WEAKNESS IN THE CRITICALLY ILL: CLINICAL IMPLICATIONS FOR PHYSICAL THERAPISTS ACROSS THE CONTINUUM OF CARE

Christiane Perme, PT CCS
Senior Physical Therapist
The Methodist Hospital
Houston, TX

Muscle weakness in ICU

- Muscle weakness is a complication of critical illness that results in complex challenges for physical therapists working in ICU and across the continuum of care
- Weakness in the ICU is associated with ventilator weaning failure, prolonged rehabilitation, and hospital mortality

Where do patients go after ICU???

- Acute care
- Home
- Outpatient physical therapy
- Skilled nursing facility (SNF)
- Inpatient rehabilitation unit
- Long term acute care hospital (LTAC)
- Nursing home

Unroe M et al. One-year trajectories of care and resource utilization for recipients of prolonged mechanical ventilation: a cohort study.
Ann Intern Med. 2010 August 3; 153(3): 167–175

- Objectives—To describe one-year trajectories of care and resource utilization for prolonged mechanical ventilation patients
- Design—One-year prospective cohort study
- Setting—5 ICUs at Duke University Medical Center
- Participants—126 prolonged mechanical ventilation patients as well as their 126 surrogates and 54 ICU physicians were enrolled consecutively during one year

Unroe M et al. One-year trajectories of care and resource utilization for recipients of prolonged mechanical ventilation: a cohort study.
Ann Intern Med. 2010 August 3; 153(3): 167–175

- Conclusions—Prolonged mechanical ventilation patients experience multiple transitions of care, resulting in extraordinary health care costs and persistent, profound disability.
Weakness in the ICU

Does it matter if a patient in ICU is:
- Hypotensive?
- Desaturating?
- Hurting?
- Bleeding?
- Has low cardiac output?

Does it matter if the patient in ICU is weak?

Does it really matter if the patient is weak??????

BED REST VERSUS IMMOBILITY

Bed rest:
- Medical treatment involving a period of consistent day and night recumbence in bed
- It is a procedure that can be potentially harmful to patients
- It contributes to deconditioning, NOT recovery

Immobility:
- “Immovable, fixed, not moving, motionless ”

Consequences of Bedrest

- Shifting of body fluids from the extremities in the thorax
- Decreased total blood volume
- Decreased hemoglobin concentration
- Increased resting heart rate
- Decreased VO2 max
- Decreased ventilation leading to airway closure, atelectasis, secretion retention, and interstitial fluid accumulation
- Kidney stones and infection due to fluid stasis in the kidneys
- Increased calcium excretion
- Musculoskeletal changes
- Emotional and behavior disorders

Terms used to describe weakness in ICU

- ICU-acquired weakness
- Critical illness polyneuropathy
- Critical illness myopathy
- ICU acquired paresis
- Critical illness neuromuscular abnormalities
- Critical illness polyneuropathy/myopathy
- Acute quadriplegic myopathy
- Intensive care neuropathy
- Intensive care polyneuropathy
- Neuropathy of critical illness
- ICU myopathy
- Myopathy of critical illness

Motor weakness in the ICU

Neuromuscular disorders in critical illness can affect all parts of the motor unit:
- Anterior horn cell (Motor)
- Peripheral nerve (Sensory and Motor)
- Neuromuscular junction (Motor)
- Muscle (Motor)
**Muscle Wasting in ICU**

- Overall muscle strength depends on:
  - Total muscle mass
  - Force generating capacity (force per cross-sectional area)
- ICUAW is usually accompanied by muscle wasting
- Muscle wasting does not necessarily lead to neuromuscular dysfunction

**Motor weakness in the ICU**

- Pre-existing neuromuscular disorder that leads to ICU admission:
  - Guillain-Bare syndrome
  - Myasthenia Gravis
  - ALS
- New onset of neuromuscular disorder:
  - Undiagnosed neuromuscular disorders
  - Spinal cord infarct after aortic surgery
  - Epidural abscess
- Complications of non-neuromuscular critical illness:
  - Critical Illness Polyneuropathy (CIP)
  - Critical Illness Myopathy (CIM)
  - Prolonged Neuromuscular Blockade

**Weakness in the ICU: Incidence**

- Exact incidence is unknown due to a wide variation in diagnostic criteria
- CIP and CIM are the most likely causes of weakness after ICU admission
- It occurs in at least 50% of critical ill patients
- Depending on the patient population, a prevalence of ICUAW of up to 100% of critical ill patients is described, with sepsis or systemic inflammatory response syndrome (SIRS) as one of the most important risk factors
  

**Weakness in the ICU: Diagnostic tests**

- MRI of cervical spinal cord
- Motor and sensory nerve conduction
- Needle EMG of muscle
- Phrenic nerve conduction studies and needle EMG of the diaphragm
- Measurement of serum creatinine phosphokinase (CPK) concentration
- Muscle biopsy
- Nerve biopsy (rarely indicated)

**Risk factors for weakness in the ICU**

- Bed rest
- Immobility
- Prolonged ventilatory support
- Difficulty weaning from the ventilator
- Sepsis
- Multi-organ failure
- Medications
  - Corticosteroids
  - Neuromuscular blockers
- Hyperglycemia

**Critical Illness Polyneuropathy (CIP)**

- The true incidence of CIP is unknown
- CIP is primarily a distal axonopathy
- Usually both sensory and motor nerves are involved
- Despite our current advances in understanding CIP, the pathogenesis remain speculative
CIP- Pathophysiology

- Microcirculation to organs throughout the body is disturbed in sepsis
- Cytokines secreted in sepsis increase microvascular permeability
- Despite oxygen being delivered by mechanical ventilation, there is severe oxygen debt at the parenchyma level
- Such disturbances may explain dysfunction of muscle and nerve in sepsis

CIP- Treatment

- Treatment of sepsis and MODS
- Management of difficulty in weaning from ventilator
- Attempts at direct treatment of CIP
- Physiotherapy and rehabilitation
  - Muscle & Nerve - Aug 2005

"In a majority of cases physical therapy is the only effective rehabilitation treatment available."


Critical Illness Polyneuropathy (CIP)

TAKE HOME MESSAGE

- CIP is the main contributor to persistent disability
- There is no specific pharmacological treatment for CIP
- Severe sepsis/Septic shock
- Multi system organ failure
- Recovery of kidney/lung function?????

Critical Illness Myopathy (CIM)

TAKE HOME MESSAGE

- CIM can be associated with complete recovery
- There is no specific pharmacological treatment for CIM
- Likely that patients did not have multiple organ failure
- Associated with recovery of kidney function????

CIM- Pathophysiology

- The true incidence of CIM is unknown
- Muscle biopsy is the diagnostic method of choice
- There is proximal as well as distal muscle weakness
- The major feature is diffuse flacid weakness in all limbs

CIM- Treatment

- There is no specific pharmacological treatment for CIM
- Early recognition, avoidance of risk factors and aggressive treatment of sepsis may partly reduce the incidence of CIM


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Christiane Perme ,PT CCS
cperme@tmhs.org
Critical Illness Polyneuropathy and Myopathy

- Evidence of acute and chronic denervation
- Also evidence of primary muscle change

Treatment for CIPNM

"At this point in time, no treatments for established CIPNM have been proven to be effective"

Am J Respir Crit Care Med 2003

DEVELOPMENT OF CIPN/CIM

Bolton, C. Muscle and Nerve, Aug 2005

TAKE HOME MESSAGE

"CIP is the main contributor to persistent disability, whereas CIM can be associated with complete recovery".

Lancet Neurol 2011; 10: 931–41

AGING

- Primary aging causes deterioration in cellular structure and function – Independently of disease!
  - Cardiac
  - Pulmonary
  - Renal
  - Metabolic
  - ** Decrease in lean muscle mass by up to 40% at the age of 80 yrs**
- Elderly patients have decreased physiologic reserve
**ASSESSMENT MUSCLE WEAKNESS IN CRITICALLY ILL PATIENTS**

- Neuromuscular and central nervous system involvement can be coincidental
- Muscle strength and sensation examination in ICU may be inadequate and not reliable:
  - Sedation
  - Limited ability or inability to communicate
  - MMT requires the attention and comprehension of the patient

**Methods:**
- Patients requiring more than 3 days of mechanical ventilation.
- Two observers performed systematic strength assessments of each patient.
- The primary outcome measure was interobserver agreement of weakness

Additional information about the study
- 2 observers performed the structured MMT:
  - Senior medical resident
  - Attending critical care physician
- Although all patients were initially identified in the ICU, only 10 examinations occurred in the ICU
- The remaining 20 took place after ICU discharge to the hospital ward.
- Only 2 patients were receiving mechanical ventilation at the time of examination

**Conclusions:**
- Manual muscle testing (MMT) during critical illness was not possible for most patients because of coma, delirium and/or injury
- Among patients who were able to participate in testing, we found that interobserver agreement regarding ICUAW was good, particularly when evaluated after ICU discharge.
- MMT is insufficient for early detection of ICU-acquired neuromuscular dysfunction in most patients and may be unreliable during critical illness
PREVENTION AND TREATMENT OF MUSCLE WEAKNESS IN ICU

NEW INITIATIVES

EVIDENCE-BASED PRACTICE

* Mobilizing patients in ICU is safe, feasible and improves physical function!
* It can reduce length of hospital stay and costs!
  * It can decrease Delirium

– Schweickert WD. Lancet. 2009 May ; 373:1874-1882
– Burtin C. Crit Care Med. 2009 Sep;37(9):2499-505

ARE PATIENTS MOBILIZED IN ICU?


  • 49 separate interviews (33 nurses) identifying barriers and facilitators to mobility in and out of bed
  • From the 49 activity descriptions, 41 related to in-bed activity

  • Reasons for not mobilizing patients:
    – 59% of the nurses stated that unstable vital signs
    – 46% stated that low respiratory energy reserves
    – 34% of the nurses stated safety issues, which included loss of tubes or catheters and potential injury of the patient or staff.

  • Reasons which facilitated activities:
    – Presence of a protocol
    – Glasgow coma score greater than 10
    – Beds that provided a chair position
    – Physician’s order


– Close to 50% of patients during that same period had no change in body position

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Christiane Perme ,PT CCS
cperme@tmhs.org
WHAT CAN WE DO WHEN PATIENTS ARE STILL IN THE HOSPITAL ????

• “FUNCTIONAL MOBILITY RECONCILIATION”
• Reengineer hospital care with focus on function, including an accurate assessment not only on admission but throughout the hospital stay

NEW INITIATIVES: THERAPEUTIC INTERVENTIONS

INSPIRATORY MUSCLE TRAINING (IMT)

NEW INITIATIVES: THERAPEUTIC INTERVENTIONS

ELECTRICAL STIMULATION

Conclusions: The provision of an ICU diary is effective in aiding psychological recovery and reducing the incidence of new PTSD.

Conclusions: EMS is well tolerated and seems to preserve the muscle mass of critically ill patients. The potential use of EMS as a preventive and rehabilitation tool in ICU patients with polyneuromyopathy needs to be further investigated.
Electrical muscle stimulation prevents critical illness polyneuromyopathy: a randomized parallel intervention trial

Christina Routsi, Vasiliki Genisouli, Ioannis Vasilaki, Dimitrios Karatzanou, Theodore Piskali, Efxi Tripodaki, Ayaki Markaki, Dimitrios Zervaos and Serafin Namas*

- EMS of both LES:
  - Vastus lat
  - Vastus med
  - Peroneous longus muscles
- 55 minutes daily sessions
- EMS sessions until ICU discharge
- CIPNM was diagnosed clinically with the medical research council (MRC) scale for muscle strength (maximum score 60, <48/60 cut off for diagnosis)


- Randomized interventional study with a single leg exercise design and the contralateral leg as a control
- 8 adult male ICU patients with septic shock
- 7 consecutive days of EMS for 60 minutes/day on the quadriceps

CONCLUSION:
- Marked decrease in quadriceps volume in the first week after septic shock.
- The loss of muscle mass was unaffected by transcutaneous EMS applied for 60 minutes/day over 7 days

Challenge for physical therapists in ICU

Reliable outcome measure!

Functional Independence Measure (FIM)

- Scores from 1 (total assist) to 7 (completely safe and independent)
- Total score typically cannot be given because it includes items like stairs negotiation, bowel and bladder management...
- A few authors have used items from the FIM in ICU studies, however reliability of individual item scores has not been established
The Functional Status Score for ICU (FSS-ICU)

- Based on the FIM scoring system
- Tasks included in the FSS-ICU:
  - Rolling
  - Supine-to-sit
  - Sitting on edge of bed
  - Sit-to-stand
  - Ambulation
- Reliability and validity not reported. References:

PFIT procedure

Using standardized instructions patients performed (in order):
1. Sit to stand (from a standardized chair) with assistance recorded as 0–3 people.
2. Marching on the spot as long as possible. Time (seconds), steps and cadence (steps/min) were recorded.
3. Bilateral shoulder flexion (full range of motion) as long as possible. Patients began with hands on their thighs, and measurement ceased when shoulder flexion was < 90°, or > 2 s had elapsed between flexion movements, time (seconds), repetitions and cadence (reps/min) were recorded.
4. Muscle strength testing (Oxford scale, graded 0–5)31 for knee extension and shoulder flexion.

OUTCOME MEASURE FOR FUNCTION OF PATIENTS IN ICU

- There is a need to create a reliable tool to:
  - Objectively quantify function of patients in ICU at one moment in time
  - Standardize the assessment of functional status for patients in the ICU
  - Objectively quantify changes in function of patients during the course of an ICU stay

PERME ICU MOBILITY SCORE

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SCORE WILL INCREASE
- As functional mobility improves
  OR
- Need for ICU support which may impact mobility decreases

SCORE WILL DECREASE
- As functional mobility declines
  OR
- Need for ICU support which may impact mobility increases

Skinner EH et al. Development of a physical function outcome measure (PFIT) and a pilot exercise training protocol for use in intensive care.
Critical Care and Resuscitation June 2009

- Objective: To develop an outcome measure as a basis for prescribing and evaluating rehabilitation in the critically ill, and to measure its reliability and responsiveness to change
- Results: The PFIT demonstrated good reliability and was responsive to change. Twelve patients completed testing and exercise sessions with no adverse events
- Conclusions: The PFIT is a reliable and responsive outcome measure, and the pilot training protocol was safe and feasible
TAKE HOME MESSAGE
WHAT CAN WE DO WHEN AS PHYSICAL THERAPIST WHEN PATIENTS ARE STILL IN ICU ????

- Identify risk factors
- Make the link between risk factors and weakness
- Develop strategies to address muscle weakness early in the disease process
- Promote interdisciplinary team work
- Continue to strive for an reliable outcome measure specific for patients in ICU
- Encourage patients and family members to use a diary

WEAKNESS IN THE CRITICALLY ILL: DOES IT MATTER?

LONG-TERM OUTCOMES


- Subjects: 109 survivors of ARDS
- Evaluated at 3, 6 and 12 months post hospital discharge
- Patient characteristics:
  - Age: 45 (36-58)
  - APACHE II: 23 (17-27)
  - Ventilator days: 21 (12-40)
  - ICU LOS: 25 days (15-45)
- All patients reported poor function and attributed this to the loss of muscle bulk, proximal weakness, and fatigue
- Only 49% were working at 12 months


- University of Copenhagen
- Physical outcome in survivors 1 year after septic shock
- 174 adult patients in a mixed ICU
- Survivors were interviewed about physical function and socioeconomic status
- Of the 80 survivors, 2 were still hospitalized
- 78 were invited to participate and 70 replied
- After 12 months, 2/3 of the patients had NOT regained their pre-admission physical status
- 81% of patients attributed this to loss of muscle mass


Conclusion:
“Physical function is substantially reduced in survivors of septic shock one year after discharge.”

Quality of life in the five years after intensive care: a cohort study
Brier C, Calverton EM, Roughton R, Arkle K, MacDonald G, Klae K

- Methods: A prospective longitudinal cohort study in a University Hospital in the UK.
- Subjects: 300 ICU patients of median age 60.5 years and median length of stay 6.7 days
Conclusions

- ICU admission is associated with a high mortality, a poor physical quality of life and a low quality adjusted life years gained compared to the general population for 5 years after discharge.
- In this group critical illness associated with ICU admission should be treated as a life time diagnosis with associated excess mortality, morbidity and the requirement for ongoing health care support.

Cuthbertson et al. Critical Care 2010, 14:R6

Marike van der Schaaf, MSc et al. Poor functional recovery after a critical illness: a longitudinal study. J Rehabil Med 2009; 41: 1041-1048

RESULTS:
- 48% mortality rate
- Physical functioning improved after 6 months
- After 1 year:
  - 69% still had restricted ADLs
  - Only 50% returned to work

Measurements:
- MIP and MEP
- Muscle performance of quadriceps, latissimus dorsi, and biceps
- FIM

Results: (n=77)
- 67 patients (87%) survived
- 55 (74%) succeeded in weaning during their stay in the weaning center.

Conclusions:
- Findings suggest that BADL is associated with survival and weaning-success
- Muscle testing performance of the latissimus dorsi is an independent predictor of BADL


- Prospective cohort study
- Peripheral muscle training was delivered daily
- Assessed whether the degree of change in functional status after comprehensive rehabilitation influenced clinical outcomes in 77 tracheotomized patients admitted to a weaning center for difficult weaning

Measurements:
- MIP and MEP
- Muscle performance of quadriceps, latissimus dorsi, and biceps
- FIM

Results: (n=77)
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- Findings suggest that BADL is associated with survival and weaning-success
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Respiratory care. March 2011 Vol 56 no 3

MANAGEMENT OF SURVIVORS OF CRITICAL ILLNESS AFTER DISCHARGE FROM ICU:
POST-INTENSIVE CARE SYNDROME (PICS)

POST-INTENSIVE CARE SYNDROME (PICS)

- Society of Critical Care Medicine (SCCM) Task Force on the Long-Term Consequences of ICU
- Meetings:
  - September 2010
  - September 2012

Management of Survivors of Critical Illness After Discharge from ICU: Post-intensive Care Syndrome (PICS)
Improving long-term outcomes after discharge from intensive care unit: Report from a stakeholders’ conference

Elliott D et al. Health-related quality of life and physical recovery after a critical illness: a multi-centre randomised controlled trial of a home-based physical rehabilitation program.

Crit Care 2011; 15:R142

- Random assignment 1 week post-hospital discharge
- Application of their 8-week home-based rehabilitation program
- Both control and intervention groups had important reductions in functional status prior to the institution of the rehabilitation program
- Both groups had meaningful improvements in functional and quality-of-life measures at the end of the study.

Elliott D et al. Health-related quality of life and physical recovery after a critical illness: a multi-centre randomised controlled trial of a home-based physical rehabilitation program.

Crit Care 2011; 15:R142

Conclusion

- There was no statistically significant improvement in functional outcome associated with the study intervention at 26 weeks of follow-up.

Discussion

- Only included patients who went home
- The patients in this study were mechanically ventilated for a relatively brief period of time and may not have had well-established and clinically important ICU-acquired weakness
- Outcome measures:
  - 6 minute walk test
  - Physical Component Summary (PCS) of the 36-item Short-Form Health Survey (SF-36)

Objectives: To explore and explain the challenges, concerns, and coping modalities in ICU survivors living with a partner or spouse during the first 12 months post ICU discharge.

- Design: Qualitative, longitudinal grounded theory study.
- Settings: 5 ICUs in Denmark, 4 general, 1 neurosurgical.
- Methods: 35 interviews with patients and their partners at 3 and 12 months post ICU discharge plus two group interviews with patients only and two with partners only
**Findings:** The ICU survivors struggled for independence and focused chiefly on:
- ‘recovering physical strength’
- ‘regaining functional capacity’
- ‘resuming domestic roles’

*Intensive and Critical Care Nursing* (2012) 28, 105—113

**Objective:** To explore former ICU patients’ views on what the key components of a post ICU rehabilitation programme should be
- 35 participants completed an online questionnaire
- Participants (22 to 70 years) were asked open questions about their ICU experience and their views on ICU rehabilitation.
- Participants were: aged from the USA (22), the UK (8), Canada (2), Australia (1) and other (2)
- 30 female and five male.

**Findings:** 3 themes were identified: ‘Information and education’, ‘Personal support’ and ‘Assessment and therapy’


**Connolly et al. Critical Care** 2012, 16:226

The aim of this review was to:
- Consider which patients are likely to require rehabilitation following critical illness
- Perform an integrative review of the available evidence of content and nature of exercise rehabilitation programmes for survivors of critical illness
- “Because of the variability in study methodology and inadequate level of detail of reported exercise prescription, at present there can be no clear recommendations for clinical practice from this review.”

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Christiane Perme ,PT CCS
cperme@tmhs.org
Exercise testing in survivors of intensive care—is there a role for cardiopulmonary exercise testing?
Steve Benington*, David McWilliams, Jane Eddleston, Dougal Atkinson
Manchester Royal Infirmary, M9 9PL, Manchester, UK

Journal of Critical Care

Treatment of the Post-ICU Patient in an Outpatient Setting
BRADFORD VOKE, MD, Naval Hospital Yokosuka, Japan
FRANK GRASS, MD, Naval Medical Center San Diego, California


WHAT IS THE FUTURE???

- Prevention of PICS (Post intensive care syndrome)?
- Encourage use of ICU diaries?
- Develop an ICU Rehab manual?
- Develop an Post-ICU Rehab manual?
- Create ICU follow up clinics?
- How do we identify and provide appropriate resources to help these individuals reintegrate in society?

TAKE HOME MESSAGE: Home exercise program
- Success of unsupervised home exercise programs:
  - Motivation
  - Ability to correctly learn and perform the specific activities
- Caution should be used in applying standard education:
  - Consider heterogeneity of the post-critical illness population
  - Significant pre-existing chronic disease
  - Family support
  - Resources

THANK YOU!

Christiane Perme, PT CCS
Senior Physical Therapist
The Methodist Hospital
Houston, TX
Phone: 713-441-2675
cperme@tmhs.org

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Christiane Perme ,PT CCS
cperme@tmhs.org