ICU Weakness – Clinical Manifestations

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Outline

• Classification of ICU acquired weakness
• Diagnosis of ICU acquired weakness
• New techniques to diagnose weakness
• Swallowing dysfunction
Neurological Disorders in the ICU

- Patients admitted to ICU for primary neuromuscular disorders
  - Polio
  - Guillain-Barre syndrome
  - Myasthenia Gravis
Not new disorders: Present as difficult to wean

• Most likely causes of weaning failure
  – Cardiac and pulmonary causes
  – Neuromuscular dysfunction
    • 17% when assessed clinically
    • Almost universally present when diagnosed with EMGs
    • Affect respiratory muscles

• May see grimace to painful stimuli without withdrawal
Clinical presentations: Weakness after recovery

- Weakness symmetric
  - Not focal

- Reflexes can be diminished
  - Can be normal

- Sensory exam may reveal
  - Distal loss to pain, temperature, and vibration

![Graph showing medical research scores for different body parts.](image)
Terminology: A moving target ICU-acquired weakness?

- Polyneuropathy
  - Critical Illness

- Myopathy
  - Critical Illness
  - Myosin loss
  - Thick filament
  - Acute necrotizing
  - Acute quadriplegic

- Important for many reasons
  - Understand natural history
  - Determine prognosis
  - Determine pathogenesis
  - Develop proper therapies

- Problems:
  - Patient heterogeneity
  - Baseline dysfunction
Classification of ICU acquired weakness

ICU Acquired Weakness

- ICU polyneuromyopathy
- ICU polyneuropathy
- Deconditioning
- ICU myopathy
Diagnostic criteria for ICU-AW

• Generalized weakness develops after critical illness

• Diffuse: involving proximal and distal muscles
  – ?dependence on mechanical ventilation

• MRC score of < 48 or MRC < 4 in all testable muscle groups
Other presentations: Focal weakness and central causes

• Mononeuropathies
  – Ischemia
  – Pressure palsies
  – Compartment syndromes

• Hemiparesis
  – Secondary to CVA
Clinical presentations: Acute discovery of a chronic disease

• Weakness prior to ICU admission
  – Spinal cord compression
  – Guillain-Barre syndrome
  – Myasthenia Gravis
  – Lambert-Eaton syndrome
  – Polymyositis
  – West Nile Virus

• Need to exclude these diagnoses
Diagnostic tests to identify ICU-acquired weakness
MRC Scale for Muscle Exam

• Functions assessed
  – Upper extremity: wrist flexion, forearm flexion, shoulder abduction
  – Lower extremity: ankle dorsiflexion, knee extension, hip flexion

• Score for each movement (Ceiling effect)
  – 0–No visible contraction
  – 1–Visible muscle contraction, but no limb movement
  – 2–Active movement, but not against gravity
  – 3–Active movement against gravity
  – 4–Active movement against gravity and resistance
  – 5–Active movement against full resistance

• Maximum score: 60
• ICU Acquired Weakness < 48
• Minimum score: 0 (quadriplegia)
Difficult to Perform MRC in ICU

- Took 8 days to be able to perform the exam
  - 2/3 occurred after ICU discharge
  - Only 10 occurred in the ICU

39 excluded for Research Related reasons
Diagnostic Test: Dynamometer

• Measures distal muscle strength in kg of force
  – Gender and age differences

• Surrogate for global weakness in other NMDs

• Reasonable sensitivity and specificity for ICU weakness
  – 80% and 83%
1. Nerve conduction studies
   - (sensory and motor)
2. Examine needle response
   - Spontaneous
   - Movement of muscle (difficult to do in ICU)
Normal Nerve Conduction Studies and EMGs

Sensory response

Motor response

Normal Recruitment on EMG
# Diagnostic Criteria for Neuropathy

## Clinical Manifestations

1. Sensory Deficits
2. Distal greater than proximal weakness

## Electrophysiology

1. Low amplitude or absent sensory nerve action potentials
2. Low amplitude motor unit potentials
3. Reduced motor unit recruitment
4. Normal muscle excitability on direct muscle stimulation
Neuropathy

Absent sensory

Low amplitude motor

Neurogenic recruitment of large motor units
**Diagnostic Criteria for Myopathy**

<table>
<thead>
<tr>
<th>Clinical Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No Sensory Deficits</td>
</tr>
<tr>
<td>2. Proximal greater than distal weakness</td>
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</table>

<table>
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<tr>
<th>Electrophysiology</th>
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<tr>
<td>1. Retained sensory nerve action potentials</td>
</tr>
<tr>
<td>2. Low amplitude motor unit potentials</td>
</tr>
<tr>
<td>3. Early motor unit recruitment</td>
</tr>
<tr>
<td>4. Absent or reduced muscle excitability</td>
</tr>
</tbody>
</table>
Myopathy

Normal sensory

Low amplitude motor

Myopathic recruitment of small, polyphasic motor units
Type of Neuromuscular Dysfunction

- 23 patients had ICU stay of > 7 days
  - 3 patients died before Day 14
- 20 patients with serial neuromuscular data

<table>
<thead>
<tr>
<th>Type</th>
<th>Count</th>
</tr>
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<tbody>
<tr>
<td>Normal</td>
<td>N=10</td>
</tr>
<tr>
<td>Myopathy</td>
<td>N=1</td>
</tr>
<tr>
<td>Neuropathy</td>
<td>N=1</td>
</tr>
<tr>
<td>Myopathy +</td>
<td>N=8</td>
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Diagram:
- Normal: N=10
- Myopathy: N=1
- Neuropathy: N=1
- Myopathy + Neuropathy: N=8
Deconditioning

• Defined as multiple changes in organ function caused by inactivity

• Immobilization of muscles cause marked atrophy

• Can occur after only 4 hours of bed rest
  – Decreased strength; normal NCS/EMGs

• ↓ muscle mass  ➔ ↓ muscle function
Problems with NCS and EMGs in the ICU

- Edema in patients can cause low amplitude on sensory NCS
- EMGs require patient cooperation
- Electrical interference from other machines
- Lines and tubing in the way
- Can take over 90 minutes to perform
Can we simplify the electrophysiological exam?

- Severe sepsis and non-septic patients with acute respiratory failure (n=75)
- NCS: bilaterally exams of:
  - 3 sensory nerves: sural, radial, median
  - 3 motor nerves: peroneal, tibial, median
- EMGs: performed

- 24% developed CIPNM; 30% deconditioned; 36% were normal
### Accuracy of single nerve NCS for CIPNM

<table>
<thead>
<tr>
<th>Nerve (recording site)</th>
<th>c-Statistic AUC</th>
<th>Best cutoff amplitude value</th>
<th>Normal nerve amplitude</th>
<th>Sensitivity (with 95% CI)</th>
<th>Specificity (with 95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sural antidromic ($n = 61$)</td>
<td>0.8611</td>
<td>4.0 µV</td>
<td>$&gt;10$ µV</td>
<td>94% (88–100%)</td>
<td>70% (59–81%)</td>
</tr>
<tr>
<td>Radial antidromic ($n = 61$)</td>
<td>0.6903</td>
<td>16.2 µV</td>
<td>$&gt;20$ µV</td>
<td>75% (64–86%)</td>
<td>71% (60–82%)</td>
</tr>
<tr>
<td>Sensory median orthodromic ($n = 61$)</td>
<td>0.7369</td>
<td>5.2 µV</td>
<td>$&gt;10$ µV</td>
<td>81% (71–91%)</td>
<td>67% (55–79%)</td>
</tr>
<tr>
<td>Peroneal (EDB) ($n = 60$)</td>
<td>0.8856</td>
<td>0.65 mV</td>
<td>$&gt;0.8$ mV</td>
<td>94% (88–100%)</td>
<td>74% (63–85%)</td>
</tr>
<tr>
<td>Tibial (AHB) ($n = 63$)</td>
<td>0.8315</td>
<td>5.8 mV</td>
<td>$&gt;1$ mV</td>
<td>94% (88–100%)</td>
<td>69% (58–80%)</td>
</tr>
<tr>
<td>Motor median (APB) ($n = 60$)</td>
<td>0.7209</td>
<td>3.8 mV</td>
<td>$&gt;5$ mV</td>
<td>63% (51–75%)</td>
<td>77% (65–89%)</td>
</tr>
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*EDB extensor digitorum brevis, AHB abductor hallucis brevis, APB abductor pollicis brevis*

- Combine the peroneal and sural nerves
  - C-statistic: .934
  - Sensitivity = 100%, Specificity of 81%

Moss Intensive Care Med 2014
Post extubation dysphagia and aspiration

- Oral Preparatory Phase
- Oral Transit Phase
- Pharyngeal Stage
- Esophageal Stage

Oropharyngeal and laryngeal edema
- Vocal cord granuloma formation
- Delayed swallowing onset time

Dysphagia And Aspiration In ARF Survivors
- Vocal cord immobility
- Reduced laryngeal sensation
- Reduced Pharyngeal Clearance

Trachea
Epiglottis
Swallowed food
Arytenoid
Aspiration
Food in larynx
Conclusions

• Understand the diagnostic methods and criteria that define ICU-AW

• Make sure you exclude other causes of weakness in these patients

Set the stage for the session

• Pathogenesis of ICU-AW

• Therapies for ICU-AW