Early Mobility of Critically ill Neurological Patients- Are We Really Behind?

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All speakers have nothing to disclose.

All equipment described in the presentation are what is available at our facilities, and speakers have no financial gain from discussing them.

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Objectives

• Describe etiology, risk factors, pathophysiology, and clinical presentation for stroke, TBI, subarachnoid hemorrhage and other neurological conditions commonly seen in the intensive care unit (ICU)
• Discuss the challenges and barriers commonly encountered when treating neurological patients in the ICU
• Identify and apply appropriate, evidence-based outcomes measures and interventions that could be utilized for implementation of early mobility of neurological patients requiring ICU management
• Outline components and implementation of different models for early mobility practices in critically ill neurological patients across the lifespan.
Current evidence for early mobility in other ICUs

Expert consensus and recommendations on safety criteria for active mobilization of

An Environmental Scan for Early Mobilization Practices in U.S. ICUs

Rita N. Bakhru, MD, MS\textsuperscript{1,2}; Douglas J. Wiebe, PhD\textsuperscript{3,4,5}; David J. McWilliams, MSc\textsuperscript{6}; Vicki J. Spuhler, RN, MS\textsuperscript{7,8}; William D. Schweickert, MD\textsuperscript{9}; Tina S. Mele, MD, PhD\textsuperscript{10}; Michael Sharpe, MD\textsuperscript{11}; J. Kevin Snoemaker, PhD\textsuperscript{12}; Douglas D. Fraser, MD, PhD\textsuperscript{13};
Clinical Science

Resource-efficient care unit: who should care for them?

Developing a Mobility Protocol for Early Mobilization of Patients in a Surgical/Intensive Care Unit

Early, goal-directed mobilisation in the surgical intensive care unit: a randomised controlled trial.

Schaller, Stefan J - 2016
ISSN: 0140-6736

Early Rehabilitation in the Medical and Surgical Intensive Care Units for Patients With and Without Mechanical Ventilation: An Interprofessional Performance Improvement Project.

Corcoran, John R - 2017
ISSN: 1934-1482
Current evidence for early mobility – Cardiac, Oncology and Burns ICU

Effectiveness of an Early Mobilization Protocol in a Trauma and Burns Intensive Care Unit: A Retrospective Cohort Study

Clark, Diane E; Lowman, John D; Griffin, Russell L; Matthews, Helen M; Reiff, Donald A. Physical Therapy, Washington Vol. 93, Iss. 2, (Feb 2013): 186-96.

A Descriptive Report of Early Mobilization for Critically Ill Ventilated Patients With Cancer

Amanda Weeks, MOT, OTR/L; Claudine Campbell, MOT, OTR/L; Prabalini Rajendram, MD; Weiji Shi, MS; Louis P. Voigt, MD
So what do we have so far in the Neuro ICU?

• Safety during mobilization is a concern
  - hemiparesis or hemiplegia
  - cognitive impairment
  - tenuous intracerebral pressure and cerebral perfusion
  - dislodgement of cerebral monitoring
  - other indwelling devices
To evaluate the cumulative mortality and long-term functional outcome in unselected consecutive neurocritical care patients admitted to a specialty 10-bed neuro-ICU in Austria during 36 month period

- Excluded patients requiring neurosurgical interventions
- Outcome measures - Glasgow Outcome Scale and modified Rankin scale (mean 2.7 ± 0.97 yrs post discharge)
Survival and long-term functional outcome in 1,155 consecutive neurocritical care patients.

Broessner, Gregor • 2007

• **Predictors of Unfavorable Outcomes:**
  
i. Admission diagnosis
  
ii. Sex (women)

iii. Age of >70 yrs (odds ratio, 8.45; 95% confidence interval, 4.52–15.83; \( p < .01 \))

iv. TISS-28 of >40 points at admission (odds ratio, 4.05; 95% confidence interval, 2.54–6.44; \( p < .01 \))

v. TISS-28 of >40 points at discharge from the neuro-ICU (odds ratio, 3.50; 95% confidence interval 1.51–8.09; \( p < .01 \))

vi. Length of stay (odds ratio, 1.01; 95% confidence interval, 1.00–1.03; \( p < .02 \))
• No mention of any rehabilitative interventions if any
Outcome of Intensive Care Unit-Dependent, Tracheotomized Patients with Cerebrovascular Diseases.

Ponfick, Matthias • 2015


- Retrospective study
- 143 patients (ischemic stroke, primary ICH, SAH)
- Outcome Measures
  - FIM
  - weaning and rehabilitation duration
  - duration of mechanical ventilation (MV) in the acute care hospital (preweaning)
  - mortality rates
• No differences regarding weaning and rehabilitation durations, or FIM scores in between each entity
• Every day on MV generates a 3.2% reduction of the possibility to achieve a beneficial outcome (FIM ≥ 50 points [only moderate assistance necessary])
• Every day in-patient rehabilitation without MV increases the chance for favorable outcome by 1.9%
• Mortality rates were 5% for IS and 10% for PICH and SAH, respectively
Retrospective study from Germany to investigate if longer weaning is associated with inferior rehabilitative outcome in critical illness polyneuropathy (CIP) and cerebrovascular diseases (CVD)

Outcome Measures - weaning durations (WD), FIM scores, mortality rates and discharge modalities

PT/OT/SLP/Therapeutic nursing – 300 minutes /day for 6 days/wk

Increased WD in CIP but significant functional gains compared to CVD

Mortality was equal in both groups (13% vs. 6%, p > 0.05)

Longer rehabilitation duration (RD) positively correlated with higher Delta-FIM (DFIM) in both entities ($p = 0.006, r = 0.21$)
Pros and Cons

• MV and WD in CIP and CVD were compared
• Though duration of rehab mentioned, specific interventions not clear
• Time to intervention after admission or MV not detailed
Common Barriers to Mobility
# Common Barriers to Mobility

<table>
<thead>
<tr>
<th>Intrinsic (Patient related)</th>
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</thead>
<tbody>
<tr>
<td>• Elevated ICP</td>
</tr>
<tr>
<td>• Neurological storming</td>
</tr>
<tr>
<td>• Unstable Hemodynamics</td>
</tr>
<tr>
<td>• Absence of bone flap</td>
</tr>
<tr>
<td>• Pain</td>
</tr>
<tr>
<td>• Decreased arousal</td>
</tr>
<tr>
<td>• Impaired cognition</td>
</tr>
<tr>
<td>• Physical impairments (Hemi/Quad/Para)</td>
</tr>
<tr>
<td>• Obesity</td>
</tr>
<tr>
<td>• Unstable spine</td>
</tr>
<tr>
<td>• Surgical precautions (flat bedrest)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Extrinsic (Environmental)</th>
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<tbody>
<tr>
<td>• EVDs that cannot be clamped</td>
</tr>
<tr>
<td>• Lines/tubes – MV/CVVHD</td>
</tr>
<tr>
<td>• Staffing/resources</td>
</tr>
<tr>
<td>• Fear/uncertainty of safety/Knowledge</td>
</tr>
<tr>
<td>• Adequate equipment for safe patient handling</td>
</tr>
<tr>
<td>• Inappropriate activity orders</td>
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<tr>
<td>• Timing of PT consults</td>
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12/10/17
Commonly seen lines/tubes/drains in the Neuro ICU

- External Ventricular Drainage
- Arterial lines – femoral/radial/axillary/brachial/pedal
- Continuous EEG
- PICCO monitoring
- PLEX catheters
- Femoral sheaths

- Mechanical Ventilation
- CVVHD
- Davol drains
- J-P drains
- Central lines
- PICC lines
Pictures of various lines/tubes/drains
CSF and ICP issues

- Pathophysiology
- Outcome measures
- Medical and surgical management
- Precautions
• Autoregulation of cerebral blood flow
• Factors that increases CPP
  - hypoxia, per
  - Hypercarbia
  - Blood pressure
  - Cerebral blood flow

Autoregulation keeps CBF normal as long as CPP is between 50 and 150 mm Hg.
Relationship between cerebral perfusion and ICP (CPP = MAP - ICP)

- ↓ Systolic BP
- ↓ CPP
- ↑ ICP
- ↑ CBV
- ↑ Vasodilation
Figure – External ventricular drainage
Effect of early physiotherapy on intracranial pressure and cerebral perfusion pressure.

Roth C¹, Stitz H, Kalhout A, Kleffmann J, Deinsberger W, Ferbert A.

- Observational study
- Intervention – PROM
- No significant differences between mean CPP and MAP comparing ICP before and after PROM in all groups
- No adverse side effects of PROM were observed
22 patients with brain injury or stroke
20 minutes of in bed supine cycling (passive)
Intervention - 7 ± 5 days post admission to Neuro ICU
Cycling increased MAP (p = 0.029) and SV (p = 0.003) significantly
After exercise CO, SV, MAP, and CPP decreased significantly
No changes in HR, SVV, SpO₂, or ICP were noted when compared to values obtained during exercise
There were no differences in data obtained before versus after exercise
• Prospective Study
• SAH patients w/ EVD(n=26) over 12 month period
• Algorithm based mobility by PT/OT
• 101 sessions attempted
• 24 sessions were held due to
  - worsening neurologic examination (10)
  - pulmonary instability (2)
  - hemodynamic instability (2)
  - provider request (1)
  - other conditions of medical instability (3)
Six sessions were initiated but aborted mid-session for:
- increased lethargy (1)
- pain (1)
- elevated ICP (1)
- drain malfunction (1)
- hypotension (2)

On average, patients were mobilized:
- 3 times (1Y5) while their EVD was in place.
- The mean length of a single therapy session was 32 (20Y55) minutes.
- Early mobilization was associated with discharge.
• No adverse events, defined by patient falls, catheter dislodgment, CSF overdrainage, or permanent complications, occurred during the 12-month intervention period.
Implementation of an Early Mobility Pathway in Neurointensive Care Unit Patients With External Ventricular Devices

Moyer, Megan; Young, Bethany; Wilensky, Eileen Maloney; Borst, Joseph; Pino, William; Hart, Marisa; LoBreglio, Jesse; Zaleski, Derek; Leonor, Isaira; Kung, David; Smith, Michelle; Zager, Eric; Grady, M. Sean; Kumar, Monisha

Journal of Neuroscience Nursing: April 2017 - Volume 49 - Issue 2 - p 102–107
Physiological Effects of Early Incremental Mobilization of a Patient with Acute Intracerebral and Intraventricular Hemorrhage Requiring Dual External Ventricular Drainage.
Picture of patient with EVD being mobilized
Picture of patient with dual EVD
Picture of patient with EVD on Comibilizer
Early mobility models in the Neuro ICU
• Purpose
  – To study if early mobility program increase highest the level of mobility achieved during a NICU stay?
    - If early mobility program improve hospital and NICU LOS, 30-day mortality, discharge disposition home, quality metrics (ventilator-associated pneumonia [VAP], blood stream infection, deep vein thrombosis [DVT], and hospital-acquired pressure ulcer [HAPU]), and psychological profile (depression, anxiety, and hostility) using Brief Symptom Inventory-BSI-DAH?
• Prospective, two-group pre/post comparative design with data collection 4 months pre- and post-intervention with a 4-month run-in period in a 22 bed urban Neuro ICU
• Initiated on the day of admission unless physiologically unstable
• Highest Level of mobility for upto 13 days
• Primarily a nurse led mobility program
• Clinical tech to assist w/ mobility

Klein, Kate • 2015


No line dislodgements reported

Klein, Kate • 2015

- Relatively large sample size (pre-intervention=260(n) and post-intervention = 377(n))
- Though APACHE III and Charlston Comorbidity index was used, no detailed patient characteristics in terms of the neurological diagnoses or % with critical lines other than MV are mentioned
- Dosage is not included – duration/frequency
- No mention about rehabilitation interventions received
Clinical outcomes of patient mobility in a neuroscience intensive care unit.

Mulkey, Malissa • 2014

The effect of increased mobility on morbidity in the neurointensive care unit.


• Progressive Upright Mobility Protocol (PUMP) Plus
• 10 month pre- intervention period and 6 month of post intervention period
• increased mobility by 300% (p < 0.0001)
• reduction in neurointensive care unit length of stay (LOS; p < 0.004), hospital LOS (p < 0.004), hospital-acquired infections (p < 0.05), and ventilator-associated pneumonias (p < 0.001), and decreased the number of patient days in restraints (p < 0.05)
• No increases in adverse events as measured by falls or inadvertent line disconnections.

Megan A. Brissiea,*, Meg Zomorodib, Sharmila Soares-Sardinhac, J. Dedrick Jordand
Ischemic vs hemorrhagic stroke

- Pathophysiology
- Outcome measures
- Interventions
Ischemic Stroke

Old age
Race

Most of the areas of the brain

Hemorrhagic Stroke
Primary ICH
Secondary ICH (anticoagulant use)

Young and middle Age
African Americans/Asians/Latin Americans

Cerebral lobes
Basal Ganglia
Thalamus
Brainstem
Cerebellar
Early mobility and Stroke

- AVERT trial
- HeadPoST trial
- Akershus Early Mobilization in Stroke Study (AKEMIS) trial
- AMOBES trial
Recombinant tissue plasminogen activator (tPA) and Mobility
Hemorrhagic stroke
Figure: Cascade of neural injury initiated by intracerebral haemorrhage:

The steps in the first 4 h are related to the direct effect of the haematoma, later steps to the products released from the haematoma.

BBB=blood–brain barrier.
MMP=matrix metallopeptidase.
TNF=tumour necrosis factor.
PMN=polymorphonuclear cells.
Management of Intracerebral Hemorrhage

Early Management

- Airway Support
- Blood pressure control (<180mmHg)
- Intracranial pressure control
- Reversal of anticoagulation (Vit K/FFP)

Rapid deterioration/clinical evidence of trans tentorial herniation, or mass-effect or obstructive hydrocephalus on neuroimaging

- EVD placement
- Surgical Evacuation/Hemicraniectomy
- Hyperventilation
- Hypertonic Saline/Mannitol
Intraventricular hemorrhage

• Dynamic process that may follow ICH
• Increased chance of death and severe disability at 90 days
• Intraventricular administration of thrombolytics improves outcome
• CLEAR- IVH trial - ongoing
ICH score

- Clinical grading scale for risk stratification
- 5 categories are independent predictors of 30-day mortality
- ↑ score → ↑ Mortality
- ICH volume – calculated from CT image
- GCS score – at admission or after resuscitation

Very early rehabilitation (<48 hours)

3 center RCT in China

Inclusion Criteria – first time ICH, no contraindications to mobility, Fugl Meyer Score of 27-90

VER + Standard Care & Standard Care Group
Effect of an evidence-based mobility intervention on the level of function in acute intracerebral and subarachnoid hemorrhagic stroke patients on a neurointensive care unit.

Rand ML¹, Darbinian JA².

- **DESIGN**: Retrospective pre- and postintervention study.
- **SETTING**: Regional neurointensive care unit.
- **PARTICIPANTS**: Adult patients with ICH and SAH (N=361).
- **INTERVENTION**: Daily mobility intervention based on patient’s current LOF.
- **MAIN OUTCOME MEASURE**: Walking >15.24m (LOF 5) by neurointensive care unit discharge.
361 patients (52.6% women; mean age, 62.1y; ICH stroke, 63.2%; aphasia, 35%; hemiplegia, 33%) were included.

There was a 2.3-fold increase in patients with hemorrhagic stroke achieving a LOF of 5 by neurointensive care unit discharge after introduction of a mobility intervention.
Clinical reasoning & things to consider

- Severity and type of stroke
- Timing
- Interventions received – tPA, evacuation, thrombectomy…
- Hemodynamic parameters set by the MD
- Neuroimaging
- Discussion with the MD
- Close monitoring during mobility
Subarachnoid hemorrhage

- Causes
  - Trauma
  - Aneurysm rupture
  - Vascular malformation (arteriovenous malformation or dural arteriovenous fistula)
  - Idiopathic

- Delayed complications
  - Rerupture
  - Hydrocephalus
  - Vasospasm
  - Hyponatremia
SAH – Management

• Aneurysm Repair (clipping/endovascular coiling)
• Medical management
  – Airway Protection
  - Blood Pressure management (pre & post aneurysm treatment)
  - Preventing rebleeding prior to treatment
  - Managing vasospasm
  - Treating hydrocephalus
  - Treating hyponatremia
  - limiting secondary brain insults
  - preventing DVT and pulmonary embolus (PE)
Early rehabilitation in patients with acute aneurysmal subarachnoid hemorrhage.

Karic T, Sorteberg A, Haug Nordenmark T, Becker F, Roe C.
Impact of early mobilization and rehabilitation on global functional outcome one year after aneurysmal subarachnoid hemorrhage.

Karic T¹, Røe C, Nordenmark TH, Becker F, Sorteberg A.
Effect of early mobilization and rehabilitation on complications in aneurysmal subarachnoid hemorrhage.

Karic T^1,2, Røe C^1,3, Nordenmark TH^1, Becker F^4,3, Sorteberg W^2, Sorteberg A^2,3.

- Prospective interventional study in intermediate neuro ward post aneurysm repair
- Control group (standard treatment) & Early rehab group (POD1 after repair)
- Acute and chronic hydrocephalus were similar in both groups
- Pulmonary infections, thromboembolic events, and death before discharge or within 90 days after the ictus were similar between the 2 groups
- Each step of mobilization achieved during the first 4 days after aneurysm repair reduced the risk of severe vasospasm by 30%
Efficacy of Early Rehabilitation After Surgical Repair of Acute Aneurysmal Subarachnoid Hemorrhage: Outcomes After Verticalization on Days 2-5 Versus Day 12 Post-Bleeding.

Milevanovic A¹, Grujicic D, Bogosavljevic V, Jokovic M, Mujovic N, Markovic IP.
Points to consider when treating patients with SAH

• Cause (ruptured vs unruptured)
• Interventions
Traumatic Brain Injury - Pathophysiology and management

• Pathophysiology
  – “diffuse axonal injury”
  – SDH, EDH, traumatic SAH, traumatic IPH, IVH
    • Mass effect/MLS
  – Anoxic brain injury
Marshall's CT Classification of TBI
# Brain Injury Outcome Measures: Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Glasgow Coma Scale</th>
<th>Scale</th>
<th>Score</th>
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<tbody>
<tr>
<td><strong>Eye Opening Response</strong></td>
<td>Eyes open spontaneously</td>
<td>4 Points</td>
</tr>
<tr>
<td></td>
<td>Eyes open to verbal command, speech, or shout</td>
<td>3 Points</td>
</tr>
<tr>
<td></td>
<td>Eyes open to pain (not applied to face)</td>
<td>2 Points</td>
</tr>
<tr>
<td></td>
<td>No eye opening</td>
<td>1 Point</td>
</tr>
<tr>
<td><strong>Verbal Response</strong></td>
<td>Oriented</td>
<td>5 Points</td>
</tr>
<tr>
<td></td>
<td>Confused conversation, but able to answer questions</td>
<td>4 Points</td>
</tr>
<tr>
<td></td>
<td>Inappropriate responses, words discernible</td>
<td>3 Points</td>
</tr>
<tr>
<td></td>
<td>Incomprehensible sounds or speech</td>
<td>2 Points</td>
</tr>
<tr>
<td></td>
<td>No verbal response</td>
<td>1 Point</td>
</tr>
<tr>
<td><strong>Motor Response</strong></td>
<td>Obey's commands for movement</td>
<td>6 Points</td>
</tr>
<tr>
<td></td>
<td>Purposeful movement to painful stimulus</td>
<td>5 Points</td>
</tr>
<tr>
<td></td>
<td>Withdraws from pain</td>
<td>4 Points</td>
</tr>
<tr>
<td></td>
<td>Abnormal (spastic) flexion, decorticate posture</td>
<td>3 Points</td>
</tr>
<tr>
<td></td>
<td>Extensor (rigid) response, decerebrate posture</td>
<td>2 Points</td>
</tr>
<tr>
<td></td>
<td>No motor response</td>
<td>1 Point</td>
</tr>
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*Minor Brain Injury = 13-15 points; Moderate Brain Injury = 9-12 points; Severe Brain Injury = 3-8 points*
Brain Injury Outcome Measures:
RANCHO LOS AMIGOS-Level of Cognitive Functioning Scale

Level I - No Response
Level II - Generalized Response
Level III - Localized Response
Level IV - Confused, Agitated Response
Level V - Confused, Inappropriate, Nonagitated Response
Level VI - Confused, Appropriate Response
Level VII - Automatic, Appropriate Response
Level VIII - Purposeful, Appropriate Response
### JFK Coma Recovery Scale - Revised (CRS-R) Subscales

<table>
<thead>
<tr>
<th>CRS-R subscale</th>
<th>Vegetative State</th>
<th>Minimally Conscious State</th>
<th>Emergence from Minimally Conscious State (MCS+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory</td>
<td>Less than or equal to 2 and</td>
<td>3-4 OR</td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>Less than or equal to 1 and</td>
<td>2-5 OR</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>Less than or equal to 2 and</td>
<td>3-5 OR</td>
<td>6 OR</td>
</tr>
<tr>
<td>Oromotor/verbal</td>
<td>Less than or equal to 2 and</td>
<td>3 OR</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>0</td>
<td>1</td>
<td>2-3</td>
</tr>
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</table>
Brain Injury Outcome Measures

• Functional Status Score for ICU
• Agitated Behavior Scale
• Moss Attention Rating Scale
Brain Injury Prognosis

• Favorable functional outcomes-younger age, higher CRS-R ratings at rehab admission
• Favorable behavioral outcomes (recovered consciousness)- females, younger age, higher CRS-R ratings at admission
• Odds ratio demonstrated that increased age, lower CRS-R scores at admission, and longer ICU stays predicted poorer outcomes
• Limited research on early mobilization of severe TBI patients-typically begins later than patients with stroke (>1 week after injury)

• Typically more passive verticalization protocols used likely due to disorders of consciousness/impaired command following
  – Verticalization with stepping/passive lower extremity exercise can reduce complications such as syncope or orthostasis
• Stepping verticalization started 12.4 +/- 7.3 days after injury
• Showed significant improvements in CRS-R score for the protocol group vs control
• other measures including LCF, GCS, and DRS all significantly improved for both groups, not significantly significant
Tilt Table Therapies for Patients with Severe Disorders of Consciousness: A Randomized, Controlled Trial


- 50 patients with all disorders of consciousness, >4 weeks (mean 8 weeks) post-injury
- Randomized to
  - Control (regular tilt table)
  - Erigo (tilt table with stepping)
- 10 sessions over 3-4 weeks

- 3&6 week follow-up: both groups significant improvement in CRS-R scores as compared to baseline
  - Intra-individual differences were significantly superior for control group
  - Erigo patients spent average of 4 min greater time at 70 degrees
Things to consider when mobilizing patients in traumatic brain injury

- Severity of injury
- Presence of skull/facial fractures – monitor for CSF leak
- Intracranial pressure parameters
- Neurological storming
Spinal cord injuries

• Traumatic
• Non-traumatic
Spinal Cord Injury Classifications

- American Spinal Cord Injury Association Classification
  
  **Grade A** - Complete lack of motor and sensory function below the level of injury (including the anal area)
  
  **Grade B** - Some sensation below the level of the injury (including anal sensation)
  
  **Grade C** - Some muscle movement is spared below the level of injury, but 50 percent of the muscles below the level of injury cannot move against gravity
  
  **Grade D** – >50 percent) of the muscles that are spared below the level of injury are strong enough to move against gravity
  
  **Grade E** - All neurologic function has returned
Spinal Cord Syndromes

- Central Cord
- Anterior Cord
- Posterior Cord
- Brown-Sequard
SCI Complications

• Neurogenic Shock
  – Traumatic injuries can also experience hemodynamic or hypovolemic shock due to blood loss
  – Orthostatic hypotension
• Autonomic Dysreflexia
• Respiratory Complications
• Venous Thromboembolism/Pulmonary Embolism
SCI Exercise Considerations

• Impaired cardiovascular response to exercise
• Early ROM can enhance patient outcomes- full UE ROM, tenodesis grasp, elongated hamstrings
• Active Exercise (PRE) to maintain and increase muscular strength
• Sitting program/endurance- being as soon as medical and spinal stability achieved
SCI Outcome Measures

• Highly recommended measures from SCI Edge Taskforce for acute (0-3 months)
  – ASIA Impairment Scale
  – TUG
  – Hand Held Myometry
  – 6 Minute and 10 meter walk tests
  – Walking Index for Spinal Cord Injury II
SCI and FES

• Functional electrical stimulation has been shown to be beneficial for SCI patients
  – Improved cardiovascular response to exercise
  – Improved body composition
  – Improved motor function (increased strength, endurance, muscle bulk, improved ASIA motor and sensory scores)
Brain tumors

- Patients typically present with neurologic deficits consistent with tumor location
  - Pathology of tumor may affect overall rehabilitation approach
- ICU considerations:
  - Management of complications as previously noted
  - Outcome measures as noted above for brain injury as well as those specific to patient’s individual limitations
Status Epilepticus and Seizures

• Can be caused by acute systemic illness, primary neurologic injury/pathology, medication side-effect and can have wide array of symptoms

• Status Epilepticus = clinical and/or electrographic seizure activity lasting >5 min or recurrent seizures in 5 min interval without return to neurologic baseline
  – Refractory if does not respond to two or more AEDs
Status Epilepticus and Seizures: Medical Management

• ABC- Airway, breathing, circulation focuses on stabilization of vital signs
• 1st Line antiepileptic drug
  – Usually benzodiazepine (Lorazepam)
• Treatment when known and/or diagnostic work-up of underlying cause

• 2nd line AEDs include IV fosphenytoin/phenytoin, valproic acid, phenobarbital
• Continuous-infusion AEDs such as pentobarbital, midazolam and propofol are used to treat RSE
Physical Therapist Role in Status Epilepticus

• 2010 multi-center study on functional outcomes after convulsive status epilepticus showed >50% left ICU with severe functional impairment
Other Neurological Conditions

• Guillain Barre Syndrome
• Myasthenia Gravis
• ALS
• Little to no current research for ICU rehab specific to these populations
Case Example – Guillain Barre Syndrome
Case Example – ALS
Case Example – Myasthenia Gravis
Palliative care & Brain death

• Appropriateness of therapy consult and goals of care in patients who are palliative care
Early Mobility of children who are Neurologically Compromised in the Pediatric Intensive Care Unit
Brain Injury

- Stroke
  - Sickle cell
- Traumatic
- Anoxic
  - Near Drowning
- Non-traumatic
  - AVM
- Non-Accidental Trauma
  - Shaken Baby Syndrome
- Craniosynostosis

Cerebral Spinal Fluid Involvement

- Hydrocephalus
- Chiari Malformations
- Meningitis
  - Bacterial verse Viral
- Spina Bifida
Diagnoses: Pediatric

Seizure Disorders
• Epilepsy
• Genetic syndromes
• Hemispherectomy

Cancer
• Pediatric Brain Tumor
  – Gliomas (33% of all pediatric)
    • Pilocytic Astrocytomas (33% of gliomas)
    • Low grade gliomas (27% of gliomas)
    • High grade gliomas (21% of gliomas)
  – Embryonal Tumors (15% of all pediatric)
    • Medulloblastomas (62% of embryonal)
    • Atypical teratoid/ rhabdoid tumor (15%)
    • Primitive Neuroectodermal Tumor (15%)
• Other cancer sequelae

Diagnoses: Pediatric

**Spinal Cord**
- Acquired SCI
  - Acute Flaccid Paralysis
  - Transverse Myelitis
  - Acute disseminated encephalomyelitis (ADEM)
- Traumatic SCI

**Neuromuscular Disorders**
- Muscular Dystrophy
- Spinal Muscular Atrophy
- Guillain-Barre Syndrome
- Myasthenia Gravis
Current evidence for early mobility in Pediatric ICUs

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Early mobilization in the pediatric intensive care unit: a systematic review

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Acute Rehabilitation Practices in Critically Ill Children: A Multicenter Study*

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conducted on behalf of the Canadian Critical Care Trials Group
What about Neuro pediatric populations?

• Lack of evidence regarding mobilization of pediatric TBIs/ neuro diagnoses
• Base all other populations on adult literature to start, why is neuro different
  – It is and it isn’t…. 
The goals are the same
- Prevent ICU acquired weakness
- Promote quality of life for patient and families
- Facilitate neuroplasticity
- Encourage functional mobility

Pediatric concerns
- Overall physiological fragility (ie infants)
- Dysautonomia/ storming is more prevalent secondary to TBI being much more common diagnosis, and occurs more than
  - Diagnosed by any of the 4: fever, tachycardia, hypertension, tachypnea, hyperhidrosis, and dystonic posturing without other cause (Rabinstein et al 2008)
Looked at hospitalized children with TBI who were admitted to the ICU and survived to discharge and the utilization of rehab services.

- Only 41% received either a PT or OT evaluation
- Only 26% received a speech or swallow evaluation
- The median time to receive evaluation is 5 to 7 days after hospital admission.
Factors for receiving therapy evaluation services in ICU

- Older children
- A motor vehicle traffic mechanism
- Greater head injury or overall injury severity
- Extremity fractures
- Admission to a hospital with a Level I ACS pediatric trauma designation

“Children with TBI may have unique risks that appropriately delay initiation of PT or OT, such as worsening of intracranial hypertension with physical movement or stimulation. However, this occurs in a minority of patients, and peak intracranial hypertension risk generally passes prior to day 7.”
Rehab Outcome Measures

• Goal: guidance from outcome measures to impact overall patient treatment/intervention particularly for:
  – Sensory stimulation
  – Agitation
  – Cognition
  – Motor

Previously discussed:
  – Glasgow Coma Scale
  – Rancho Levels of Cognitive Functioning

Additional Measures used at JHH PICU:
  – JFK Coma Recovery Scale
  – Rappaport Coma/Near Coma Scale
  – State Behavioral Scale
Glasgow Coma Scale

• Comprises three tests: eye, verbal and motor responses. The three values separately as well as their sum are considered.
• Critical cut scores for the Glasgow Coma Scale score should be set slightly lower for children (5 points) than adults (8 points)
  – Low scores indicate the severity of brain injury and is considered predictive of death and potential of recovery
• Scoring indicates overall severity of BI
  – 3 to 5: Very severe brain injury
  – 6 to 8: Severe brain injury (still in coma)
  – 9 to 12: moderate TBI (out of coma)
  – 13 to 15: mild TBI

Balestreri 2004; Chung 2006
JFK-Coma Recovery Scale (JFK-CRS)

• Purpose:
  – to assist with differential diagnosis, prognostic assessment and treatment planning in patients with disorders of consciousness.

• Implications:
  – can help direct sensory stimulation intervention based on where largest response is seen.

• Pediatrics: Not validated in pediatric population yet.
  – JHH trialing from 6 months and up.

Giacino 2004; http://www.tbims.org/combi/crs/index.html
Rappaport Coma/Near Coma Scale

• Developed to measure small clinical changes in patients with severe brain injuries who function at very low levels characteristic of near-vegetative and vegetative states.
• Expands the Disability Rating Scale
• Parameters:
  – Auditory
  – Visual with priming
  – Threat
  – Olfactory
  – Tactile
  – Pain
  – Vocalization

Rappaport et al 1987; http://www.tbims.org/combi/crs/index.html
State Behavioral Scale (SBS)

- Allows medical professionals to have description of sedation-agitation continuum in pediatric population
- Tested in 6 weeks to children who were 6 years old
- Based off of two adult ICU scales:
  - Sedation-Agitation Scale (SAS)
  - Motor Activity Assessment Scale (MAAS)
- In our PICU, this should be reported in chart by nursing in their flow sheet and only when the patient is sedated.
- Defer outcome measures if patient is scored a +2 on the SBS.

Curley 2006
Experiences of the use of the JFK CRS and CNC at Johns Hopkins Children’s Center

• Total Patients tested: 15 over the past 2 years
  – Majority discharged to Inpatient Rehabilitation
  – Five patients had disordered consciousness leading to additional testing than initial evaluation.

• Perform JFK-CRS and CNC weekly with PT/OT performing alternating.

• Barriers
  – Medical Stability: high ICPs
  – Sedation: unstable verse agitation → EDUCATION
  – Improvement: moves out of Rancho Level 1/2/3 therefore not appropriate
  – Language Impairments: Aphasia
  – Salient objects: use of toys in JFK kit for motor or visual testing
Interventions for the Critically ill pediatric patient with TBI

• All ages
  – Developmental positioning
• Bed Mobility
  – Rolling
  – Developmental: Supine → sidelying → prone → quadruped
  – Bed mobility: supine → sidelying → sitting
• Transfers
  – Sit to stand
  – Transfers to bedside chair or wheelchair
• Standing (static/dynamic activity)
• Wheelchair walking
• Ambulation in room/ hallway
• Stairs
Evidence of Long Term sequela

Early mobility in the ICU is just as important for an 4 month old patient as a 90 year old patient.
Case Report: Peds 1

- CB- Brain tumor with brainstem involvement
Case Report: Peds 2
Case Report: Peds 3
Case: Peds 4
Positioning in the ICU: the pre-term and/or medically complex newborn

• Coughlin et al (2010)
  – Evidence for developmentally supported positioning
  – Can impact postural stability

  – Impacted in the clinically ill population:
    • Vestibular input all from external world
    • Underdeveloped visual system
    • Inconsistent tactile/proprioceptive support

  – Improvements noted in the neuromotor/neurosensory systems with containment
    • Positioned toward flexion
Important considerations

- Regardless of age most medically complex infants with poor handling tolerance can benefit from containment during routine care (Bryne & Garber 2013)

- Minimizing stimuli

- Limited 3rd trimester crowding (pre-term) can impact muscle development and promote extended posture (Zarem et al. 2013)

- Prone positioning is associated with decreased central apnea (Heimler et al. 1992)
Challenges of positioning in the PICU

- Decreased RN comfort with handling
- More post-surgical medical complexity
- Increased use of paralytics/sedation
- Less consistency of care
- Family involvement
- Carryover/positioning devices
1. Harrison's Principles of Internal Medicine, 19edition
Dennis Kasper, Anthony Fauci, Stephen Hauser, Dan Longo, J. Larry Jameson, Joseph Loscalzo


22. Krewer C, Luther M, Koenig E, Müller F. Tilt Table Therapies for Patients with Severe Disorders of Consciousness: A Randomized, Controlled Trial; PLoS ONE; 2015; 10(12)


Questions?

Adult tower

Pediatric tower