EARLY MOBILITY OF MECHANICALLY VENTILATED ADULTS IN ICU

DELFINA VASQUEZ PT, DPT, CSRS.

OBJECTIVES

- Identify importance of early mobilization of mechanically ventilated and critically ill patients
- Identify safety criteria to mobilize patients in the ICU
- Identify contraindications to mobilization

ACTIVE MOBILIZATION IN ICU

- In the past, critically ill patients were often managed with deep sedation and bed rest.[1]

- However, multiple controlled trials have investigated the importance of early mobility and have published those results in recent years.

WHY DO WE DO EARLY MOBILITY IN ICU?

- Primary goal: Optimize cardiopulmonary and neuromuscular function
- Minimize loss of mobility/function.[2-4]
- Decrease risk of delirium.[2-4]
- Facilitate ventilator weaning.[2-4]
- Reduce length of stay.[2-4]

WEAKNESS IN THE CRITICALLY ILL

- Impact Of Bedrest and Immobility

  -Skeletal muscle strength may decline:

  In a young healthy adult

  - Strict bed rest: ~ 1% to 1.5 % per day.[5]
  - Body density reduction, circulatory complications, respiratory changes, GI slows down, etc..[6]

  In the elderly

  - Muscle wasting occurred early and more rapidly during the first week of critical illness.[7-8]

ABSOLUTE CONTRAINDICATIONS FOR EARLY MOBILITY AND WALKING PROGRAM

1. Comatose, unresponsive patients or patients on neuromuscular paralytic agents
2. Abnormal resting EKG with hemodynamic compromise
3. Unstable angina, or unstable heart failure
4. Hemodynamic instability requiring
   - -High doses or multiple vasopressor drugs
5. Significant oxygenation dysfunction requiring
   - -$Fio_2 > 0.6$
   - -Positive end-expiratory pressure > 10 mm Hg
   - -worsening respiratory failure
6. Cerebral edema with uncontrolled ICP
7. Unstable fractures
8. Grave prognosis and is transferring to comfort care

Managing the Patient on Mechanical Ventilation in ICU: Early Mobility and Walking Program

Christiane Perme, PT, CCS and Rohini Krishnan Chandrashekar, PT, MS, CCS

SAFETY CRITERIA TO MOBILIZE PATIENTS WHO ARE MECHANICALLY VENTILATED

Hodgson *et al. Critical Care* (2014) 18:658
DOI 10.1186/s13054-014-0658-y

CRITICAL CARE

RESEARCH Open Access

Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults

	Low risk of an adverse event. Proceed as usual according to each ICU's protocols and procedures.
	Potential risk and consequences of an adverse event are higher than green, but may be outweighed by the potential benefits of mobilization. The precautions or contraindications should be clarified prior to any mobilization episode. If mobilized, consideration should be given to doing so gradually and cautiously.
	Significant potential risk or consequences of an adverse event. Active mobilization should not occur unless specifically authorized by the treating intensive care specialist in consultation with the senior physical therapist and senior nursing staff.

RESPIRATORY CONSIDERATIONS

RESPIRATORY CONSIDERATIONS	IN-BED EXERCISES	OUT-OF-BED EXERCISES
Intubation		
Endotracheal tube [a]	●	●
Tracheostomy tube	●	●
Respiratory parameters		
Fraction of inspired oxygen		
≤ 0.6	●	●
> 0.6	▲	▲
Percutaneous oxygen saturation		
≥ 90%	●	●
< 90% [b]	▲	■
Respiratory rate		
≤ 30 bpm	●	●
> 30 bpm	▲	▲
Ventilation		
Mode HFOV	▲	■
PEEP		
≤ 10 cmH_2O	●	●
> 10 cmH_2O	▲	▲
Ventilator dysynchrony [c]	▲	▲
Rescue therapies		
Nitric oxide	▲	▲
Prostacyclin	▲	▲
Prone positioning [d]	■	■

Hodgson *et al. Critical Care* (2014) 18:658
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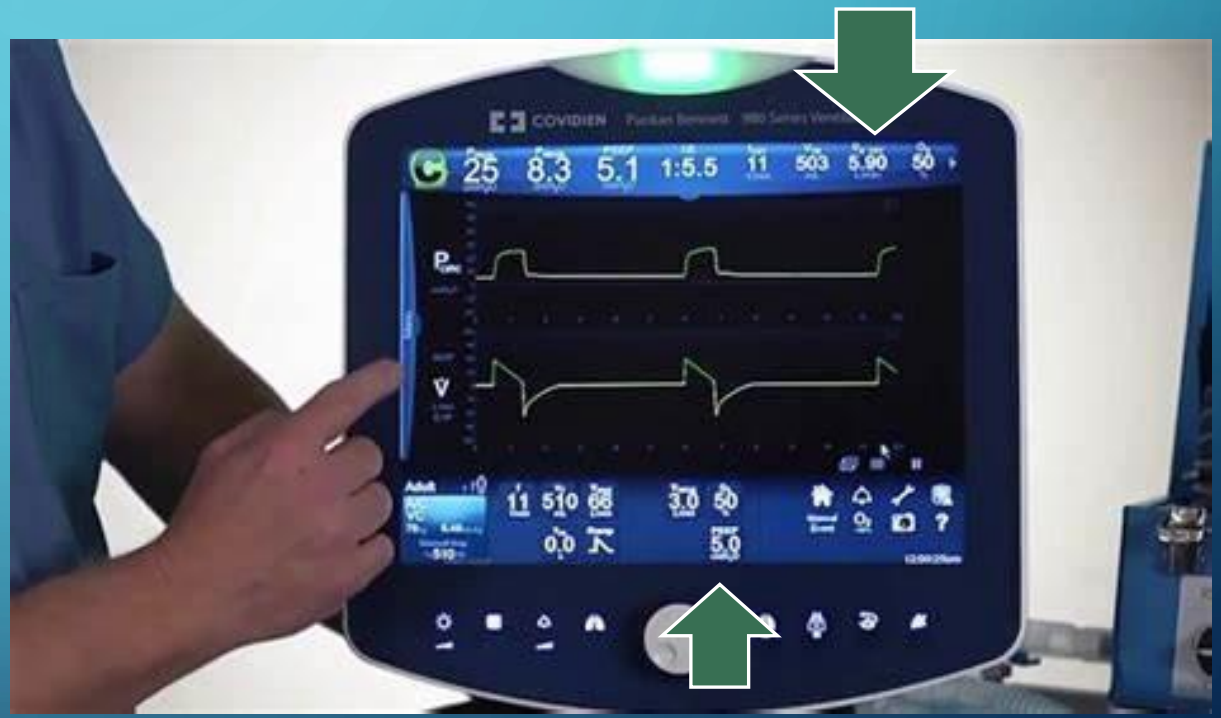
REHAB THERAPISTS NEED TO KNOW THESE

- Ventilation settings
  - mode of ventilation
  - Fio2
  - PEEP
- Patient's data
  - minute ventilation (VE: pt data)
  - RR (pt data)

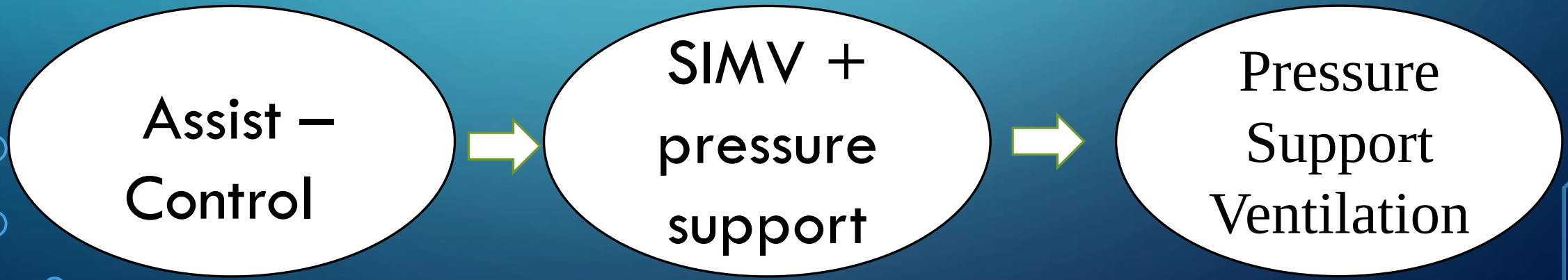


VENTILATOR MODES

- Number of ventilator modes has grown exponentially in the last decades
- One respiratory care textbook

  -174 names of modes on 34 different ventilators.[11-12]

- ~90% will be on traditional mechanical ventilator modes:



Respir Care 2014;59(11):1747–1763

PRESSURE SUPPORT

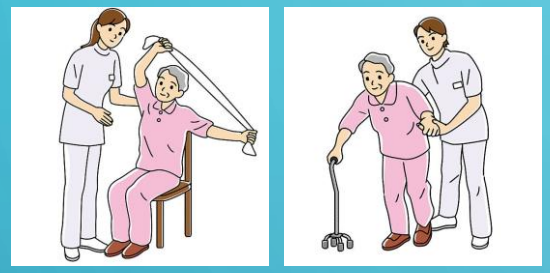
- Rapid Shallow Breathing Index (RSBI) (PB980)
- Used to assess weaning status and work of breathing on a patient on mechanical ventilation who is breathing spontaneously.
- Normal RSBI: <105 which suggest increase likelihood of being successfully extubated.[13]

  -As per RT policy in UMC: RSBI < 135

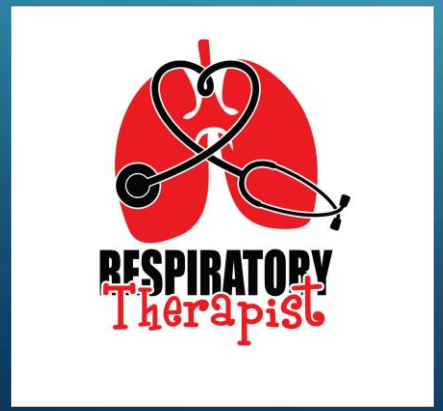
al. Rapid shallow breathing index. Ann Thorac Med. 2016 JulSep;11(3):167-76. PMID: 27512505.

WHICH DISCIPLINES NEED TO BE PRESENT WHEN WORKING WITH PTS ON MECH VENT?

IN BED/ AT EOB



OOB



CARDIOVASCULAR CONSIDERATIONS

Cardiovascular Considerations	In-bed exercises	Out-of-bed exercises
Blood pressure		
Intravenous antihypertensive therapy for hypertensive emergency [a]		
MAP [b]:		
Below target range and causing symptoms		
Below target range despite support (vasoactive and/or mechanical)		
Greater than lower limit of target range while receiving no support or low level support		
Greater than lower limit of target range while receiving moderate level support		
Greater than lower limit of target range on high level support		
Known or suspected severe pulmonary hypertension		
Cardiac arrhythmias		
Bradycardia:		
Requiring pharmacological treatment (e.g., isoprenaline) or awaiting emergency pacemaker insertion		
Not requiring pharmacological treatment and not awaiting emergency pacemaker insertion		
Transvenous or epicardial pacemaker:		
Dependent rhythm		
Stable underlying rhythm		
Any stable tachyarrhythmia:		
Ventricular rate >150 bpm		
Ventricular rate 120 to 150 bpm		
Any tachyarrhythmia with ventricular rate < 120 bpm		
Devices		
Femoral IABP [c]		
ECMO:		
Femoral [c] or subclavian (not single bicaval dual lumen cannulae)		
Single bicaval dual lumen cannulae inserted into a central vein		
Ventricular assist device		
Pulmonary artery catheter or other continuous cardiac output monitoring device		
Other cardiovascular considerations		
Shock of any cause with lactate >4mmol/L		
Known or suspected acute DVT/PE		
Known or suspected severe aortic stenosis		
Cardiac ischemia (defined as ongoing chest pain and/or dynamic EKG changes)		

IABP = intra-aortic balloon pump; ECMO = extracorporeal membrane oxygenation; bpm = beats per minute; MAP = mean arterial pressure; DVT = deep vein thrombosis; PE = pulmonary embolus.

[a] This may be a yellow (pause) for in-bed activities if the blood pressure is within target range as documented by the medical team.

[b] Experienced ICU practitioners were considered to have good judgment about the impact of cardiovascular instability and low, medium or high levels of hemodynamic support, on the ability to exercise. However, in the case of uncertainty or lack of experience, it is recommended that the decision to mobilize a patient is discussed with appropriate experienced ICU staff. The target mean arterial pressure is determined by the treating ICU team.

[c] Cycling and hip flexion may be contraindicated in the leg where the IABP/ECMO is inserted. If so, in-bed exercises may need to be modified to limit hip flexion.

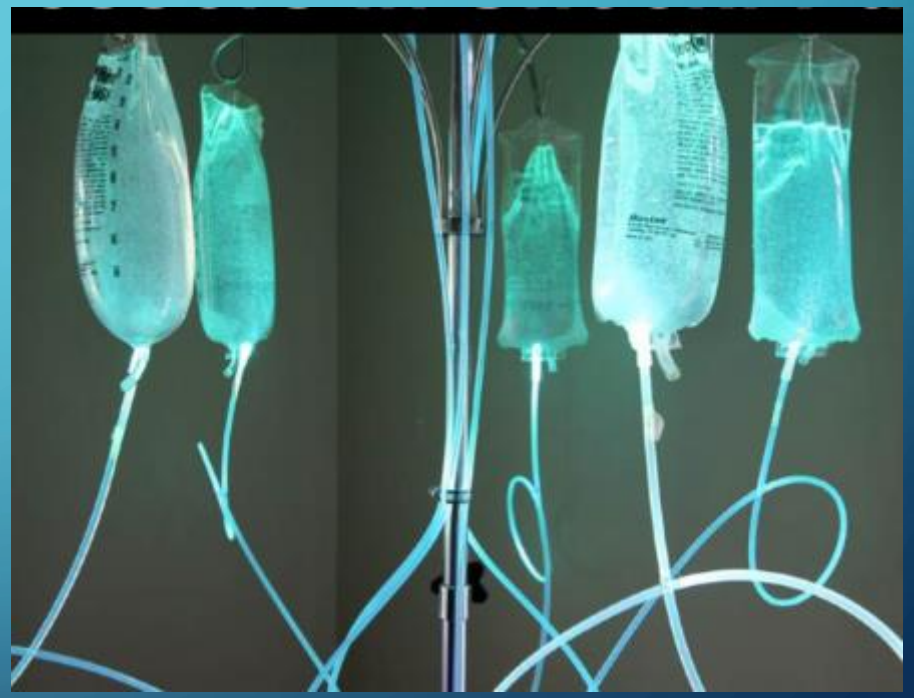
MEAN ARTERIAL PRESSURE

- It is the average pressure in patient's arteries during one cardiac cycle.[14]
- Considered a better indicator of perfusion to vital organs than SBP.[14-15]
- Normal 70-100mmHg

MAP[b]:	In-bed exercises	Out-of-bed exercises
Below target range and causing symptoms	▲	⬢
Below target range despite support (vasoactive and/or mechanical)	▲	⬢
Greater than lower limit of target range while receiving no support or low level support	●	●
Greater than lower limit of target range while receiving moderate level support	▲	▲
Greater than lower limit of target range on high level support	▲	⬢

PRESSOR SUPPORT/VASOACTIVE DRUGS

- 4 main ICU pressors: norepinephrine, epinephrine, vasopressin, phenylephrine
- Not an absolute contraindication but appropriateness of mobilization is influence by:
  - Absolute dose of vasopressor
  - Change in dose (titrating up/down within last 24 hrs)
  - Whether or not the patient is clinically well-perfused (MAP)



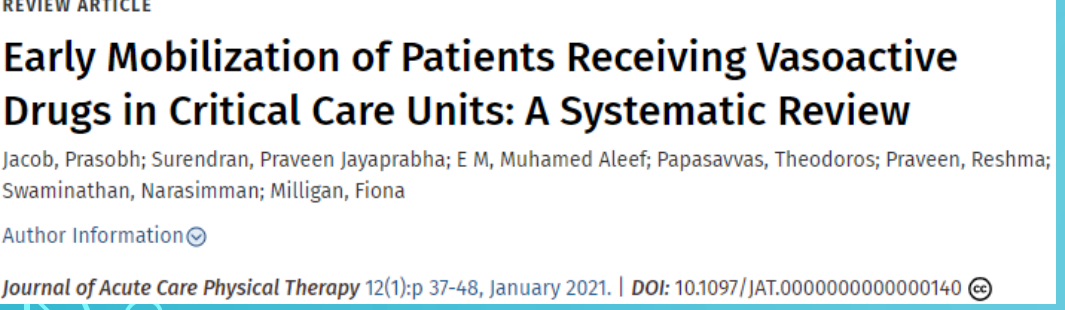
REVIEW ARTICLE

Early Mobilization of Patients Receiving Vasoactive Drugs in Critical Care Units: A Systematic Review

Jacob, Prasobh; Surendran, Praveen Jayaprabha; E M, Muhamed Aleef; Papasavvas, Theodoros; Praveen, Reshma; Swaminathan, Narasimman; Milligan, Fiona

Author Information

Journal of Acute Care Physical Therapy 12(1):p 37-48, January 2021. | *DOI:* 10.1097/JAT.0000000000000140



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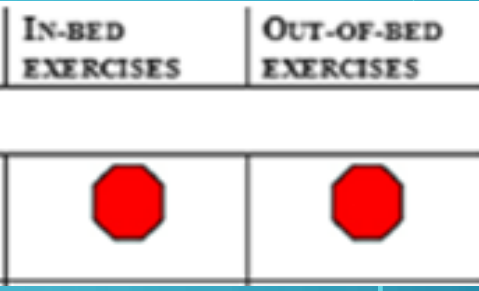
MOST COMMON ADVERSE EVENT?

- This SR states that vasoactive medications should not be considered as a contraindication for early mobilization
- None of the included studies reported any serious adverse events associated with early mobilization.
- Overall, the most commonly cited adverse event was reversible hypotension.[17]

INTRAVENOUS HYPERTENSIVE THERAPY



- For HTN emergency
- Initially, mobility is contraindicated.[10]

  -However, early mobility can usually start once BP normalizes.[18-20]
- Major exceptions:

  -Acute phase of an ischemic stroke

Meta-Analysis > Stroke. 2003 Dec;34(12):2847-50. doi: 10.1161/01.STR.0000101752.23813.C3. Epub 2003 Nov 6.

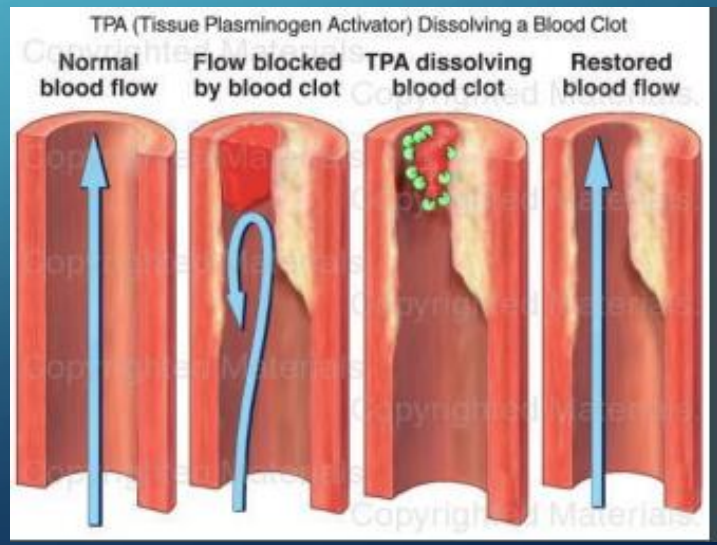
Tissue plasminogen activator for acute ischemic stroke in clinical practice: a meta-analysis of safety data

Glenn D Graham [1]

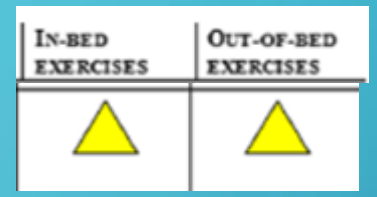
THROMBOLYTIC AGENTS

- (Tissue-type plasminogen activator-TPA
- Uses: ischemia
- ❖Side effects:
  - Decreased blood clotting
  - Bleeding: Intracranial, GI, GU..

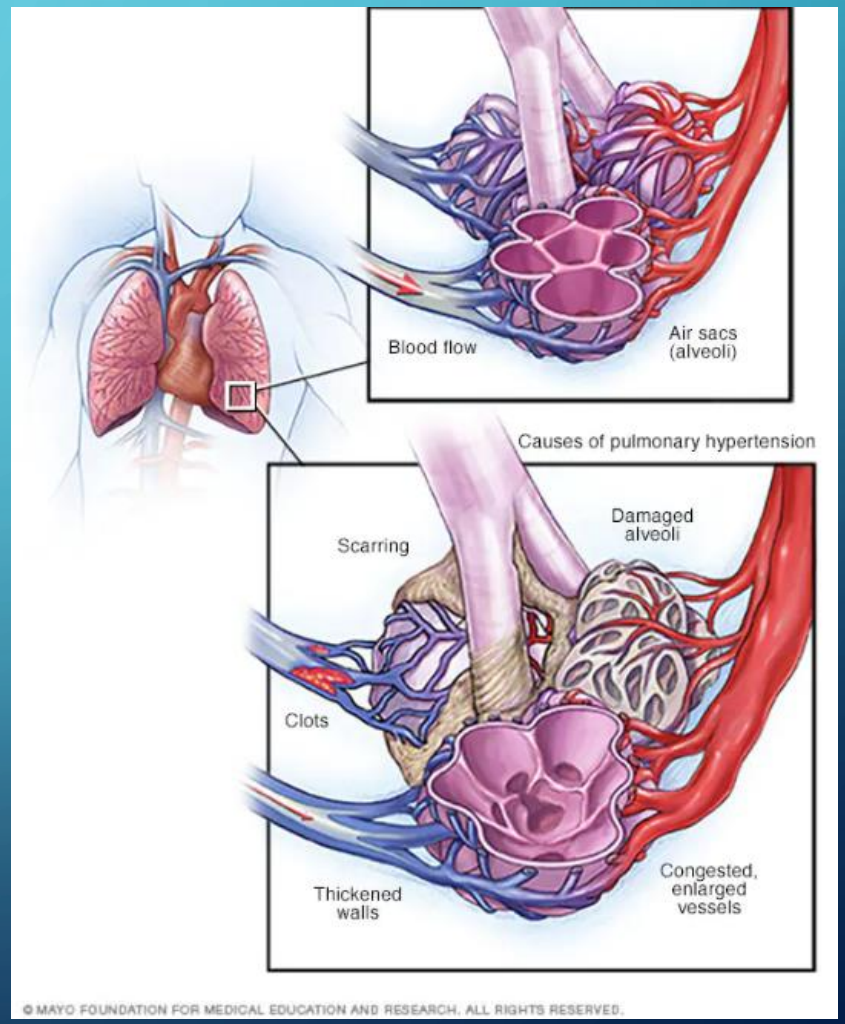
- Effects of IV tPA wear off in 6-8 hours
- Most ICH develop within first 12 hours
- Current Rehab Recommendations: Bedrest 24-48 hrs



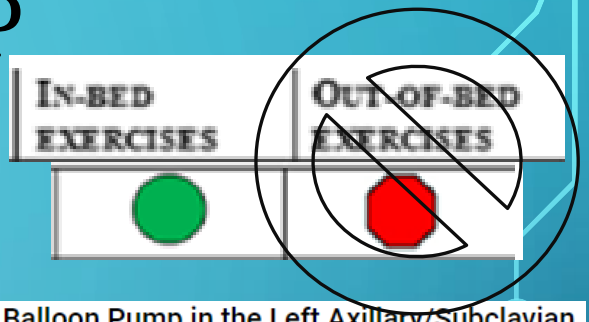
PULMONARY HTN



- Understand the reason why this patient developed pulmonary HTN
- How is the cardiac/pulmonary stability?
- Pt might present with: severe SOB, cyanosis, CP, intense fatigue, severe dizziness.[23]



INTRA-AORTIC BALLON PUMP -AXILLARY SUBCLAVIAN



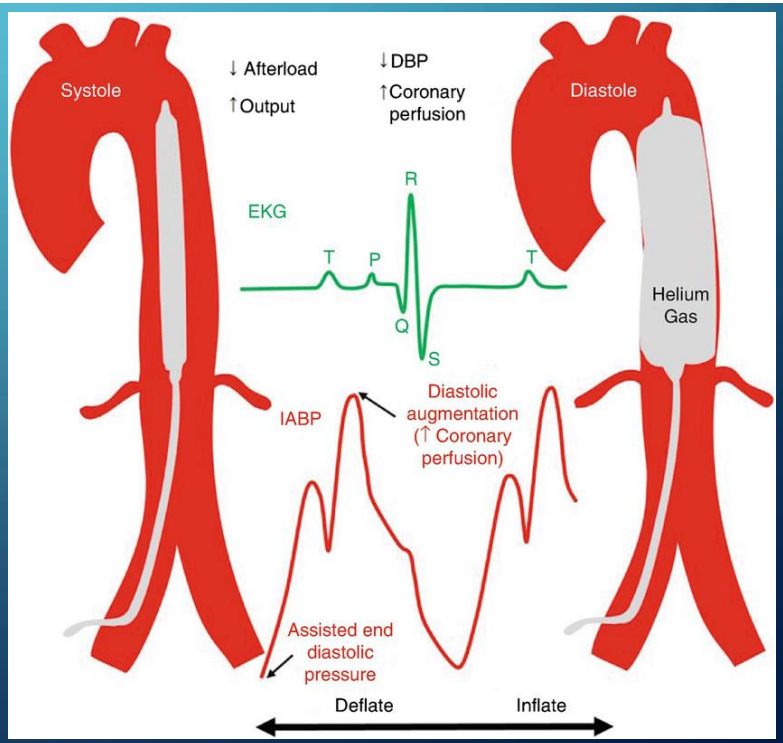
- Increases cardiac output by up to 1 L/m.
- Allows upright sitting and ambulation in those requiring extended support.[25]
- Precautions with axillary/subclavian artery IABP
  - - Limit shoulder flexion to 90 degrees
  - - Monitor perfusion on the upper extremity
  - - Notify RN immediately if any vascular changes
  - - Encourage walking program

Percutaneous Placement of an Intra-Aortic Balloon Pump in the Left Axillary/Subclavian Position Provides Safe, Ambulatory Long-Term Support as Bridge to Heart Transplantation FREE ACCESS

Mini Focus Issue: Advanced Heart Failure

Jerry D. Estep, Andrea M. Cordero-Reyes, Arvind Bhimaraj, Barry Trachtenberg, Nashwa Khalil, Matthias Loebe, Brian Bruckner, Carlos M. Orrego, Jean Bismuth, Neal S. Kleiman, and Guillermo Torre-Amione

J Am Coll Cardiol HF. 2013 Oct, 1 (5) 382–388



https://mechanicalboost.com/intra-aortic-balloon-pump/

INTRA-AORTIC BALLOON PUMP – FEMORAL ARTERY

- - Patients with femoral artery IABP are on bed rest!
- - **Involved hip should not be flexed >30 deg**
- - However

- Ambulation of selected patients with femoral IABPs appears to be a safe activity using the enclosed protocol (pt used tilt table until being upright, then ambulated- preventing hip flexion when sitting at EOB).[26]

ASAIO J. 2022 May 1;68(5):714-720. doi: 10.1097/MAT.0000000000001557. Epub 2021 Aug 6.

Safety and Feasibility of an Early Mobilization Protocol for Patients with Femoral Intra-Aortic Balloon Pumps as Bridge to Heart Transplant

Stacey Chen [1], Lynette Lester [1], Greta L Piper [2], Bridget Toy [3], Mary Saputo [4], Wendy Chan [5],

J Card Fail. 2020 Jul;26(7):621-625. doi: 10.1016/j.cardfail.2020.05.010. Epub 2020 May 21.

Safe Ambulation of Critically Ill Cardiac Patients With Femoral Balloon Pumps: A Case Cohort Study

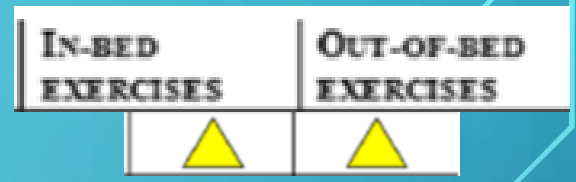
Stephen C Ramsey [1], Jason Lucas [2], Peter Barrett [2], William L Ballard [2], Prashant Kaul [2], Andrew J Klein [2]

Journal of Thoracic Disease

J Thorac Dis. 2016 Jul; 8(7): 1388–1390.
doi: 10.21037/jtd.2016.05.55
PMCID: PMC4958885
PMID: 27501243

New clinical criteria for septic shock: serum lactate level as new emerging vital sign

Su Mi Lee and Won Suk An



SHOCK IN THE ICU

- Shock in the ICU is a state of organ hypoperfusion.[28]
- The mortality rate of patients with both hypotension and lactate ≥4 mmol/L is 46.1%.[28]
- PT/OT should MONITOR BP/MAP closely. Check lactate before working with these pts

NEUROLOGICAL CONSIDERATIONS

NEUROLOGICAL CONSIDERATIONS	IN-BED EXERCISES	OUT-OF-BED EXERCISES
Level of consciousness		
Patient drowsy, calm or restless (e.g., RASS -1 to +1)		
Patient lightly sedated or agitated (e.g., RASS -2 or +2)		
Patient unrousable or deeply sedated (e.g., RASS <-2)		
Patient very agitated or combative (e.g., RASS >+2)		
Delirium		
Delirium tool (e.g., CAM-ICU) –ve		
Delirium tool +ve and able to follow simple commands		
Delirium tool +ve and not able to follow commands		
Intracranial pressure		
Active management of intracranial hypertension, with ICP not in desired range		
Intracranial pressure monitoring without active management of intracranial hypertension		
Other neurological considerations		
Craniectomy		
Open lumbar drain (not clamped)		
Subgaleal drain		
Spinal precautions (pre-clearance or fixation)		
Acute spinal cord injury		
Subarachnoid haemorrhage with unclipped aneurysm		
Vasospasm post-aneurysmal clipping		
Uncontrolled seizures		

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INTRACRANIAL PRESSURE

- Normal ICP in adults ranges from 10 to 20 cm H20.[29]
- Intracranial hypertension: sustained ICP >20mm Hg

  -keep HOB> 30 deg

  -keep neck in neutral

	In-bed exercises	Out-of-bed exercises
Intracranial pressure		
Active management of intracranial hypertension, with ICP not in desired range		
Intracranial pressure monitoring without active management of intracranial hypertension		

	In-bed exercises	Out-of-bed exercises
Open EVD (not clamped)		

- External Ventricular Device (EVD)

❖ General criteria for mobility:

- Stable ICP
- Hemodynamically stable
- Stable respiratory status
- Level of alertness
- Able to follow simple commands

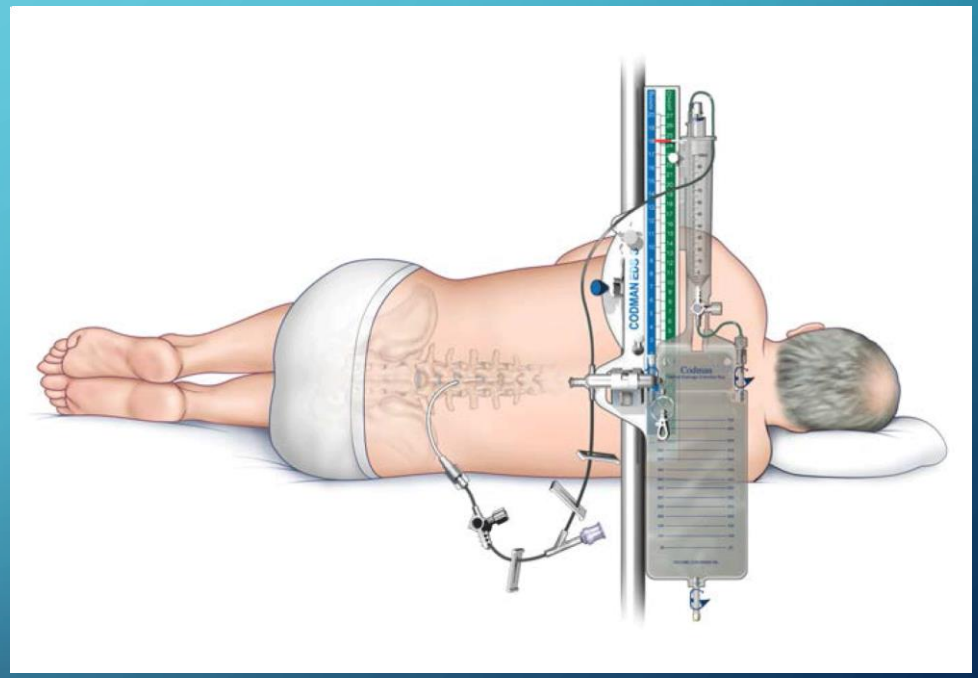
❖ RN responsibilities:

- Clamp/reset height prior AND after mobility
- Level drain during mobility, if appropriate

	In-bed exercises	Out-of-bed exercises
Open lumbar drain (not clamped)		

LUMBAR DRAIN

- They are utilized to manage CSF leaks and alleviate pressure on the brain or spinal cord.
- Mobility: use same criteria for mobility as EVD
- RN must clamp drain before OOB



Lifenph.com. Published 2022. https://www.lifenph.com/nphdiagnosis

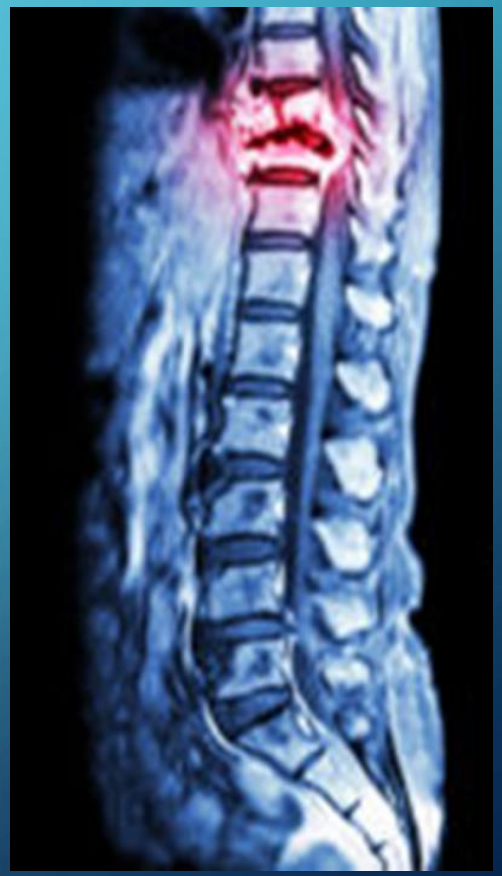
ACUTE SPINAL CORD INJURY

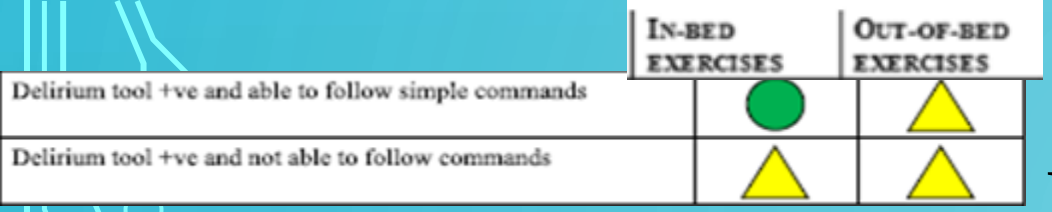
- Rehabilitation starts once a patient is stable
- PT/OT should confirm the following BEFORE starting therapy:

  -Complete or incomplete injury?

  -Brace needed? What type of brace?

  -Is the pt hemodynamic stable?
- A lot of patient's education: pressure injury prevention, importance of upright posture, prevention of spasticity by perform PROM and or AAROM ther-ex.





DELIRIUM

- The ABCDE bundle is focused on:

  -Minimizing sedation

  - Encouraging early ventilator liberation, while assessing for delirium and management

  - Facilitating early mobilization in the ICU

- What type of exercise is optimal?

  - It is based on the patient's level of sedation

Review > Int J Nurs Stud. 2023 Feb:138:104410. doi: 10.1016/j.ijnurstu.2022.104410. Epub 2022 Nov 29.

The effect of the ABCDE/ABCDEF bundle on delirium, functional outcomes, and quality of life in critically ill patients: A systematic review and meta-analysis

- ICU delirium is a predictor of:

↑ mortality

↑ length of stay

↑ time on vent,

↑hospital costs

↑ re-intubation

↑ long-term cognitive/functional impairment

↑ discharge to long-term care facility.

- Early mobilization during SATs: associated with improved odds of return to independent functional status by discharge.[33]
- PT/OT should coordinate with RN for next SAT

Review > Ann Transl Med. 2018 Oct;6(19):384. doi: 10.21037/atm.2018.05.50.

Effects of patient positioning on respiratory mechanics in mechanically ventilated ICU patients

Mehdi Mezidi [1] [2], Claude Guérin [1] [2] [3]

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