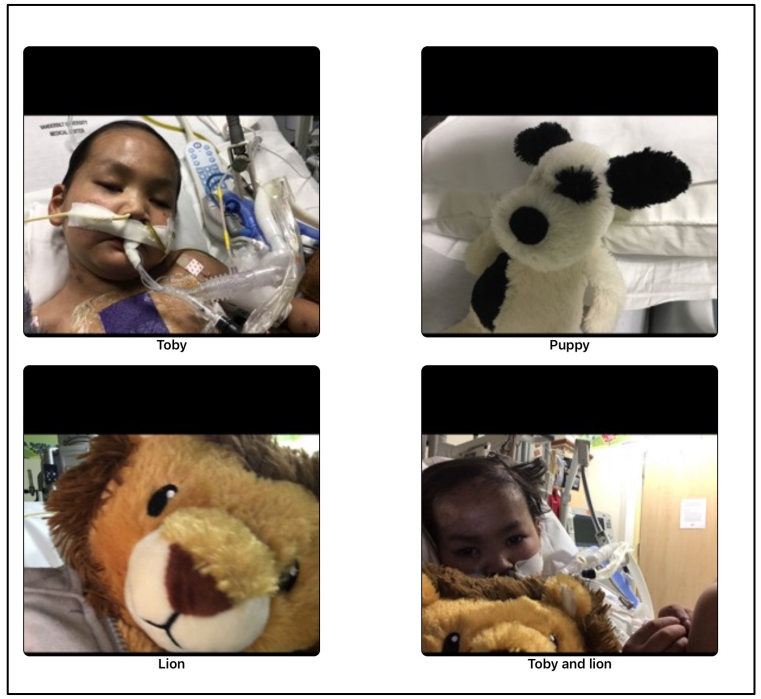

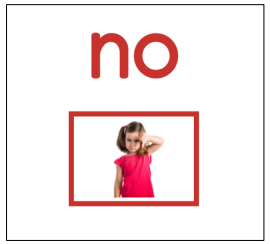

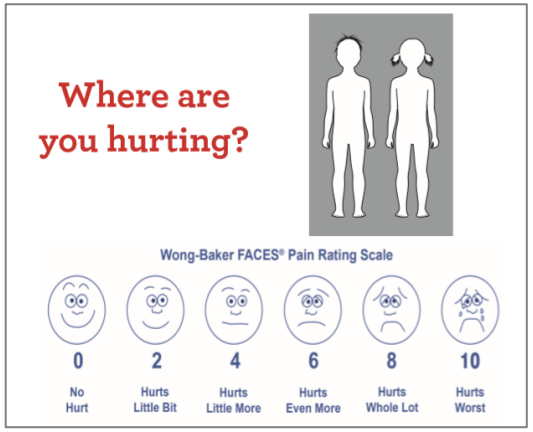

- I don't feel lightheaded ☆
- My chest feels lighter ☆
- I was scared and that's why I wanted you and dad in the room at all times ☆
- When I 1st got here I thought I was going to die ☆
- And I wanted to say some thing ☆
- WheN and what if something happens ☆
- What's going to happen about school ☆

AAC – Augmentative and Alternative Communication

Role of PM&R Team

- "Therapy Quarterback" for complex rehab needs to maximize outcomes and optimize participation with therapies
- Tone Management in event of CVA, anoxic brain injury, etc
- Comprehensive pain management; early identification of Critical Illness myopathies and neuropathies
- Neurostimulation as appropriate
- Orders for complex equipment needs
  - Custom orthoses, splinting
- Early coordination of complex ultimate discharge needs:
  - Collaboration with CM, SW, follow up clinics
  - Assist with coordination of appropriate post-acute therapies:
    - Inpatient Rehab, OP Therapies, HH Therapies
  - Early identification of barriers to therapies
- Comprehensive follow-up of post intensive care rehabilitative needs and return to function

Elizabeth Martin, M.D., MPH, MHS
Assistant Professor of Physical Medicine & Rehabilitation

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Our Early Mobility Journey

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Goals of ICU Liberation

- Provide BEST patient care
- Improve outcomes in the ICU and post ICU
- Student patient outcomes post early mobility and communication interventions
- Study staff and family perceptions
- Help establish pediatric standards of care for ICU mobility

VCH Early Mobility

Fall 2017: multi-disciplinary* committee formed

*PT, OT, RN, RT, SLP, Child-life, ICU MD, PM&R MD, rehab administration

Spring 2018: protocol finalized and approved

April 2018: education roll out

May 1, 2018: protocol go live date

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Creating the Early Mobility Protocol

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Getting Started

- Early Mobility Committee
  - Physician champion
  - Key stake-holders from every discipline
  - Champions key for implementation
- Engaging administration
  - PICU, nursing, RT, rehab administration
  - Share the data
    - EM improves outcomes
    - EM is SAFE
    - Implementation Toolkit: https://www.sccm.org/Clinical-Resources/ICULiberation-Home/Get-Started

Interdisciplinary Committee

- ICU Attendings – spearheaded meeting, protocols
- Nurse Practitioners
- Physical, Occupational, and Speech Therapy
- Respiratory Therapists
- ECMO Specialists
- Nursing Champions
- PM&R
- Child life specialists

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VCH Early Mobility Protocol

- Who Qualifies?
  - PT/OT orders placed at **72 hours ICU LOS** or sooner for high-risk patients
- What's appropriate and safe for therapy to do?
  - Patient clinical status dictates starting level
  - Therapist-led determination of levels of complexity to indicate appropriate activities
- How do we get therapy involved?
  - Order set through EStar
  - Quality improvement initiative to assess consistent placement of orders
- Ancillary support
  - **SLP** consulted on all patients > 12 months of age for communication
  - **CCLS** consulted on all EM patients
  - **School teacher** consult recently added for school aged children

VCH Early Mobility

Exclusion Criteria	Precautions (discuss during rounds)	Signs of Intolerance during mobility	Daily Routine	Communication
• Hemodynamically unstable • Active hemorrhage • Unstable ICP • Full spinal precautions (unless ordered otherwise) • Open chest < 24 hours	• Unstable fracture • CRRT/ temporary PD catheter in place • Intracardiac lines • ECMO • Receiving iNO therapy • Neurosurgical patient with specific mobility orders • External pacer dependent	• Oxygen desaturation requiring > 30% increase in FiO2 • ICP > 20 for > 5 min • Abrupt decrease in level of consciousness • Concern for any device/line integrity • Increase in arrhythmia • BP out of ordered range	• Lights on by 8 am • Complete nighttime activities (bath, weight) and lights off by 2300 • TV time limited to developmentally appropriate amount, and turned off while sleeping • Discuss frequency of hand on assessments/vital signs with medical team at night, coordinate hands on time with splinting • Daily assessment of level of activity	• SLP consult for all patients > 12 months of age for communication tools • Binders on each unit with communication tools (i.e. communication boards, call buttons, etc.)

Level 1*	Level 2*	Level 3*
• Intubated/tracheostomy with FiO2 >60% • Intubated difficult airway • New tracheostomy prior to first trach change • RASS <-3 • Vasopressor other than milrinone or low dose • Open chest > 24hr • HFOV • ECMO • Spinal precautions • Post cath patient < 12 hrs	• Intubated or tracheostomy with FiO2<60% • RASS > -2 • Noninvasive respiratory support with FiO2>60% • CRRT/temporary PD • ECMO with stable flows during turns	• Noninvasive respiratory support with FiO2 <60% • Baseline pulmonary support

Birth to 6 months

Level 1	Level 2	Level 3
		

6 years and up

Level 1	Level 2	Level 3
		

Examples of PICU Therapy Activities - Birth to 6 Months

Level 1

- Passive/Active Assisted ROM (3 times daily)
- Massage (1-2 times daily)
- Boots/Splints (on 2 hours/ off 2 hours)
- Rotate between these positions for skin integrity and developmental stimulation: supine, sidelying, prone (if medically appropriate)
- Use z-flows and nesting rolls to facilitate hands to midline and hips in neutral position (no frog legs)
- Use of mobile or suspended toys for visual stimulation

Level 2

- Level I, plus:
- At 3 months begin presenting hanging toys (low enough for patient to reach easily/accidentally)
- Starting at birth, begin tummy time. By 3 months of age, pt should be doing 60 minutes of tummy time throughout the day (as medically appropriate)

- Dependent transfer to swing, bouncy seat, tumbleform chair for extended upright positioning (at least twice daily)
- Held by caregiver (if appropriate) (daily)
- Supported sitting in bed (at every care time)

Level 3

- Levels I and II, plus:
- May begin use of bumbo seat. Pt must be supervised and must have full independent head control at all times when in bumbo. (twice daily)
- Get dressed (if appropriate with lines) (daily)
- Held by caregiver (if appropriate)
- Supported sitting in bed

3 years and older

Level 1

- Passive/Active Assisted ROM (3 times daily)
- Massage (1-2 times daily)
- Boots/Splints (on 2 hours/ off 2 hours)
- Rotate between these positions for skin integrity and developmental stimulation: supine, sidelying, prone (if medically appropriate)
- Use z-flows and nesting rolls to facilitate hands to midline and hips in neutral position (no frog legs)

Level 2

- Level I, plus:
- Encourage patient to participate in self-feeding, dressing, mouth care, as able and medically appropriate (daily)
- Use of tumbleform or neurochair for longer upright positioning (1-2 times daily)

Level 3

- Level I and II, plus:
- Ambulation if able (2-3 times daily)
- Encourage pt to stand during transfer to parent's lap or bedside chair (3 times daily)
- Supported standing play leaning on bed or couch or with use of tilt table or stander (2-3 times daily)
- Wagon or wheelchair rides as appropriate (daily)

EM Daily Algorithm

PT/OT reviews early mobility patient orders in morning

PT/OT calls bedside nurse in morning to discuss patient

PT/OT to ask if patient has any **exclusions** or **precautions**; if so nurse will discuss in am rounds with medical team (and ECMO team if applicable)

ICU nurse discusses timing of session with RT for patients on respiratory support (include ECMO team in scheduling if ECMO patient)

ICU nurse notifies PT/OT of agreed time and writes time on door sign

Early mobility session occurs at pre-discussed time

Exclusions:

- Hemodynamically unstable
- Active hemorrhage
- Unstable ICP
- Full spinal precautions
- Open chest < 24

Precautions:

- Unstable fracture
- CRRT/ temporary PD catheter
- Intracardiac lines
- ECMO*
- iNO therapy
- Neurosurgical patient with specific mobility orders
- External pacer dependent

Staff Present for Session

1st session- PT/OT/RN/RT

Subsequent sessions- one skilled therapist with RN and RT (for patients on respiratory support other than home support)

*ECMO- PT, OT, RN, RT, ECMO specialist, E1, and ICU provider (fellow, attending, ICU NP/ PA).

Dependent transfer without PT/OT in patients who have demonstrated stability in 3 consecutive sessions

(RT still must be present for patients on respiratory support)

Pre-mobility Safety Checklist

___Early mobility order in chart and patient does not meet exclusion criteria

___All necessary equipment available (feeder seat, wheel chair, suction equipment, etc.)

___Parent explained procedure

___Photo consent obtained if needed

___Diaper changed

___Oral suctioning

___Endotracheal tube suctioning

___Endotracheal tube secured

___All lines/tubes secured

___Mobility activity determined by PT/OT team

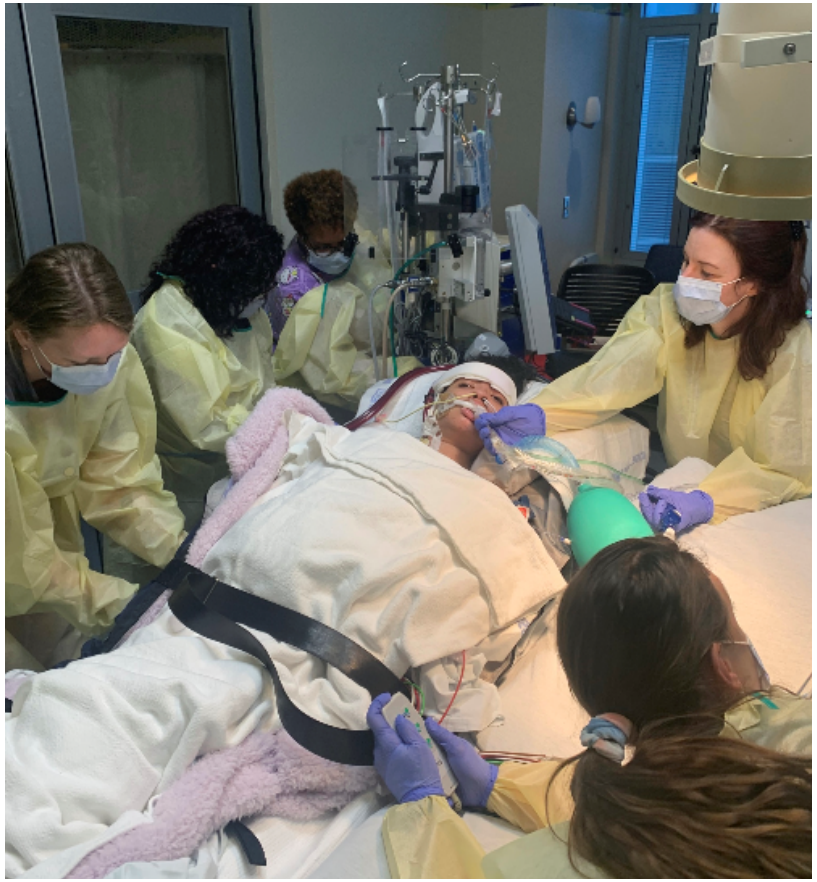
___All team members present and **roles defined**

1. Nurse: monitor lines, monitor patient vitals/status
2. Respiratory therapist: maintain airway, secure ETT during mobility
3. Physical therapist: facilitate mobility, assist throughout mobility task
4. Occupational therapist: assist with facilitation of mobility, facilitate functional activity

Pre-Mobility Checklist: ECMO

(All above apply plus)

- Cleared for early mobility by ECMO team during rounds
- ECMO cannulas secure
- **Additional team members needed:**
  - **ECMO Primer**
  - **ECMO Specialist**
  - **ICU Provider (Attending/NP/Fellow)**
- All team members present for initial session
- Members present at subsequent sessions determined by level of comfort



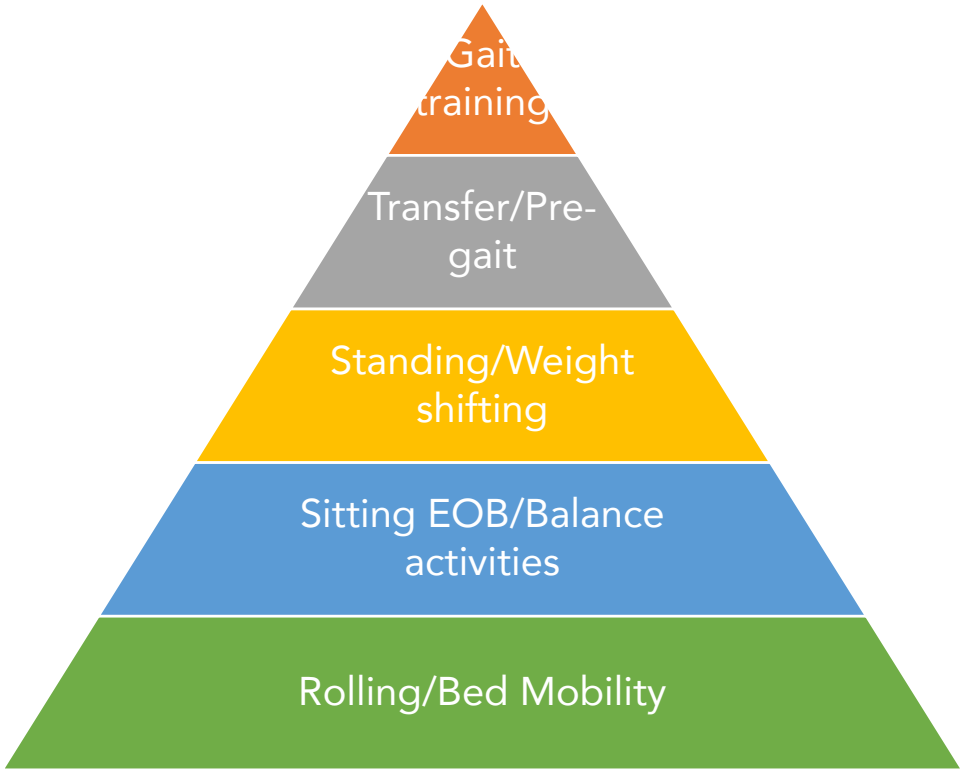
ECMO Pre-mobility Screening

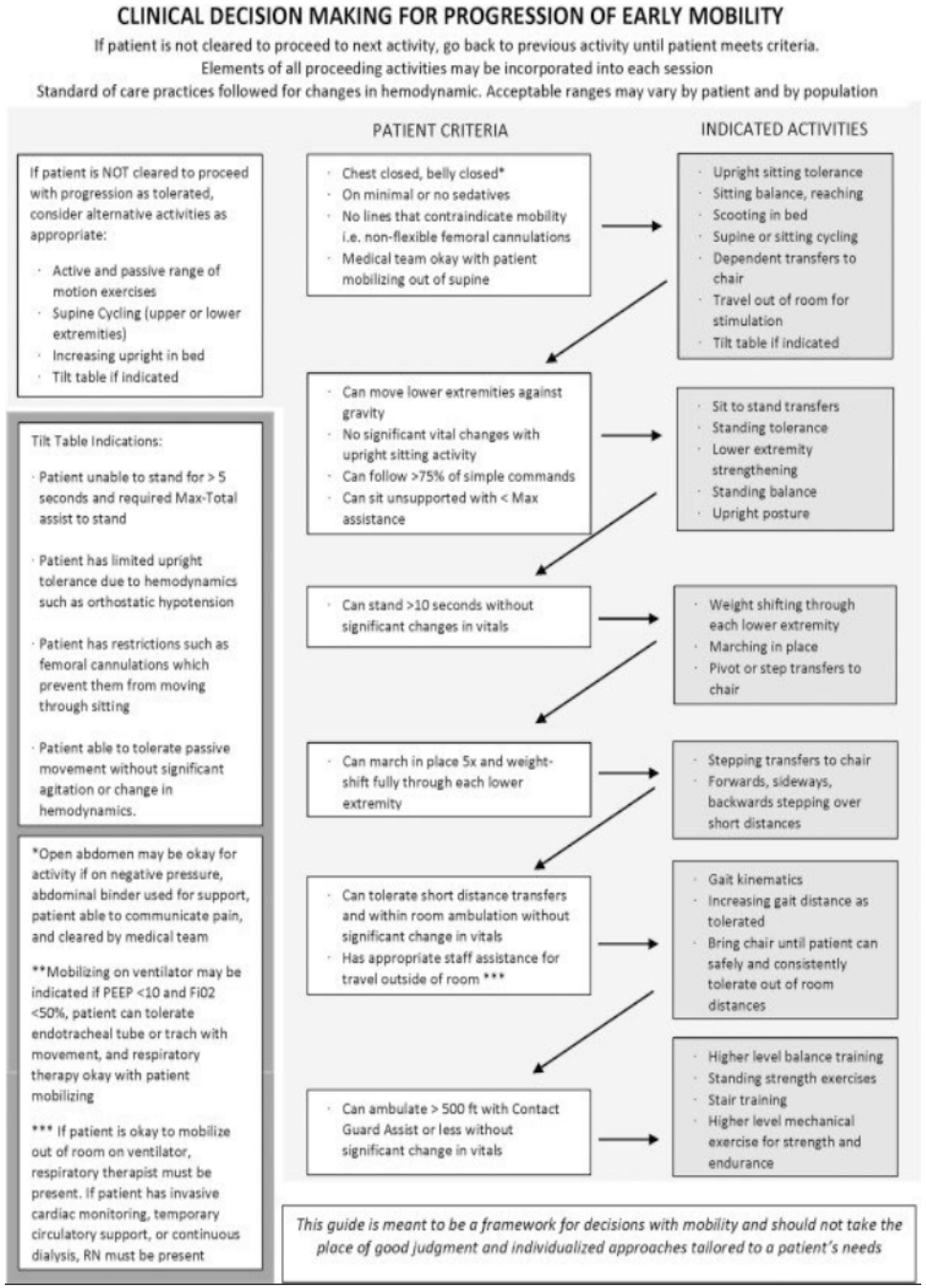
- Patient
  - Cognition (RASS/Sedation)
  - Vital Signs/Medial Stability
  - Pulsatility
  - Vascular/Neuromuscular Assessment
  - **Response to compromised ECMO Support**

- ECMO Circuit
  - Circuit tolerance with mobility
    - During day
    - Femoral cannula tolerance
  - Circuit stability
  - Cannulation site/anchors
  - Cannula color/change in color with mobility

ECMO Advantage

Decision-Tree for Appropriate Progression of Safe Mobility





Improving outcome for critically ill cardiovascular patients by increasing physical therapy staffing. Johnson et al. Archives of Physical Medicine and Rehabilitation. 2019; 100.

Comprehensive Equipment to Maximize Patient Safety with Advancement of Mobility

Neurochair

Sitting at EOB

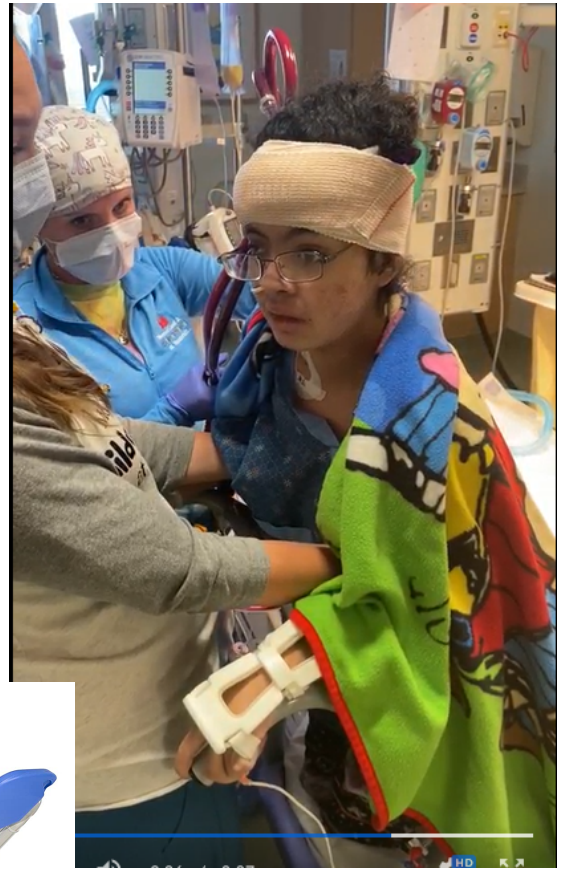
https://
vumc.app.box.com/file/
937733028711

Seated Treadmill

Wheelchair Propulsion

https://
vumc.app.box.com/file/
951002972956

Stedy



Walker

Walking!

https://
vumc.app.box.com/file/
958530344212

Emphasis on a **collaborative, multidisciplinary approach** to safely advance mobility, best meet the patient's needs, and accomplish patient- and family-selected goals to optimize participation and overall healing and recovery.

https://vumc.app.box.com/file/950195412638?s=cjs357pu00988x8f5w0swbgu8a62di92&sb=/details

Other Medical Considerations: ECMO

- Coordination of multidisciplinary mobility efforts
  - Proactive communication
- Attention to signs of stroke or focal sensory changes
  - Critical illness neuropathies or myopathies
- Anxiety management
- Time sensitive initiation of mobility strategies
  - The longer we wait to begin mobility, the more barriers to overcome

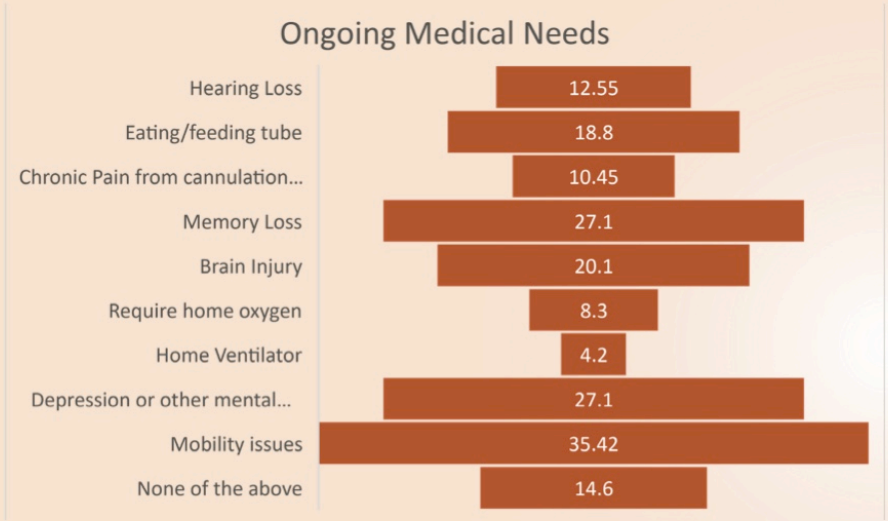
Therapy Considerations for ECMO

- Active prevention of secondary impairments
  - Pressure injuries, contracture, neuropathies, muscle atrophy
- Time sensitive progression of gross mobility
  - Medical clearance for initiation of larger mobility
  - "Fighting the clock" against active deterioration and deconditioning
  - Appropriate, safe advancement of mobility as tolerated
- Frequency of therapy treatments
  - Consideration of BID treatments as needed
- Upright positioning strategies and carryover outside of treatment times
  - Activity orders, RN education, empowered PICU/ECMO team

ECMO Mobilization

Patients & Family Support

ELSO is launching tools and services for ECMO patients, survivors, friends, and families. Always a tight community, ELSO began work in 2020 to understand what gaps in information, services, or support that are unmet. We surveyed this group to better understand the needs of the patient-related ECMO community. Several key findings:



While survey results reflects a limited data set, the feedback is still meaningful and we will be sharing more findings with our global ELSO community so you can incorporate improve your programs, including anticipating services needed once patients leave the hospital setting.

"The length of time a patient spends immobile has been the ONLY factor consistently limited to a patient developing ICU-acquired weakness"

"Intensive care unit acquired weakness (ICUAW) is being increasingly recognized as a significant clinical problem in critically ill patients who have spent longer periods of intensive care unit (ICU) stay and mechanical ventilation (usually greater than 7 days)."

-Kukreti et al[1]

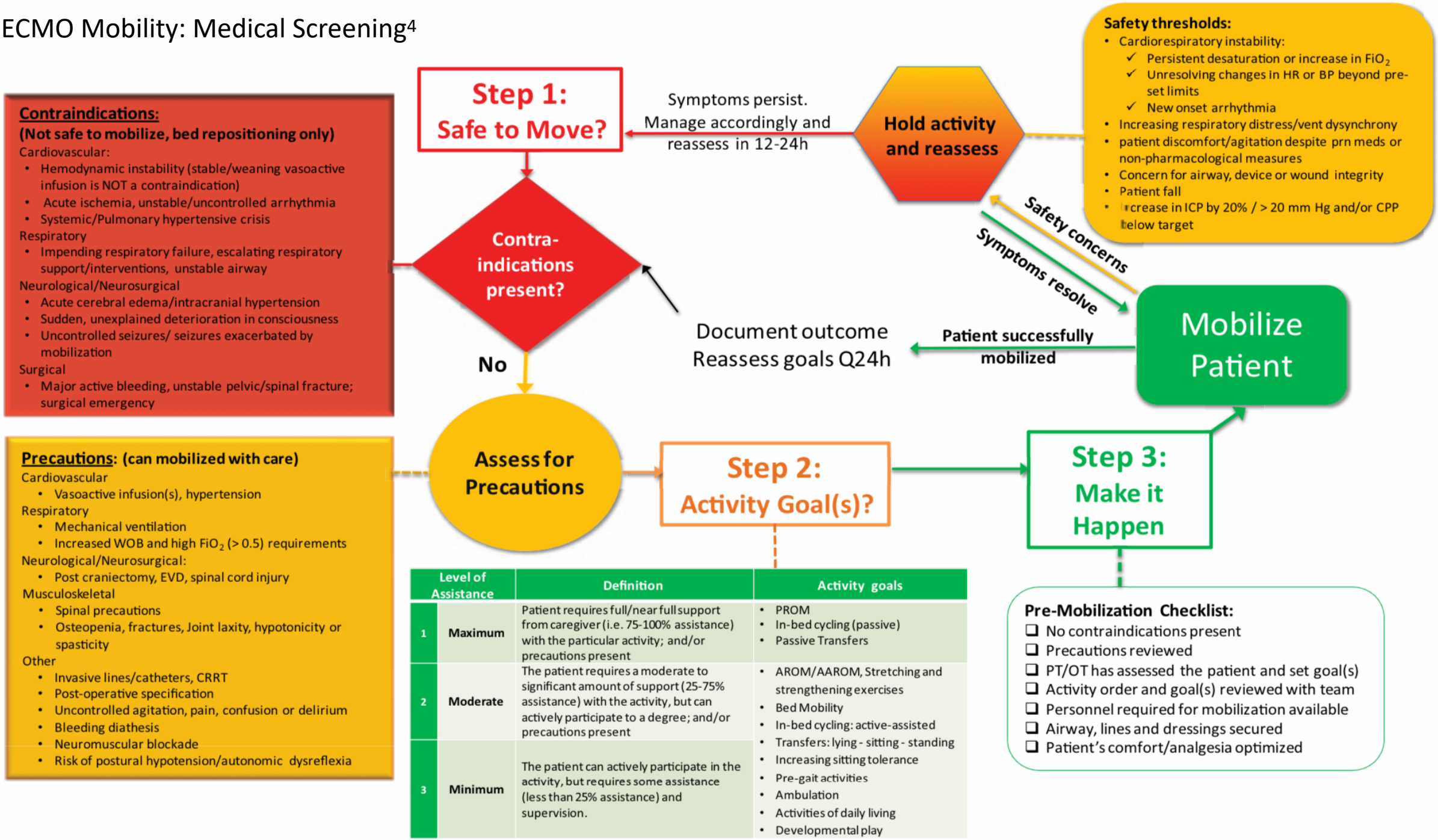
"Intensive care unit acquired weakness (ICU-AW) is a well-recognized complication in adult patients with critical illness...but is largely unexplored in the pediatric population.

As a result, children who are at risk for acquiring neuromuscular dysfunction due to critical illness are less likely to be identified, evaluated and receive appropriate therapies. Furthermore, little is known about important risk factors and how ICU-AW impacts important short and long-term clinical outcomes. "

- Ridley et al[2]

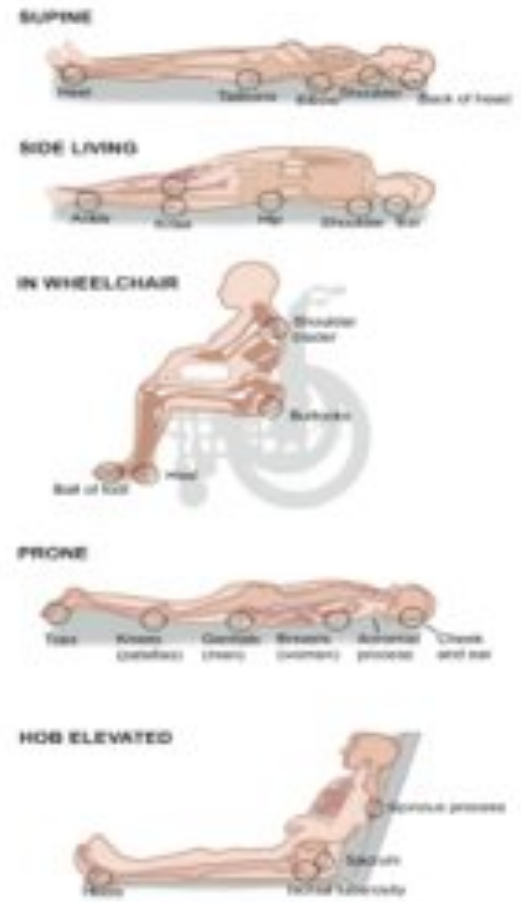
The above comes directly from Extracorporeal Membrane Support Organization 2020 Annual Report

ECMO Mobility: Medical Screening[4]



Diagnosis-Specific Considerations: SCI

- Wound Prevention
  - Strict repositioning schedule
  - True sidelying, initiation of prone positioning for high-level SCI
  - Sacral offloading every 30 minutes while sitting
  - True 90-degree upright sitting
- Sensory impairments
- Respiratory Considerations
- Upright positioning considerations
  - Blood pressure
    - ACE Wraps and Abdominal binder only during OOB positioning; doffed with return to bed
  - Pressure relief schedule/offloading
- Psychologic considerations
- Discharge coordination
- Early involvement of Physical Medicine and Rehabilitation Team (PM&R)

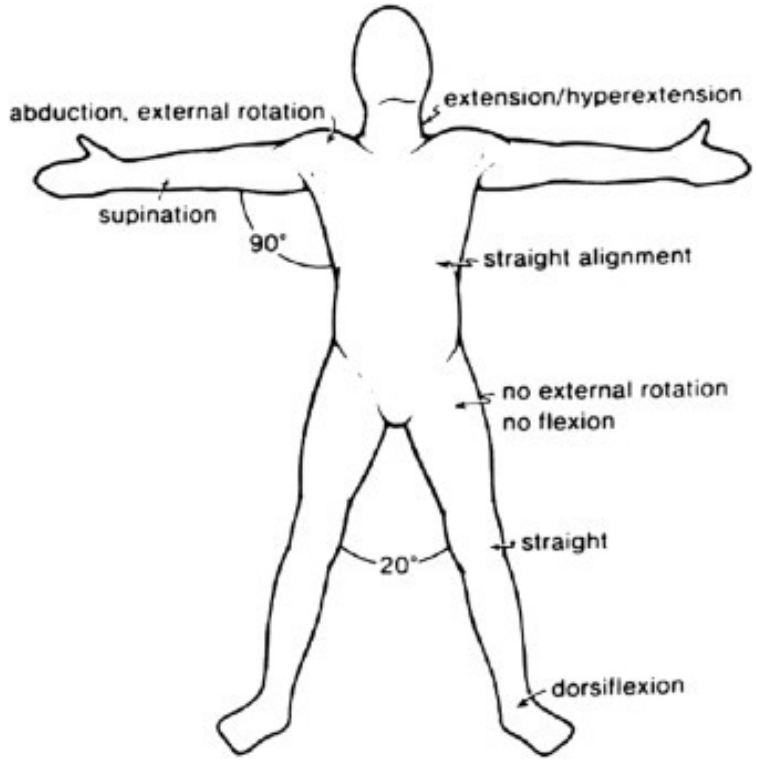


Diagnosis-Specific Considerations: TBI

- Importance of environment
  - Minimize "extra" talking or sounds/stimuli as able
  - Awareness of external stimulus during periods of agitation
  - Day/Night cycles and appropriate schedules as able
- Appropriate balance of stimulation and rest
- Safe facilitation of freedom of movement
- Behavioral considerations
  - Role of redirection > reaction
- mTBI considerations
  - "no bleed on imaging" with CT; MOI concerning for shear injury
  - RN often first to identify concerns for true injury despite absence of imaging
- Early involvement of Physical Medicine and Rehabilitation Team (PM&R)

Diagnosis-Specific Considerations: Burns

- Avoid "positions of comfort" around burned areas
- Functional mobility is the most beneficial form of therapy
- Proactive communication with Burn team – wound care, dressing changes, etc
- Strict compliance to splint wear and positioning recs by PT/OT
  - Prevent contracture
  - Maintain integrity of grafts
  - Use of signage in room describing individual positioning needs



Diagnosis Specific Considerations: Cardiac

- Sternal precautions
- Open chest
- Heart transplants
- Sensory considerations

Overcoming Barriers and Sustaining Change

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Staff Survey Pre/Post to Assess Barriers

Profession	Pre-Mobility (N=168)	Post-Mobility (N=135)	P=0.766
RN	52% (88)	54% (73)	
RT	20% (33)	13% (18)	
MD	11% (19)	14% (19)	
NP	5% (8)	5% (7)	
ECMO team	4% (7)	4% (6)	
PT	4% (6)	4% (6)	
OT	2% (3)	4% (5)	
SLP	2% (3)	1% (1)	
PA	1% (1)	0% (0)	
Years of ICU Experience	7.07 ± 6.90	6.85 ± 7.12	P=0.553
Adult ICU Experience	28% (47)	23% (31)	P=0.321

Response rates:
Pre-EM: 57%
Post-EM: 44%

N=97 paired responses

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Hanna, Eriny S. BA1; Zhao, Shilin PhD2; Shannon, Chevis N. MBA, MPH, DrPH2,3; Betters, Kristina A. MD2,4,5 Changes in Provider Perceptions Regarding Early Mobility in the PICU*, Pediatric Critical Care Medicine: January 2020 - Volume 21 - Issue 1 - p e30-e38
doi: 10.1097/PCC.0000000000002177

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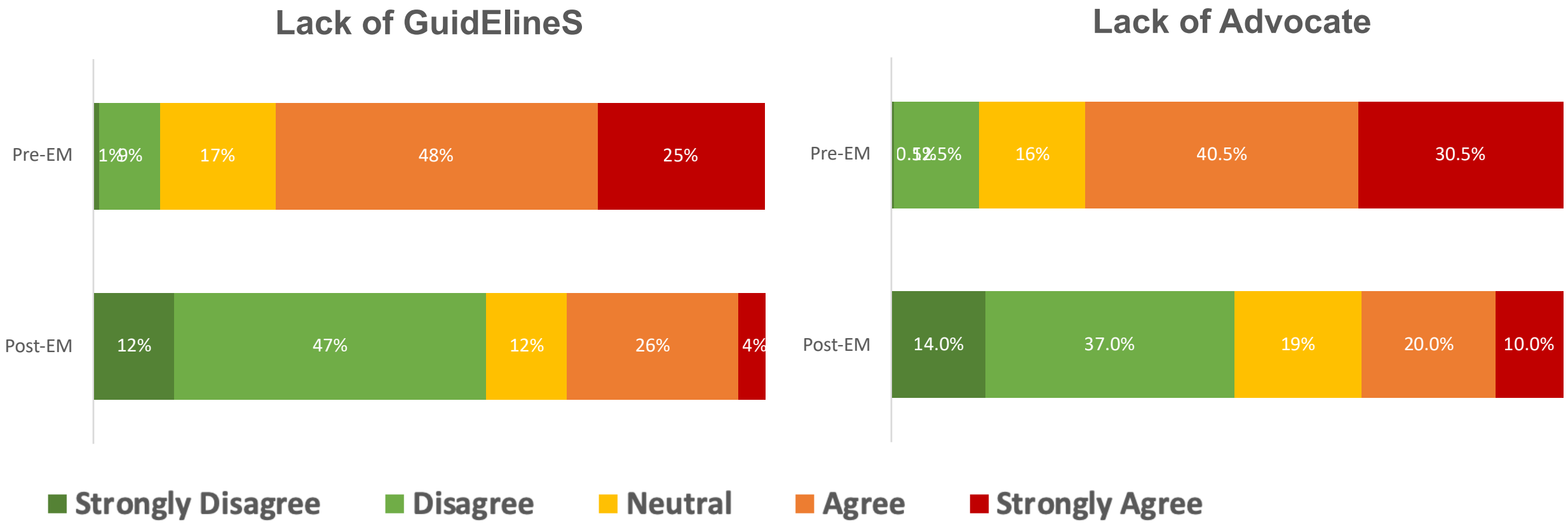

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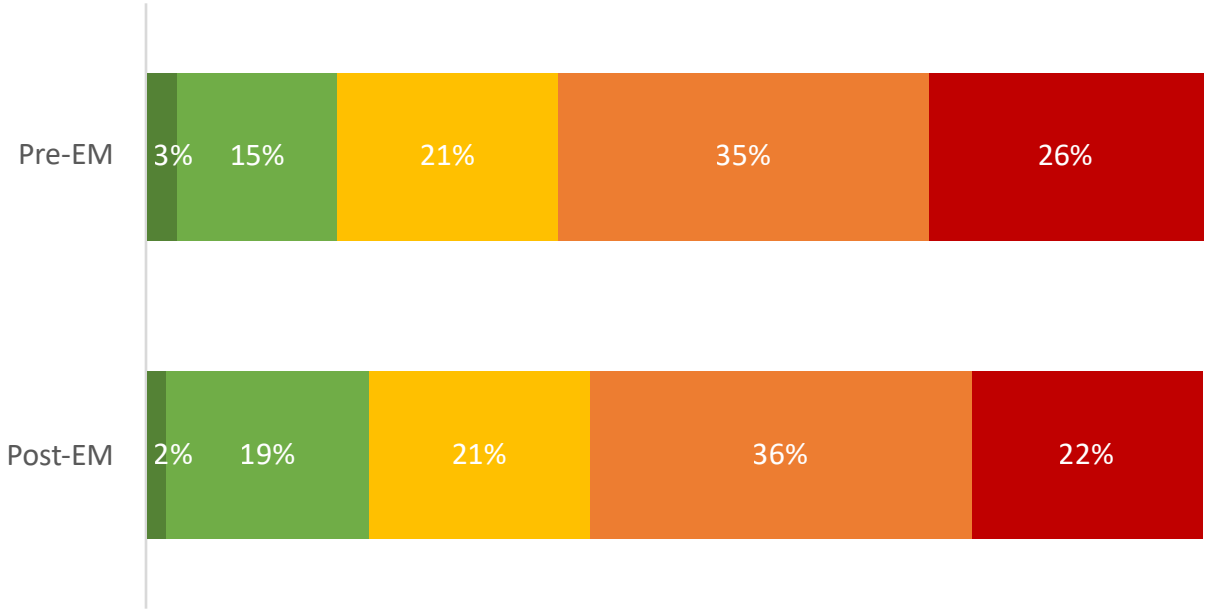
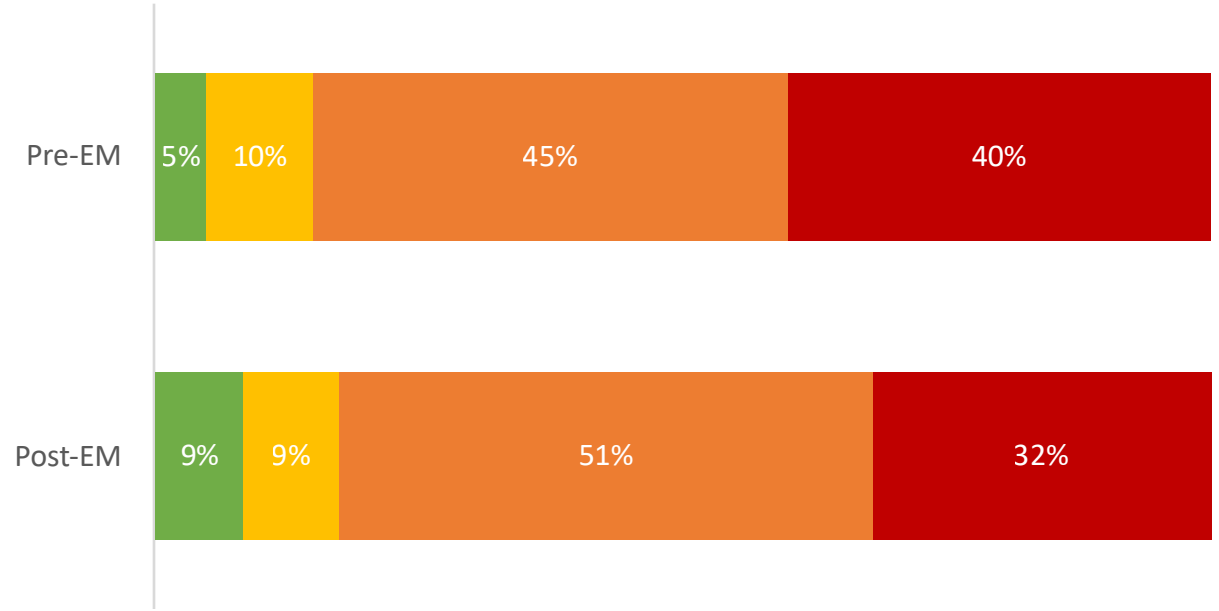
Lack of Equipment



Patient Clinically Unstable



Strongly Disagree Disagree Neutral Agree Strongly Agree

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Discussion

- Prior to EM protocol, staff exhibited concerns regarding
  - Structural barriers, including coordination and training
  - Safety of EM
  - Staff availability
- Significant changes in PICU culture and perceptions after implementation of protocol
- Remaining concerns
  - Resource availability
  - Patient status

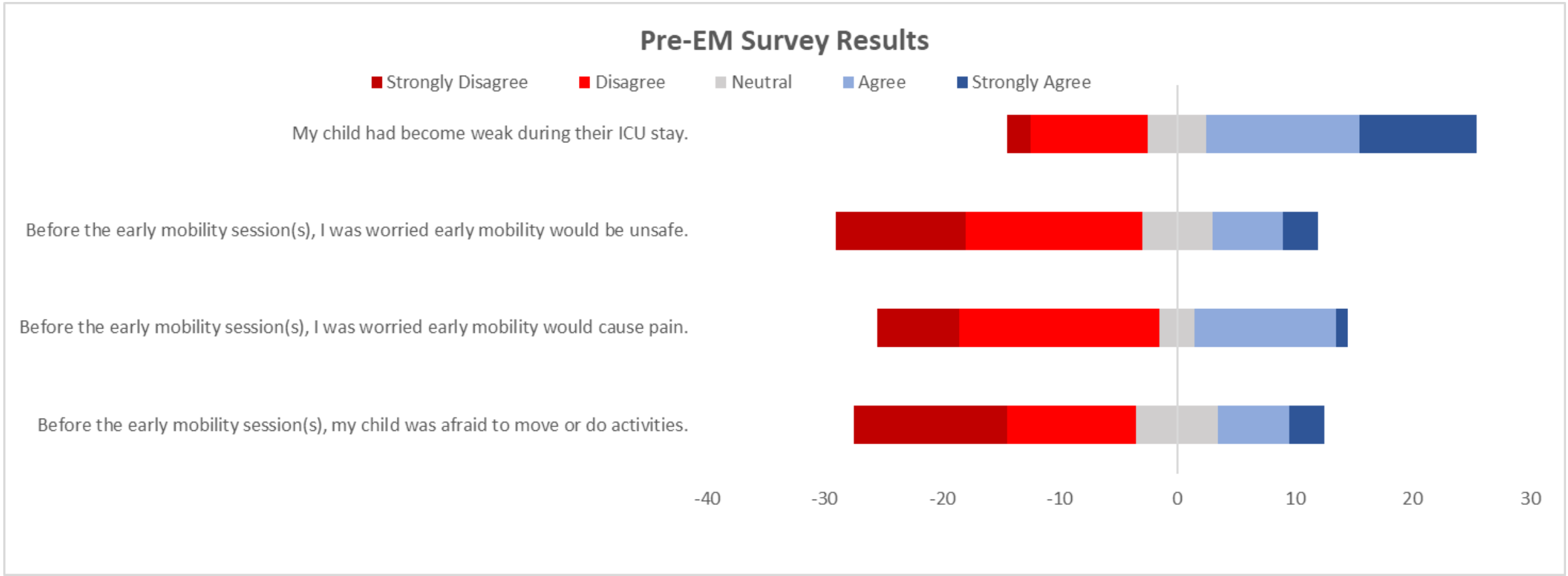
Family Survey *accepted for publication by Journal of Pediatric Rehabilitation Medicine

Table 1. Age of caregiver's child and number of caregiver witnessed early mobility sessions

	n=40
Age in years, median (25th, 75th)	3 (0.3, 11.8)
Number of EM[a] sessions witnessed	
1	6
2-5	19
6-10	6
>10	9

[a]EM= early mobility

Family Survey



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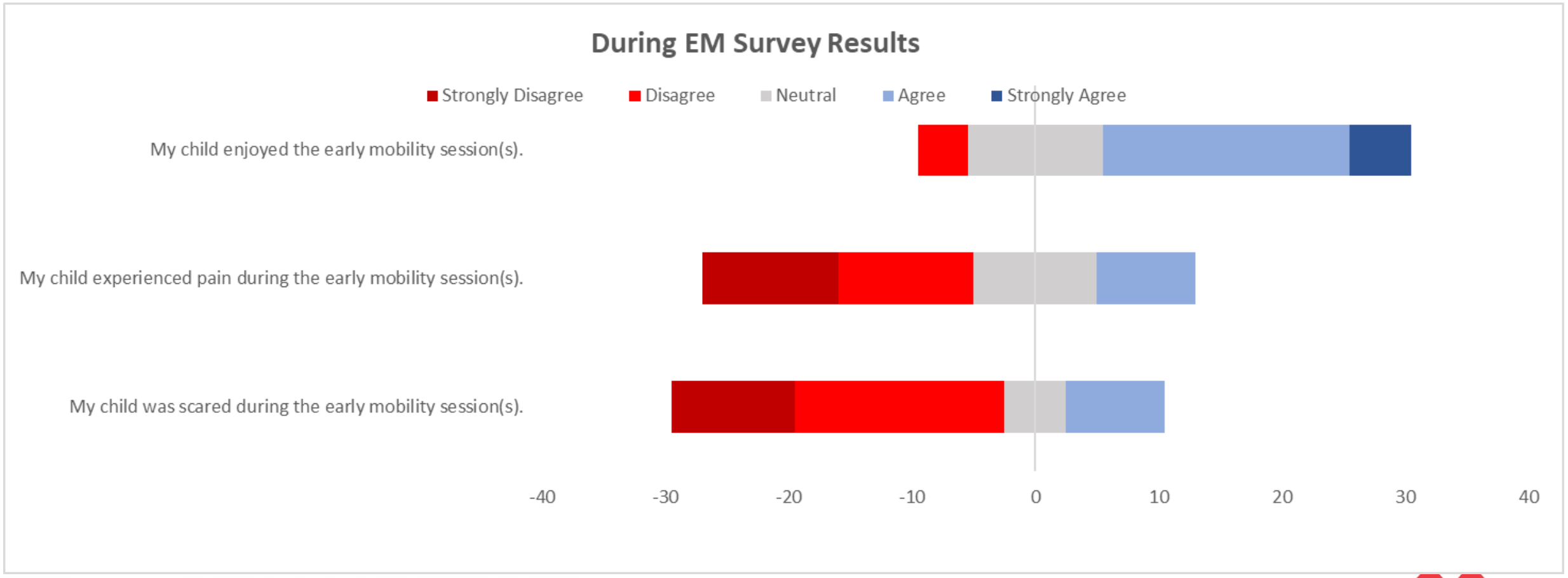
Family Survey



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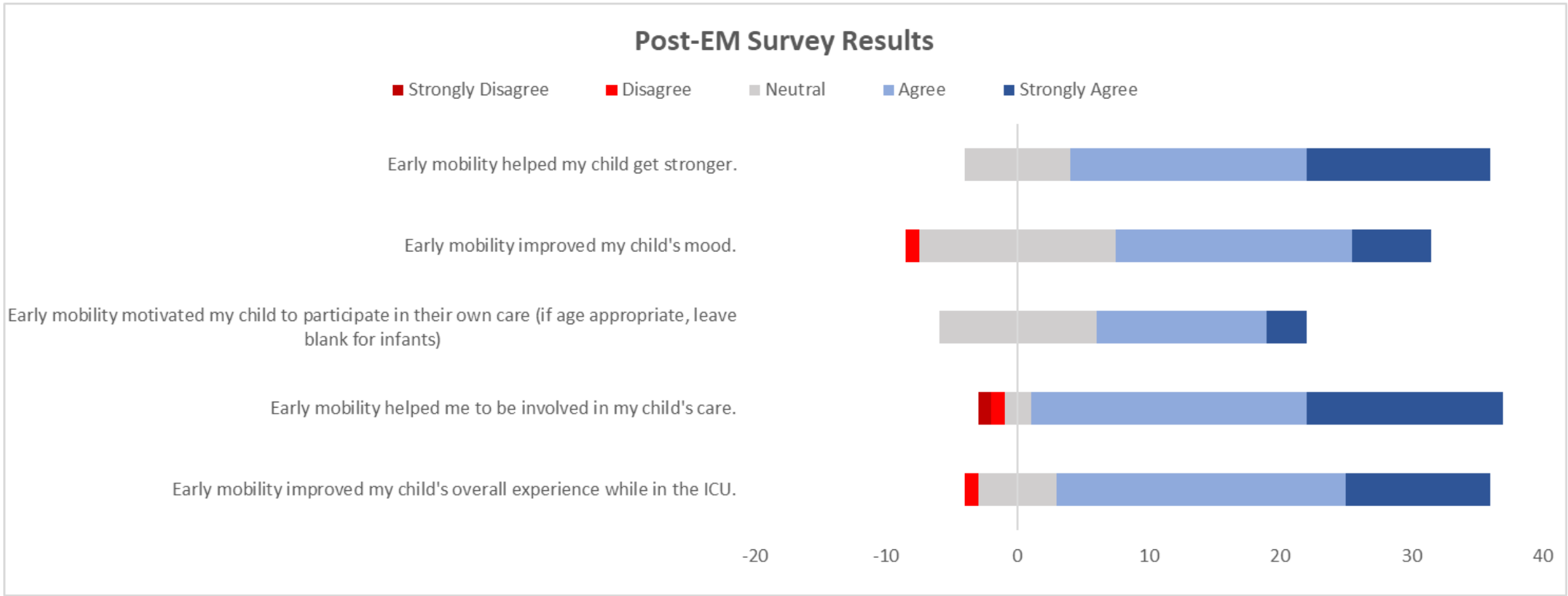
Family Survey



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Family Survey

- Overwhelmingly positive feedback from caregivers
- Next steps- to examine affect of family/caregiver presence of patient participation in Early Mobility

Therapy Staffing: Where we started and where are we now

January 2018

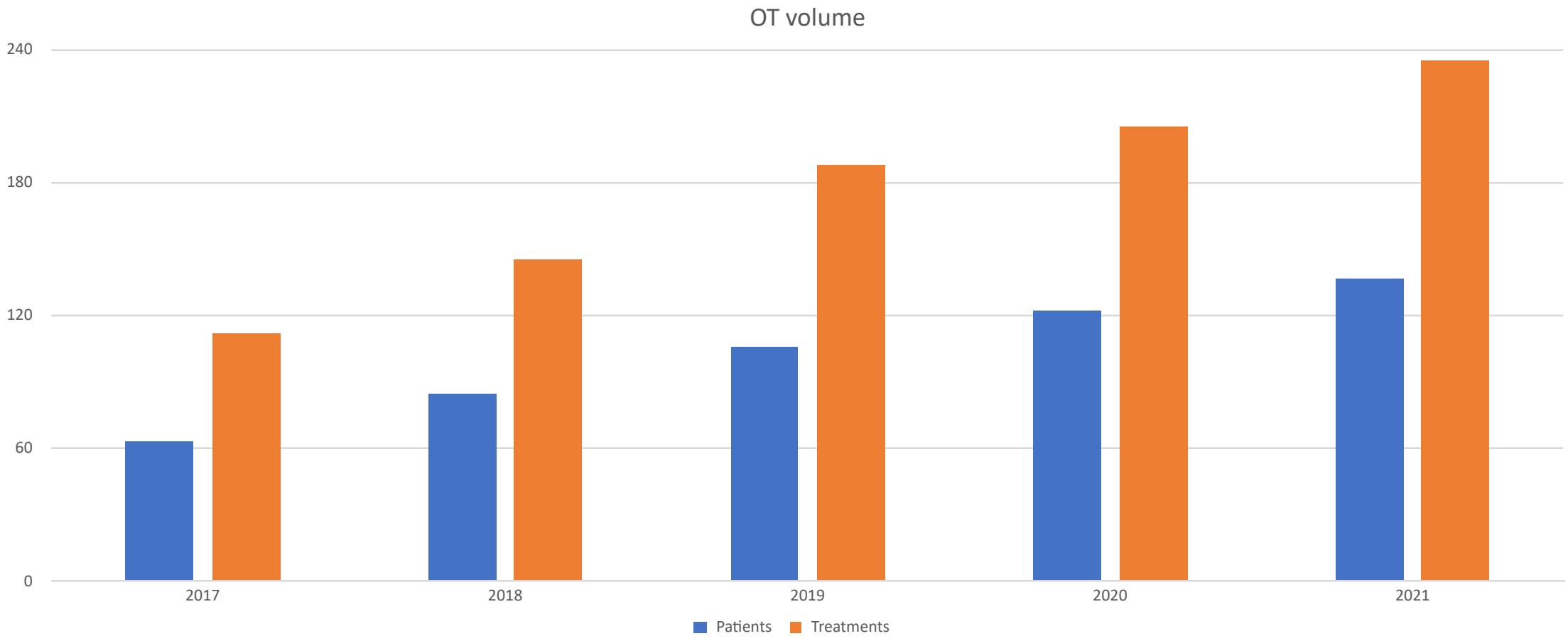
- OT: 3.6 FTE
- PT: 5.3 FTE

September 2023

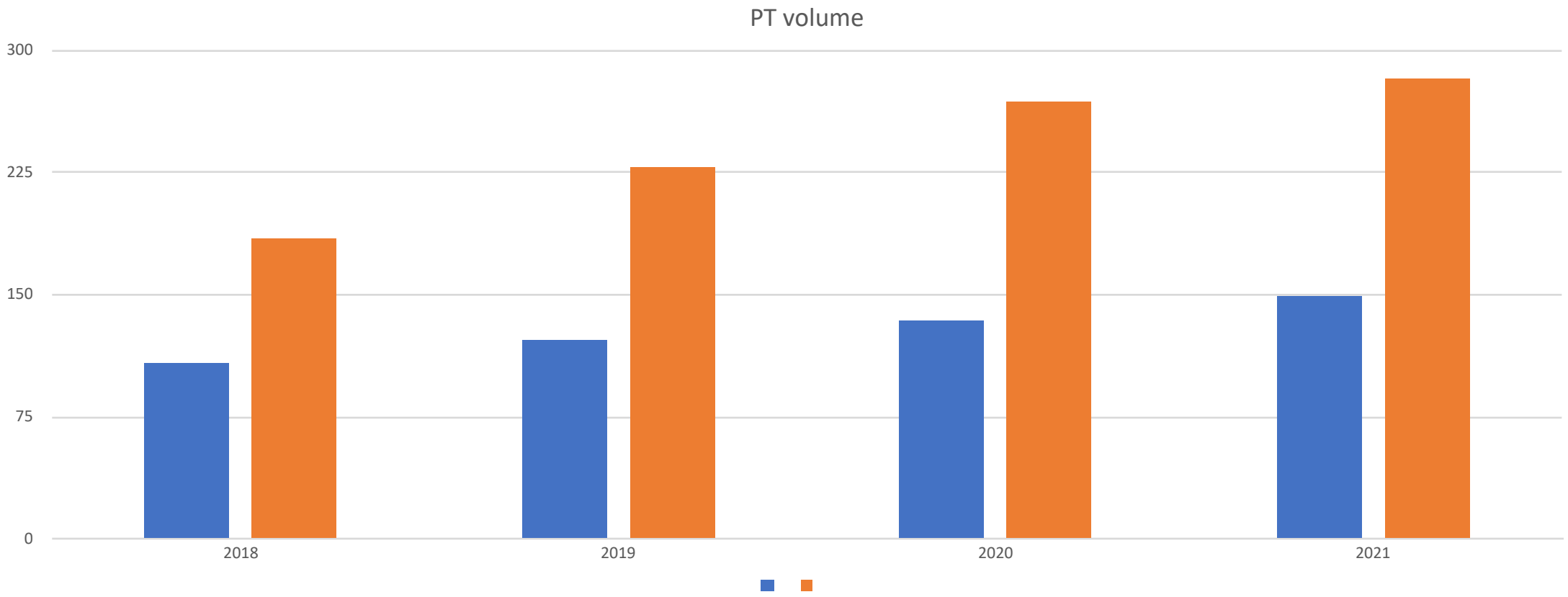
- OT:
- PT:

This had impact on therapy involvement in entire hospital system

Occupational Therapy



Physical Therapy



How did rehabilitation respond?

- Eager acceptance of protocol and model
- Ongoing assessment of needs, appropriateness of orders, best provision of care for patients
- We had to change the culture
  - Increased presence in rounds and meetings
  - Increased manager role in advocacy for department
  - We had champions!
  - Redefined our triage process
- We ensured all of our patients were being seen weekly
- Administration was kept up to date on early mobility

Equipment

- Therapy helped identify equipment needs
- Started with the most utilized and basic
- Fundraising to get dedicated equipment to EM program
- Team effort to secure storage, ensure care and cleaning protocols
- Continued advocacy from floors to obtain equipment
- Applying for many different funding sources to continue to build

Tools for Success – Changing the Culture

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Education

- Asked educators and champions in each field to educate staff
- Formal RN lectures
- Bedside teaching
- Jumpstart/emails
- Family handouts with help from Family Resource Center
- RN/rehab joint effort to create training videos
- Caregiver education resources – family groups

Transfer Videos

- Developed by Rehab team; access to QR codes for bedside signage
- Hoyer Lift - https://www.youtube.com/watch?v=dv6BBUXGfjQ&list=PLuWU7C3CDd9rk4sVvMA0oqhBCMP8weYog

- Neurochair Transfer - https://www.youtube.com/watch?v=epafJ4CQU78&list=PLuWU7C3CDd9rk4sVvMA0oqhBCMP8weYog&index=2

- Stand Pivot Transfer - https://www.youtube.com/watch?v=McxJaFWGHD0&list=PLuWU7C3CDd9rk4sVvMA0oqhBCMP8weYog&index=6

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Early Mobility in the ICU: Why it's Good for Your Child

What is early mobility?

The term "early mobility" refers to the movement and exercise therapy your child will get while they're in the ICU. It's called "early," because it happens as soon as their first few days in the ICU. It may include physical therapy or occupational therapy. Both kinds of therapy include activities and movement exercises that help strengthen muscles and improve balance, coordination, and endurance. If your child needs help communicating, a speech therapist may also work with them in the ICU.

Is it good for my child?

Yes. Research has shown that patients do better with early mobility. Early mobility should help your child get better faster.

Patients who don't move enough in the ICU have higher risk of:

- losing a lot of muscle strength very quickly
- becoming very weak
- longer ICU and hospital stays
- slower healing in the ICU and the hospital.
- weakness that lasts even after they've left hospital
- a longer time getting back to normal life and activities.

Is it safe?

Yes; research has shown that it's safe. We do everything we can to keep your child safe during early mobility, including:

- securing all of the lines and tubes that may be attached to your child so they don't get in their way
- having several staff members there to help your child when they move
- closely watching your child's vital signs (such as oxygen levels and blood pressure) when they move.

If we ever notice that your child is not doing well during early mobility, we'll stop the session and let them to rest.

Is there anything I can do to help?

Some children are ready to move after being in bed for a long time. But many others feel afraid. This is normal. If your child is scared, you can help us. Simply being there to cheer them on during therapy is a huge help. We'll also teach you safe exercises that you can do with your child outside of therapy sessions to help them get stronger.

Strategies for Carryover of Therapy Recs

- Day/Night schedule
  - Lights on during day, off during night and naps
  - Age appropriate environmental stimuli around sleep needs
- Splint wear schedule
- OOB or upright positioning
  - Goal of 2-3x/day
  - OOB for meals
  - Coupled mobility and transfers with toileting
- Inclusion of caregivers
- Proactive communication
- Functional strengthening strategies
  - "The power of DOING"
  - Socks, self-feeding, rolling, bridging in bed, lifting legs for SCDs, etc

Role of Child-life

- Visit family before and during sessions
- Helps prepare patient and family
- Assist with daily schedule coordination
- **Assists with anxiety management**
- Engages family
- Helps make mobility fun!

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Child Life with Early Mobility

- Level 1:
  - Environmental strategies for delirium prevention and calming strategies
  - Sibling support
- Level 2:
  - Encouragement of age-appropriate play and toys during upright positioning
  - Coping and stress management strategies with intubated patients
- Level 3:
  - Engaging in out of room activities and normalization of hospital environment

Child Life Assist with Coping

- Coping with functional deficits and “new normal”
- Preparation of transitions with discharge planning
  - Home
  - Inpatient Rehab facility
- Tracheostomy coping
- Transitions to home-bound schooling
- Empowerment within deficits – highlighting abilities over disabilities

Patient and Caregiver Advocacy for Therapy Goals and Mobility

- Emphasize goals that are important to the patient and family
  - Sometimes medical providers and families' goals don't align -> how can we still have a therapeutic impact?
- Family/patient empowerment
- Impact of patient and parent anxiety on progress with therapy
- Collaboration with Primary team, Child Life and Palliative Care teams
  - Minimizing anxiety, maximizing education and communication
- End of life considerations and patient-centered goals

Night Shift Strategies

- Therapy doesn't just happen in the daytime!
- Functional strengthening opportunities with bedtime ADLs
- Continued use of splints
- Upright positioning to TF chair or neurochair for dinner or bathtime
- Review of daily activities with pt or caregiver to assist with coping and wind down
- Couple cares to maximize opportunities for sleep
- Control environment with "lights off", age appropriate screen time, and sound control to encourage sleep hygiene

Patient Impact & Outcomes

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VCH Early Mobility Outcomes

Table 1: Demographic and clinical factors of patients in each cohort

	Pre-protocol (N=155)	Post-protocol (N=199)	P-value
Female, % (n)	45% (69)	37% (74)	=0.163
Year of age, average ± SD	10.25 ± 5.35	10.45 ± 5.59	=0.783
PIM2*, average ± SD	5.31 ± 10.96	3.41 ± 5.39	=0.041
Incidence of delirium, % (n)	24% (37)	28% (56)	=0.365
Required invasive mechanical ventilation, % (n)	49% (76)	57% (113)	=0.147
Required sedative drips, % (n)	46% (72)	55% (109)	=0.12

VCH Early Mobility Outcomes

Table 2: Rehabilitation outcomes of patients in each cohort

	Pre-protocol (N=155)	Post-protocol (N=199)	P-value
Evaluated by PT/OT, % (n)	51% (79)	94% (187)	<0.001
Days of PICU LOS, median (IQR)	6.0 (4.0, 9.0)	7.0 (5.0, 13.5)	=0.03
ICU day of PT/OT evaluation	4.01	3.48	=0.411
# of PT/OT sessions, median (IQR)	3.50 (2.0, 7.0)	4.0 (2.0, 9.0)	=0.043
Disposition			=0.438
Death	5% (8)	4% (7)	
Home	88% (137)	85% (170)	
Rehab facility	5% (8)	9% (17)	
Hospital transfer	1% (2)	3% (5)	

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EM Outcomes Research

- Protocol effective
  - Increased number of patients evaluated
  - Increased number of sessions in ICU (although may be affected by ICU LOS)
- More work needed on true clinical outcomes- difficult given heterogenous population, need RCT
- Need more robust data on patient functional outcomes

Prior Outcome Measures

- Limited functional outcome measures in pediatric acute care
- **Functional Status Score (FSS)**
  - Assess mental status, sensory, communication, motor, feeding, and respiratory status
  - 5 point scale, normal (1) to very severe dysfunction (5)
  - Validated for PICU with high inter-rater reliability
  - Used in adjunct to the PAMS to capture changes in function due to medical complexity
- WeeFIM
- PEDI
- BOT

What is the PAMS?

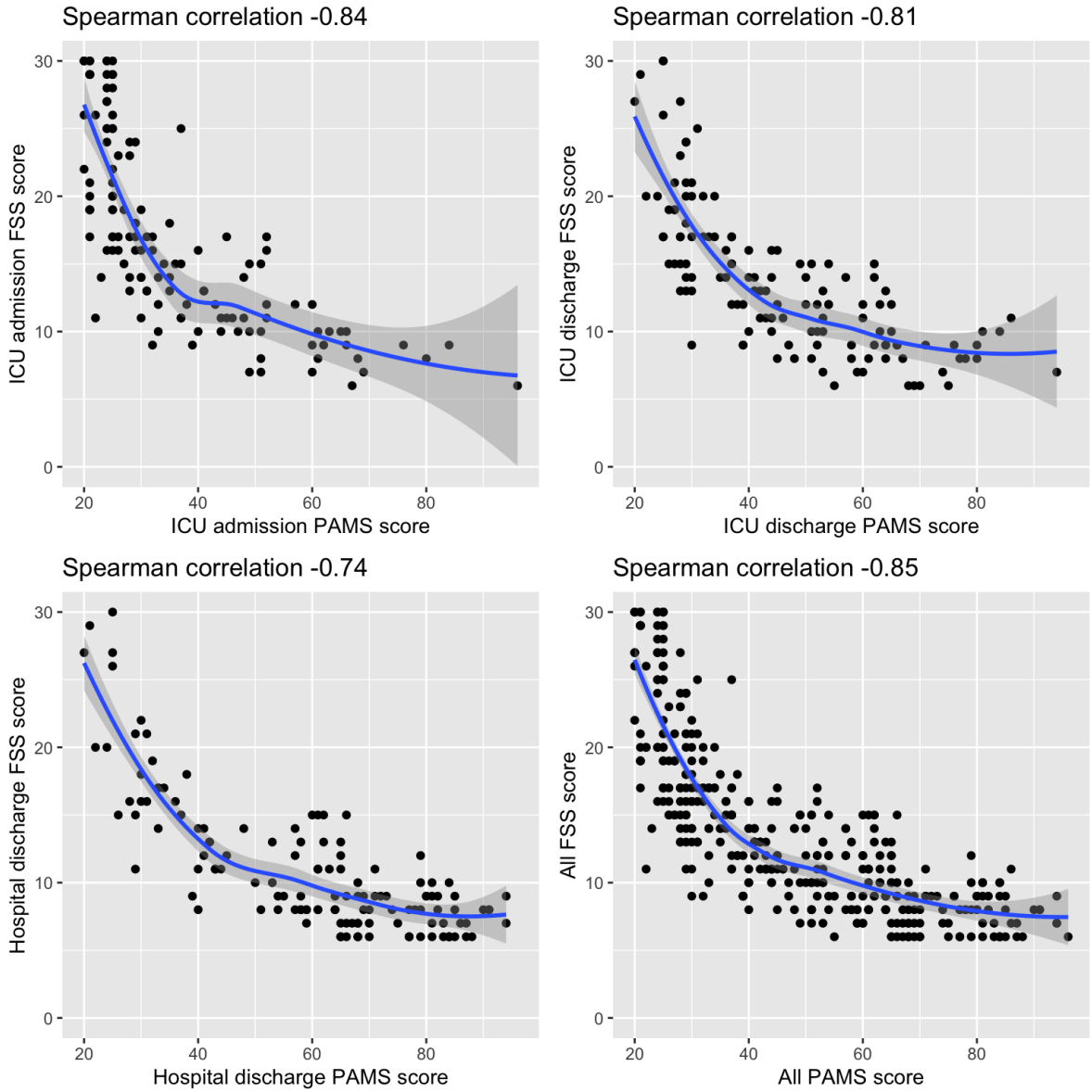
The Physical Abilities and Mobility Scale (PAMS)

- The PAMS is a 20-item measure designed to quantify progress towards PT goals.
- It was developed and studied at Kennedy Krieger as an outcome measure to track functional progress in children from ICU admission through inpatient rehabilitation
- Intended for children age 2 years and older.
- Each item is scored on an ordinal scale from 1 to 5.
- Individual item scores are totaled for a final score of 20 to 100.
- Higher scores represent higher levels of function.
- Administration time is 20-45 minutes.
- Validated in children with acquired brain injury and SCI undergoing inpatient rehab.

Melissa K. Trovato, M.D.1,2, Elena Bradley, P.T.1, Beth S. Slomine, Ph.D.1,2,3, Cynthia F. Salorio, Ph.D.1,2,3, James R. Christensen, M.D.1,2,4, and Stacy J. Suskauer, M.D.1,2,4 1Kennedy Krieger Institute. The Physical Abilities and Mobility Scale (PAMS): reliability and validity in children receiving inpatient brain injury rehabilitation*, Arch Phys Med Rehabil . Author manuscript; available in PMC 2014 July 01.

The Physical Abilities and Mobility Scale as a New Measure of Functional Progress in the PICU*

- PAMs vs. FSS



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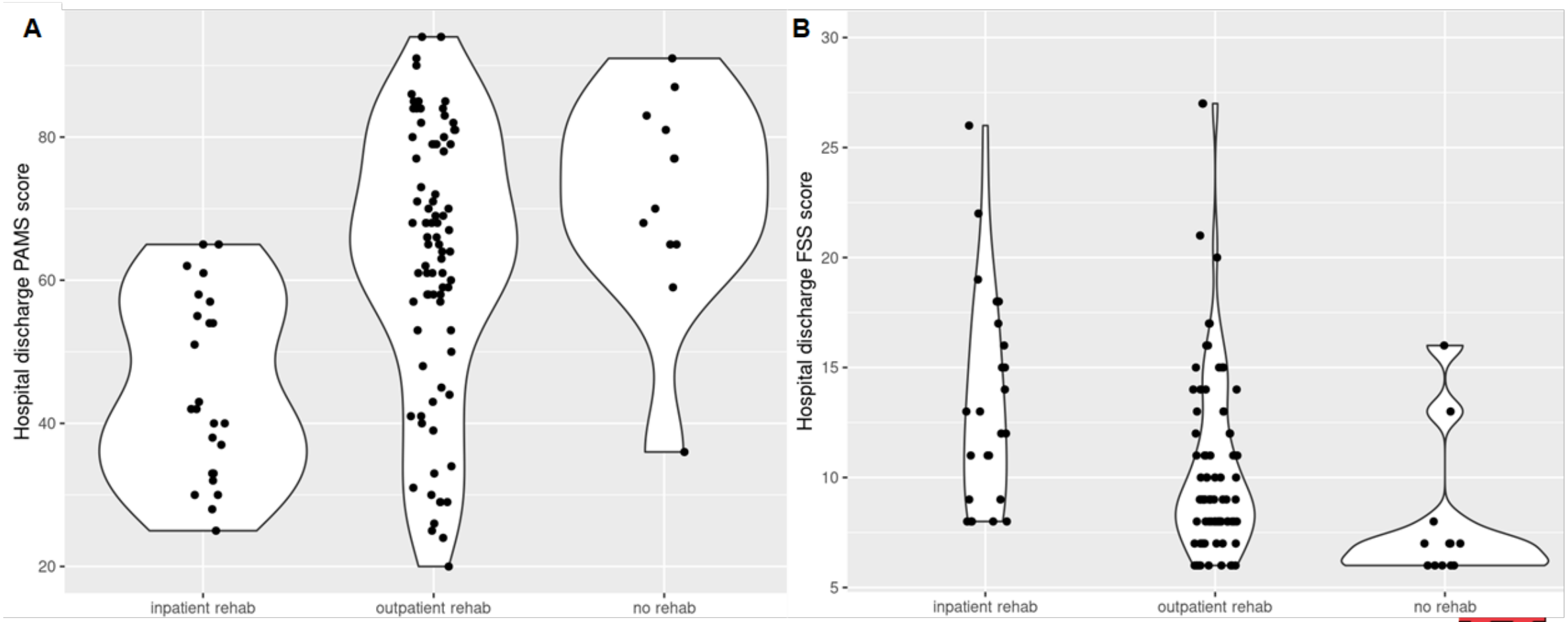
PAMS

Figure 2



Rehabilitation Recommendations at Discharge

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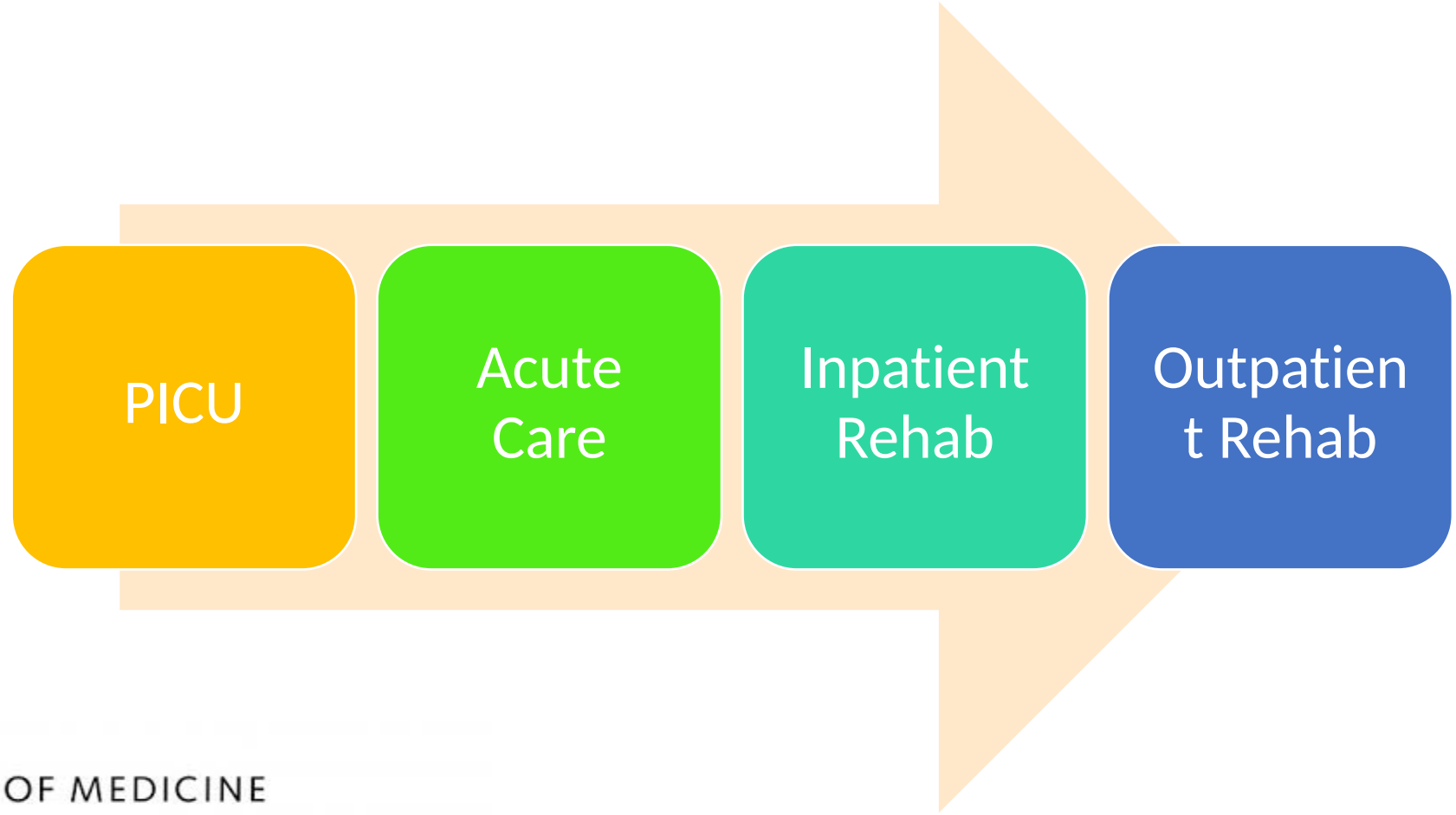
Functional Application of Data

- Assisting with advocacy for therapy resources
- Population-specific functional assessments
  - Already validated in TBI, SCI
- Guiding clinical decision-making regarding disposition planning
- Tool for follow-up clinic assessment of functional improvements or impairments
    - ICU Follow up
    - PM&R Follow up

Future Directions

- Track PAMS across the continuum of care



Future Directions- Post Intensive Care Syndrome

- **Post Intensive Care Syndrome (PICS) -** a collection of physical, mental and emotional symptoms that continue to persist after a patient leaves the intensive care unit (ICU)

- Caused by a combination of multiple factors:
  - serious medical conditions themselves (such as respiratory failure, sepsis)
  - use of life-sustaining equipment (such as endotracheal tubes, mechanical ventilators)
  - use of sedative, pain and other medications that have mind-altering (including delusional) effects.

Physical Symptoms	Cognitive Symptoms	Psychological Symptoms
Breathing difficulties	Memory difficulties	Anxiety
Weakness and balance problems	Concentration difficulties	Depression
Neuromuscular impairments	Slowed mental processing	PTSD
Pain or numbness	Trouble carrying out tasks	Sleep problems

Future Directions: (PICS)

- Who does this impact?:
  - 33% of all patients on ventilators
  - 50% of all patients admitted with severe infection, which is known as sepsis
  - Up to 50% of patients who stay in the ICU for at least one week
  - Anyone who survives a critical illness that warranted admission to an intensive care unit (ICU) is susceptible to developing post-intensive care syndrome (PICS).

- Prevalence:
  - Cognitive impairments in 25% and upwards of adult ICU survivors
  - ICU-acquired weakness in 25-100% of adults
  - 1-62% incidence of psychiatric impairments post ICU
  - Pediatric data lacking - **Choong et al. published study showing functional deterioration in 81.5% of PICU patients at ICU discharge, with 24% still experiencing deficits at 6 month follow up**
  - **We need better scales to define true incidence in children!**

Future Directions: (PICS)

- In addition to the critically ill ICU survivor, the family and loved ones (“the caregivers”) who provide the needed care and support can also develop some of the same mental and emotional symptoms of PICS. This condition is called **PICS-family (PICS-F)**.

- Outpatient management and attention for ongoing symptoms is best managed through multidisciplinary ICU follow up

- https://www.icudelirium.org/patients-and-families/pediatric-patients

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Questions?

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References

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3286494/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3191069/
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3732163/
- https://park.web.jhu.edu/
- Physical Fitness and Metabolic Syndrome in Children with Repaired Congenital Heart Disease Compared with Healthy Children. (2017, September 28). Retrieved October 05, 2018, from https://www.sciencedirect.com/science/article/pii/S0022347617311393
- Snookes, S. H., Gunn, J. K., Eldridge, B. J., Donath, S. M., Hunt, R. W., Galea, M. P., & Shekerdemian, L. (2010, April). A systematic review of motor and cognitive outcomes after early surgery for congenital heart disease. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/20231182
- Moon, J. R., Song, J., Huh, J., Kang, I. S., Park, S. W., Chang, S. A., . . . Jun, T. G. (2017, September 08). The Relationship between Parental Rearing Behavior, Resilience, and Depressive Symptoms in Adolescents with Congenital Heart Disease. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/28944224
- Wernovsky, G., Light, D. J. (2016). Neurodevelopmental Outcomes in Children with Congenital Heart Disease – What can we impact? *Pediatric Critical Care Medicine.* 8(1), pp. 232,242.
- Basken, A. (2016, May 05). Research Matters: Risk and Prevalence of Developmental Delay in Young Children with Congenital Heart Disease. Retrieved from http://conqueringchd.org/research-matters-risk-and-prevalence-of-developmental-delay-in-young-children-with-congenital-heart-disease/http://conqueringchd.org/research-matters-risk-and-prevalence-of-developmental-delay-in-young-children-with-congenital-heart-disease/
- Marino, B. S. et al. (2012). Neurodevelopmental Outcomes in Children With Congenital Heart Disease: Evaluation and Management: A Scientific Statement From the American Heart Association. *Circulation. 126,* pp. 1143-1172. doi: 10.1161/CIR.0b013e318265ee8a
- Gillian, K. (2003). A Conceptual Model of the Factors Affecting the Recreation and Leisure Participation of Children with Disabilities. *Physical and Occupational Therapy in Pediatrics. 23*(1):63-90. DOI: 10.1080/J006v23n01_05
- Koukourikos, K., Tzeha, L., Pantelidou, P., Tsaloglidou, A., (2015). The importance of play during hospitalization of children. *Mater Sociomed. 27*(6), 438-441. doi: 10.5455/msm.2015.27.438-441.
- Rachwal, C., Imperial-Perez, F., Guerrero, M., Hagberg, N., Rempel, G., & Rummell, M. (n.d.). Neonatal and Pediatric Developmental Guidelines in the ... Retrieved from http://www.pcics.org/wp-content/uploads/2014/12/Neo_Pedia_Guidelines_Developmental_Care.pdf
- Mussatto, K. A. et al. (2014). Risk and Prevalence of Developmental Delay in Young Children With Congenital Heart Disease. *Pediatrics. 133*(3), 570-577. doi: 10.1542/peds.2013-2309

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References

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