Long Term Care of the ICU Patient

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Objectives

- Describe weaning of long-term mechanical ventilation
- Learn the basics of forthcoming long term vent weaning protcol
- Understand definitions of and risk factors for neuromuscular weakness
- Assess safety of initiation of physical therapy
- Recognize and manage iatrogenic medication withdrawal syndromes

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Long Term Ventilator Weaning

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Respiratory failure in the ICU

- 62 yo man admitted initially for AVR and CAB x2, extubated uneventfully on POD 1
- Transferred back to ICU with an acute STEMI, returned to OR
- Postop course complicated by right heart failure and RVAD
- Failed extubation x2
- Tracheostomy placed
- Initiated ventilator weaning with pressure support
- Transferred to floor with trach collar on hospital day 40

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Long Term Ventilator Weaning

- Liberation from mechanical ventilation vs Ventilator weaning
- Liberation
  - Daily paired sedation reduction and spontaneous breathing trial
- Weaning
  - Failure of liberation
  - Tracheostomy performed, *weaning* ventilator support progressively over time

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Scope of the problem

- Approximately 5% of patients who need mechanical ventilator support will go on to require prolonged mechanical ventilation
- In my hospital:
  - 2023 there were more than 1000 patients who spent >48 hours in the ICU at Abbott Northwestern
  - 2023 there were roughly 600 patients undergoing mechanical ventilation at Abbott Northwestern

Chronic respiratory disease 2005; 2:99-103

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Predicting prolonged respiratory failure

- Factors associated:
  - ICU admission for ARDS, pneumonia, intracranial hemorrhage
  - Elevated APACHE score
  - Admission to an ICU from:
    - Another ICU
    - Another hospital
    - Medical wards
  - Extended inpatient stay prior to admission to ICU

Chest 1996; 110(2):469

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I-TRACH Prediction Score

- I-TRACH
  - **I**ntubation in the ICU
  - **T**achcyardia above 110
  - **R**enal dysfunction (BUN >25)
  - **A**cidemia (pH <7.25)
  - Elevation of **c**reatinine >50% from baseline
  - **H**CO3 (bicarb) less than 20
- Score >4
  - PPV 45.7%, NPV 89.9% for predicting >14 days of mechanical ventilation

J intensive care med. 2018;33(10):567

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Focused care improves long-term ventilator weaning

- Respiratory ICU or LTACH
- Improve weaning success
  - 30% weaning success vs 69% weaning success
- Reduce length of stay
  - 42 vs 29 days
- Not significant: reduction in in-hospital mortality, readmission, 1 year survival

Respiratory care 2020; 65(7):1011

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Protocol use can facilitate weaning

- RT driven weaning protocol
  - Checkbox based protocol, assessment by RT
    - Clinical signs, weaning parameters, review of labs
    - Assess on admission and every 4 hours throughout the day
    - Select weaning plan (A, B or C) and progress to next plan
- Reduced time to wean from ventilation from 16.76 to 7.67 days
- Reduced mortality 0.37 vs 0.21
- Reduced cost $2200 vs $1400 per day

Open Respir med 2020; 14:62-66

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Allina-Wide Ventilator Weaning Protocol

- Stakeholders:
  - ICU physicians
  - Respiratory Therapists
  - Nurses and Nursing leaders
- Process
  - Literature review and guidance
  - Creation of protocol
  - Review and implementation
- Goal
  - Develop a consistent process
  - Improve communication and implementation
  - Wean patients more efficiently

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Allina Prolonged Vent Weaning Protocol

- Eligibility criteria
  - Tracheostomy performed
  - Stable vent settings on volume AC
  - Stable vitals (HR <110, MAP >65 without pressor)
  - Afebrile
  - Able to follow commands
  - RR <30
  - PEEP <8
  - FiO2 <50%
  - SPO2 >90%

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Step 1: Initiate Weaning Each Shift

- Switch to pressure support
- Inspiratory pressure less than 20
- Maintain Tidal Volume (TV) >3/4 of initial TV on volume AC
- Monitor
  - RR should be 12-40
  - SPO2 stable
- If so, can move to step 2

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Step 2: Reduce Amount of Support

- Decrease pressure support by 2-3 cm H2O while maintaining TV and respiratory rate
- Maintain pressure support duration for 4 hours
- Pressure support goal 10cm H2O or less
- If able to maintain for 4 hours, go to step 3
- If fail, return to step 1

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Failure criteria

- RR >35 for 5 minutes
- HR >130
- SBP >180 or <90
- FIO2 increased to >60% or increase of 10% from start of wean
- RSBI (F/TV, Tobin index) >100 for 5 minutes
- Minute ventilation >15 for 5 minutes
- Decreased level of consciousness
  - Somnolence, obtundation
- Rising end tidal CO2 (increase by 10)

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Step 3: Transition to Time Off Vent

- From pressure support of 10cm H2O or less, transition to trach collar or T-Piece
- Goal is trach collar 4 hours on, 4 hours with pressure support
- “Rest” on pressure support overnight

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Step 4: Increase Amount of Time Off Vent

- Transition to trach collar or T-Piece
- Maintain on trach collar for 12 hours a day
- “Rest” on pressure support overnight

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Step 5: Transition to Trach Collar Only

- If tolerating 12 hours a day, transition to full time use
- Consider downsize or decannulation after 48 hours

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Allina Health

Post-Tracheostomy Prolonged Ventilator Weaning Protocol

Inclusion Criteria: Status post-tracheostomy performed due to inability to be liberated from ventilator.

Evaluate BID for weaning trial with a goal to complete one weaning trial per day.

Initiate weaning trial using below screening criteria unless:

- Worsening blood pressures and/or actively titrating pressors to maintain blood pressure goals
- Unstable cardiac rhythm
- Receiving paralytics
- Increasing oxygen needs
- Peep >=10cm H2O
- FiO2 >= 60%
- ICP >=15
- ECMO, Inhaled epoprostenol, nitric oxide
- Neuromuscular disorder present

Failure Criteria:

- RR > 35 for greater than 5 minutes
- HR > 130
- SBP > 180 or < 90
- FiO2 increased to > 60% or change is 10% from start of wean
- RSBI > 100 for greater than 5 minutes
- MV >= 15 for greater than 5 minutes
- Decreased level of consciousness or other signs of hypercapnia
- Signs of hypoventilation including somnolence, obtundation, or end tidal CO2 increased by 10

Step 1:

- Set pressure support to achieve tidal volume within 100mL of current setting
- Do no exceed set inspiratory pressure of 20cm H20 (if outside the protocol, discuss with provider)
- Monitor for failure criteria
- If fail, return patient back to original settings and document reason for fail
- Reattempt next day utilizing screening criteria.
- If successful after 2 hours, proceed to step 2

Step 2:

- Decrease pressure support by 2-3 cm H2O while maintaining minute ventilation and respiratory rate
- Continue to decrease pressure support every two hours to a goal pressure support of 10 or less
- Monitor for failure criteria
- If fail, return to full vent support and reattempt next day starting at prior tolerated pressure support level
- After 6 hours, return to full vent support and restart next day at 2-3cm less than the previous tolerated pressure support level
- When tolerated for 6 hours at pressure support of 10 or less, return to full support and proceed to step 3 on the next day

Step 3:

- Transition to trach collar or T-piece
- Goal of trach collar BID up to 12 hours per day
- Rest patient on pressure support 5-10 in between trials and for 12 hours overnight
- Monitor for failure criteria
- If fail trach collar, return to step 2 at most recent pressure support
- If tolerated for 12 consecutive hours, proceed to step 4 on next day

Step 4:

- Trach Collar 12 hours during day, pressure support 5-10 for 12 hours overnight
- Monitor for failure criteria
- If fail, return to step 2 at most recent pressure support
- After 48 hours, proceed to step 5 on next day

Step 5:

- Trach collar or T-piece for 24 hours
- Monitor for failure criteria
- If fail, notify provider

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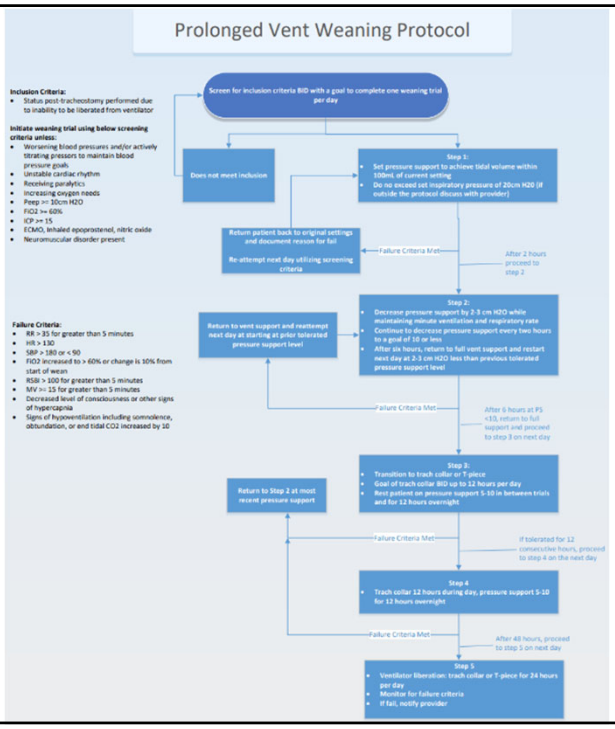

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Weakness in the ICU

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Weakness in the ICU

- 54 yo man admitted with septic shock and infected lower extremity ulcers, MRSA bacteremia
- Medical history incudes DM2, Obesity (BMI 51), CKD
- Intubated, treated with broad spectrum antibiotics
  - ID, podiatry and vascular following
  - Underwent through knee amputation the day after admission
- Extubated and re-intubated twice, now s/p tracheostomy
- PT evaluation: pt total assist for all activities of daily living

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Clinical/research definitions of ICU weakness

- Critical Illness Myopathy
  - EMG with major and minor criteria
- Critical Illness Polyneuropathy
  - EMG with additional diagnostic criteria
- ICU associated weakness
  - Manual Muscle strength testing

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Risk Factors for Weakness in the ICU

- Critical illness
- Medications
- Bedrest

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Medications and weakness

- Steroids (hydrocortisone, methylprednisolone, dexamethasone)
  - Well described muscle weakness in patients receiving steroids
    - Potentially related to glucocorticoid receptors, loss of actin/myosin, and muscle aptosis
  - Older, smaller studies suggested significant association of steroids and weakness
    - 95 patients with ARDS, 203 patients with ARDS
  - Newer, also small studies show no association with muscle weakness
- Neuromuscular blockade (cisatracurium, rocuronium)
  - Association makes intuitive sense
  - Most recent RCT of cisatracurium showed no association with weakness
  - Likewise no association in longitudinal follow up study of ICU survivors

Chest 2016; 150(3): 722

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Bedrest: the *peril*

- For each day of bedrest:
  - Loss of 3-11% of muscle strength for each day of bedrest
  - Decrease in 6 minute walk test distance, lasting up to 2 years
- For 2 weeks of immobility in young, healthy people:
  - Loss of 5-9% of quadriceps muscle mass
  - Loss of 20-27% of quadriceps muscle strength
  - 3-6 fold greater rate of muscle loss in older, frailer individuals

Respiratory Care 2016; 61(7): 971

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Perceived Barriers to Mobilization

- Endotracheal Tube
  - Feasible to mobilize with endotracheal tube:
    - Daily sedation reduction
    - Secure tubes, remove unnecessary devices
    - 1/3 of patients were moved from bed to chair to standing
    - 15% were able to ambulate
    - 4% of sessions terminated early (mostly due to ventilator dyssynchrony)
- Femoral catheters
  - Medical ICU study with femoral catheters (Central lines, arterial lines)
  - Patients able to do in-bed exercises, cycle ergometry, stand/walk
  - No catheter related adverse events

Chest 2016; 150(3):722

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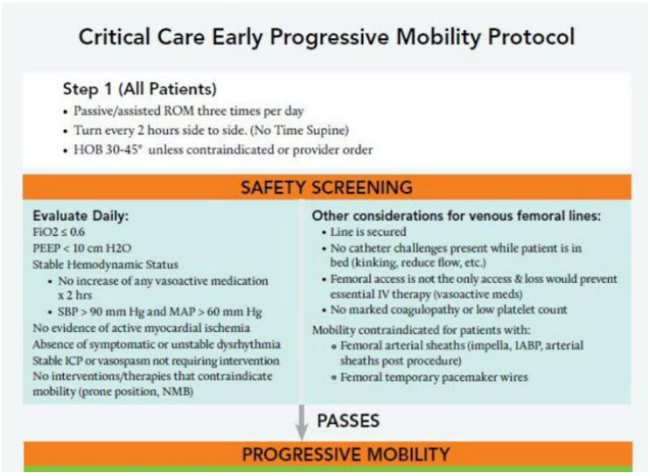
Progressive Mobility Protocol



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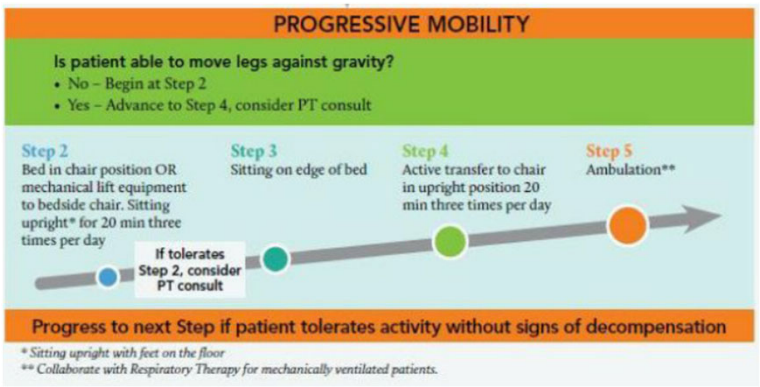
Physical Therapy Consult at Step 2



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Updating Allina's Daily Mobility Plan

- AM-PAC screening
  - Acuity Measure for Post Acute Care (short form), "Six Clicks"
- Calculated mobility goal
  - Johns Hopkins Highest Level of Mobility Goal
- Documentation of highest level of mobility

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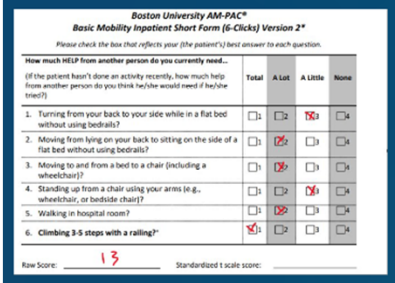
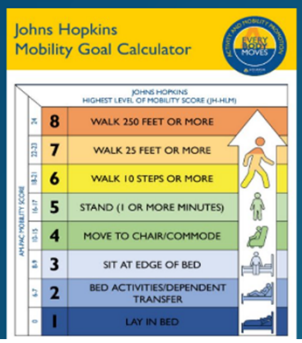
Structure of the Daily Mobility Plan

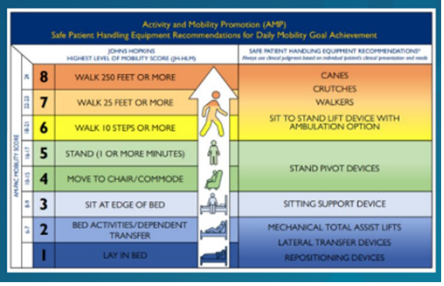
AMPAC completed daily
- RN's *best guess* about patient mobility
- 6 clicks

Mobility Goal Calculator
- Auto-calculates the *Minimum* mobility goal the patient *should* achieve
- No clicks

Highest Level of Mobility (HLM) achieved charted each shift
- Charted by RN or aide
- Reflects patient's *actual performance*







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Medication Tolerance and Withdrawal

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Medication Tolerance and Withdrawal

- 42 yo man admitted in transfer with alcohol withdrawal symptoms
- Severely agitated despite high doses of diazepam
- Intubated for sedation management, started on propofol, dexmedetomidine @ 1.5, scheduled haloperidol and diazepam
- Transitioned off dexmedetomidine on hospital day 7 due to fevers
- Significant increase in heart rate from 80 to 130
- Ongoing intermittent agitation

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Medication Tolerance and Withdrawal

- Sedative medications frequently implicated
  - Dexmedetomidine
  - Benzodiazepines
  - Opiates

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Dexmedetomidine

- Centrally acting alpha 2 agonist
  - Anxiolytic, sedative and weak analgesic properties
- Onset in 15-20 minutes
- Half life
  - 2-3 hours in healthy volunteers
  - 2.2-3.7 hours in ICU patients
  - Prolonged administration increases variability in half life

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Dexmedetomidine indications

- Initial FDA approval based on 24 hour infusion to facilitate extubation
- Used for maintenance of light sedation
  - NOT for use for deep sedation
- Also useful for alcohol and opiate withdrawal symptom management

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Dexmedetomidine withdrawal

- Prolonged infusion may precipitate withdrawal syndrome
  - Tachycardia, elevated blood pressure, agitation, delirium
- Medication management strategies
  - Clonidine
    - Oral centrally acting alpha 2 agonist
    - Prospective cohort study: addition of clonidine vs dexmedetomidine wean
    - No difference in low rate of withdrawal symptoms
    - Use associated with faster wean off of dexmedetomidine
  - Guanfacine
    - Oral centrally acting alpha 2 agonist, maybe less associated hypotension
    - Initiation of guanfacine, followed by weaning off of dexmedetomidine
    - 58% off of dexmedetomidine in 48 hours, 71% off in 72 hours
    - Half needed medications for breakthrough agitation
    - 2% had dexmedetomidine withdrawal

Crit care expl 2020; 2:e0245
Crit care expl 2022 Nov1; 4(11): e0785

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Benzodiazepines

- Bind to GABA receptor complex, enhancing binding of inhibitory neurotransmitters
- Anxiolysis at low doses
- Sedation, amnesia, anticonvulsant effects at higher doses
- Midazolam and diazepam are highly lipophilic
  - Short onset of action (minutes)
  - Rapid redistribution to peripheral tissues
- Accumulate in adipose tissue, increasing duration of effect
- Tolerance develops over time

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Midazolam

- Increase in incidence of delirium with midazolam compared to dexmedetomidine
- Risk factors:
  - Older age
  - Deep sedation
  - Dementia

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Benzodiazepine withdrawal

- Occurs in approximately one third of ICU patients
- Symptoms typically appear within 2-3 days of drug discontinuation
- Risk factors:
  - Prior/home use (benzodiazepines or alcohol)
  - High cumulative doses
  - Prolonged exposure
  - High BMI
  - Younger age

AACN Adv Crit Care 2019 Dec 15; 30(4): 353

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Benzodiazepine withdrawal symptoms

- CNS symptoms
  - Agitation
  - Delirium
  - Hallucinations
  - Tremor
  - Seizure
- GI symptoms
  - Nausea/vomiting
- Sympathetic nervous system activation
  - Diaphoresis
  - tachycardia

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Benzodiazepine withdrawal prevention

- Slow weaning of infusion rate
  - Reduce dose by 10-25% daily
- Substitution
  - Use of lorazepam IV or PO to treat symptoms
    - Note: not lipophilic, does not redistribute into tissues
- Limitations:
  - No validated tool to assess benzodiazepine withdrawal in the ICU

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Opiates in the ICU

- Opiates frequently used as part of sedation strategy
- Analgosedation
  - Analgesia-first strategy
  - Goal is to reduce deep/unnecessary sedation
- Unfortunately
  - Severe pain is inversely related to delirium
    - and
  - Increased exposure to opiates is associated with increased risk of delirium

Am J Respir Crit Care Med 2021; 204(5):566

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Opiate withdrawal

- Occurs in approximately 20% of patients
- Risk factors are similar to benzodiazepine withdrawal
  - Prolonged duration of use
  - Cumulative dose
  - History of drug use disorder
  - Rapid weaning rate
  - High BMI
  - Young age

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Opiate Withdrawal Symptoms

- CNS
  - Muscle aches
- GI symptoms
  - Diarrhea
- Sympathetic nervous system activation
  - Fever
  - Hypertension
  - Lacrimation/rhinorrhea
  - Mydriasis
  - Tachypnea
  - Yawning
- Other
  - Drug craving
  - Increased sensitivity to pain

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Opiate withdrawal management strategies

- Prolonged withdrawal
  - Reduction in dose by 10%-25% over time
- Conversion to oral equivalent
  - Transition to enteral opiates
- Adding alpha 2 agonist
  - Use of either clonidine or dexmedetomidine
- No trials exist comparing management strategies
- No validated tools to assess opiate withdrawal in the ICU

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Take Home Points

- 5% of ICU patients will need long term vent weaning
- Protocolized weaning reduces duration of mechanical ventilation
- Muscle weakness in the ICU is common
- Physical therapy is safe to initiate
- Commonly used sedatives have associated withdrawal syndromes
- Management strategies generally include gradual reduction in dose of sedative medications

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Questions

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