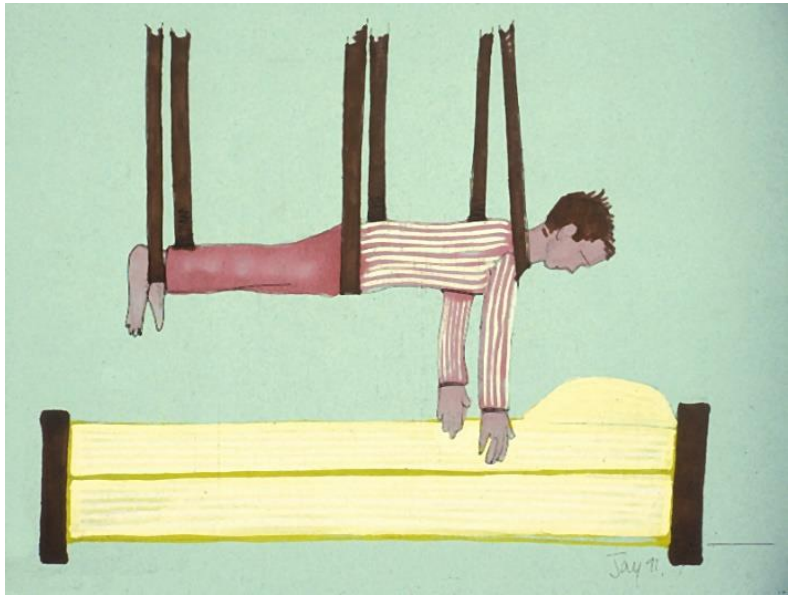
Prone Positioning: A Non-Invasive Maneuver for ARDS that Makes a Difference



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- Consultant-Michigan Hospital Association Keystone Center
- Subject matter expert HRET: CAUTI, CLABSI, HAPU, Sepsis, Safety culture
- Consultant and speaker bureau:
  - Sage Products a business unit of Stryker
  - Eloquest Healthcare
- Baxter Healthcare Advisory Board

Objectives

- Discuss the physiologic rationale and the evidence for use of the prone position in patients with ARDS
- Identify evidence-based strategies for determining when to turn, how to turn, and how long to allow patients to remain in the prone position
- Outline strategies for preventing complications

Incidence and Mortality of ARDS: The Lung Safe Study

- Large observational study to understand the global impact of severe acute respiratory failure (LUNG SAFE)
- 459 ICUs from 50 countries across 5 continents
- Primary outcome measure: ARDS incidence/Morality & use of interventions
- Results
  - 10% incidence of ARDS
  - 78% within 48hrs are mechanically ventilated
  - ARDS mortality (mild-severe) 35%-46%

Bellaini G, et al. JAMA, 2016;315(8):788-800

Prone Positioning Incidence

Prone positioning was only used in 16.3% of patients with severe ARDS in the LUNG SAFE study

Bellaini G, et al. JAMA, 2016;315(8):788-800

European Prevalence Study (APRONET): Use of PP in mild 5.9%, moderate 10.3%, severe 32.9% ARDS

Guerin C, et al. Intensive Care Med, 2018;44(1):22-37

The Berlin ARDS Definition

TIMING	Within 1 week of a known clinical insult or new/worsening respiratory symptoms
CHEST IMAGING (X-RAY OR CAT SCAN)	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules
ORIGIN OF EDEMA	Respiratory failure not fully explained by cardiac failure or fluid overload; need objective assessment (eg, echocardiography) to exclude hydrostatic edema if no risk factors present

	MILD	MODERATE	SEVERE
OXYGENATION	<200 PaO_2/FiO_2 or ≤300 with PEEP/CPAP ≥5 cm H_2O	<100 PaO_2/FiO_2 or ≤200 with PEEP ≥5 cm H_2O	≤100 PaO_2/FiO_2 with PEEP ≥5 cm H_2O
MORTALITY	27% (24% to 30%)	32% (29% to 34%)	45% (42% to 48%)

Ferguson ND, et al. *Intensive Care Med*. 2012;38(10):1573-1582.
Dharia A, et al. *ICU Director*. 2012;3(6):287-292.

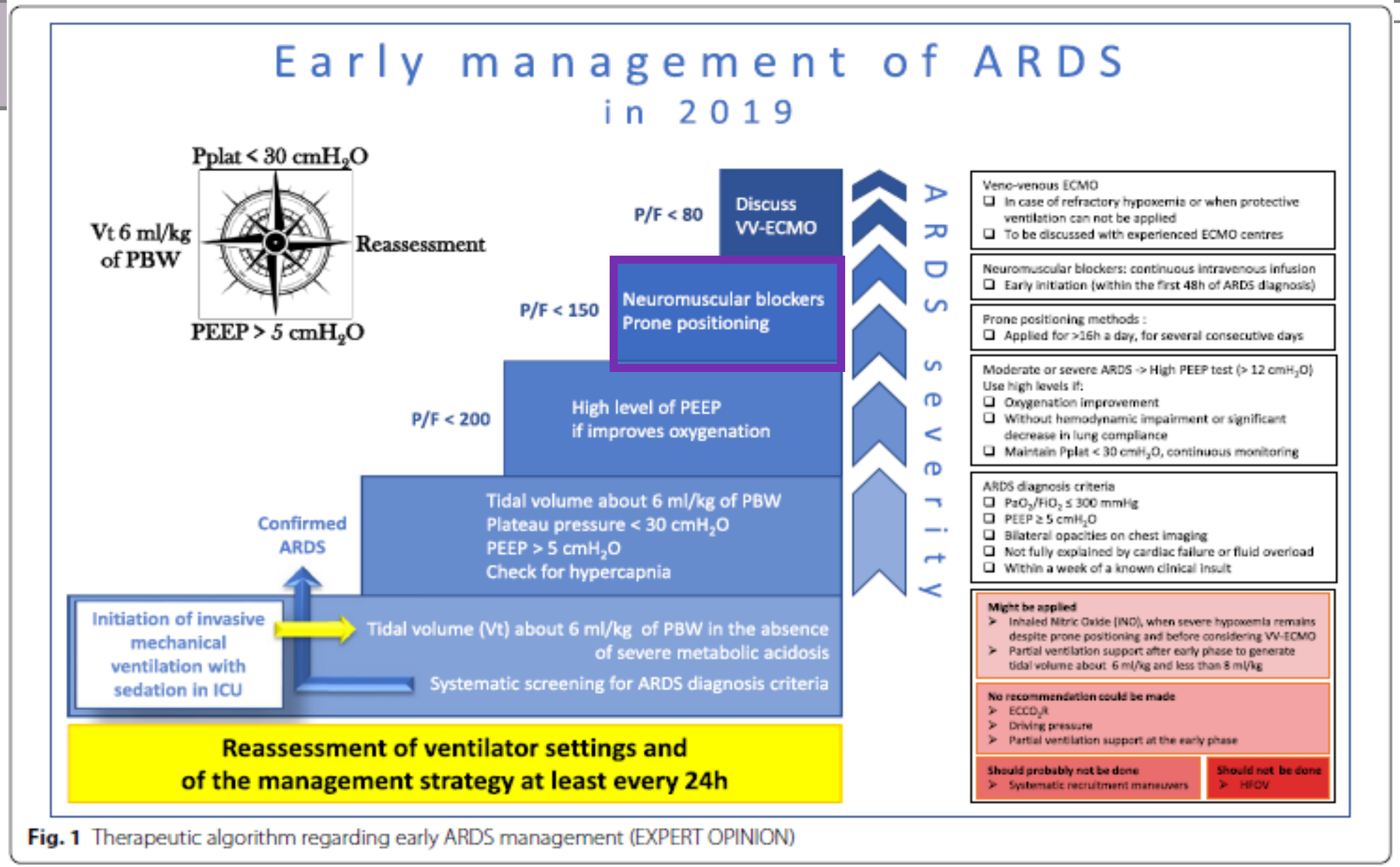


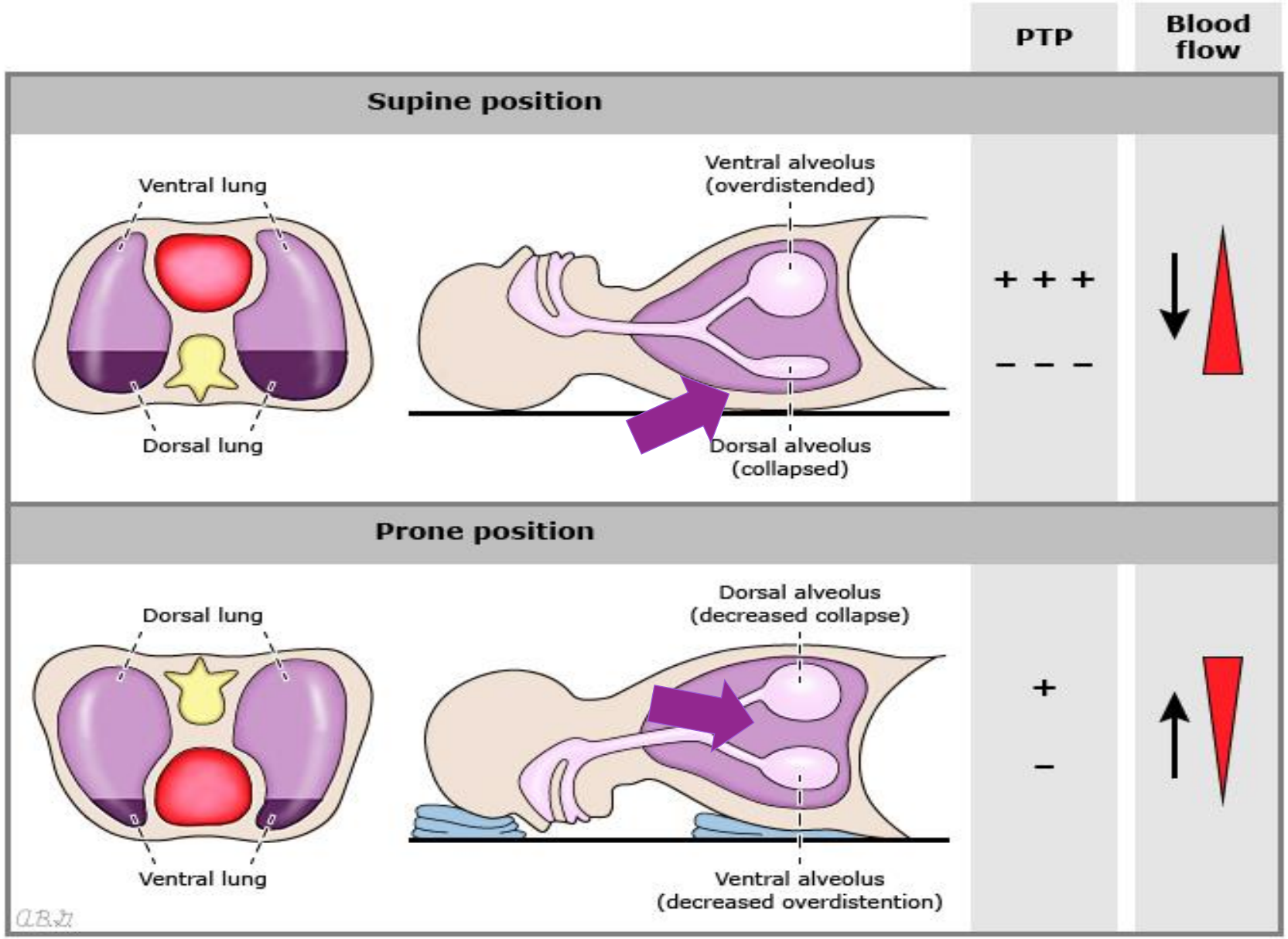
Fig. 1 Therapeutic algorithm regarding early ARDS management (EXPERT OPINION)

Papazian L, et al. Ann Intensive Care, 2019;9:69

Why Prone Positioning?

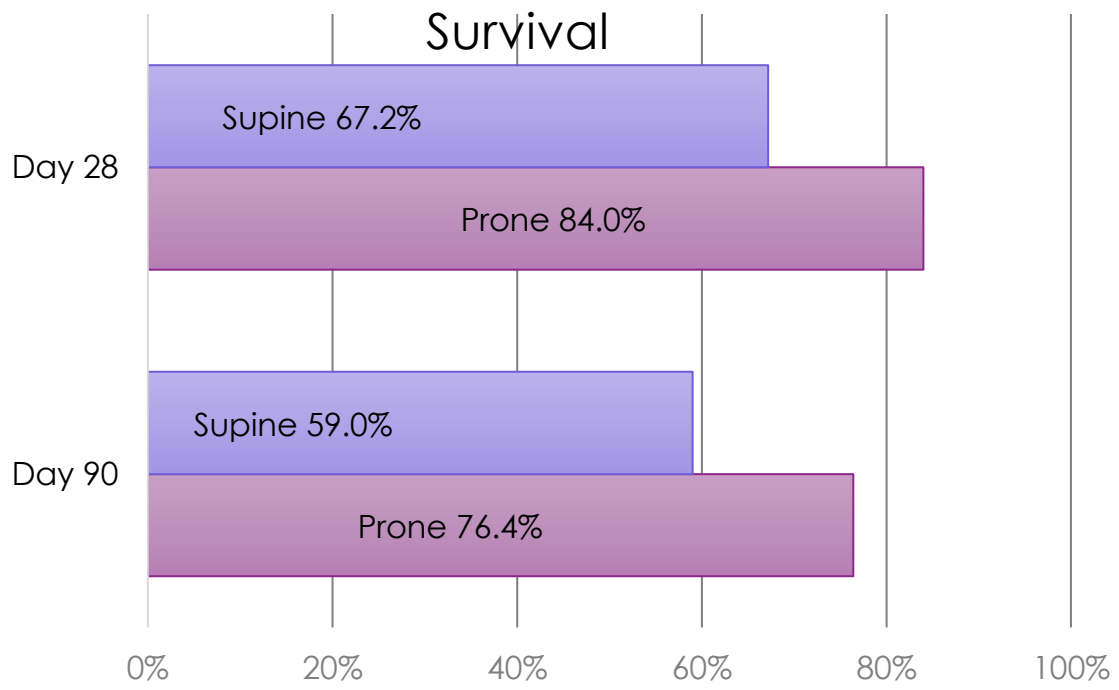
- Improves dependent aeration recruiting alveoli
- Reduces hyperinflation of nondependent regions dramatically
- Results in more homogenous lung aeration which reduces regional shear strain…less ventilator-induced lung injury (VILI)
- Decreases barotrauma and atelectrauma by recruiting and reducing overdistension that occurs with higher positive end-expiratory pressure (PEEP)
- ↓ PACO2 relates to net increase in recruitment /↓ in dead space
- Drains secretions

Fan E, et al. *Am J Resp Crit Care Med*. 2012;38(10):1573-1582.
Scholten EL, et al. *Chest*. 2017;151(1):215-224
Gattinoni J, et al. Semin Resp Crit Care Med, 2019;40:94-100.



https://www.uptodate.com/contents/prone-ventilation-for-adult-patients-with-acute-respiratory-distress-syndrome/print

Proning Severe ARDS Patients



In a randomized, controlled trial of 466 patients with severe ARDS, survival was significantly higher at 28 and 90 days in the prone position group

NNT=6

Guerin C, et al. *N Engl J Med*. 2013368(23):2159-2168.

Prone Positioning Meta-Analysis

9 randomized controlled trials / 2,242 patients

OUTCOMES	DECREASED 30-DAY MORTALITY	REDUCED 60-DAY AND 90-DAY MORTALITY	REDUCED 28-30-DAY MORTALITY
PATIENT POPULATION	ARDS patients with a PaO_2/FiO_2 ratio ≤100 mmHg	ARDS patients ventilated with PEEP ≥10 cmH_2O	ARDS patients who had duration of proning >12 hours per day (n = 1,067, RR = 0.73, 95% CI = 0.54 to 0.99; P = 0.04)

Hu SL, et al. *Crit Care*. 2014;18(3):R109.

Case Study

- Mr. Smith is a 60-year-old male 88kg male 5 feet 10 inches. Patient has a 2-day history of fever and chills. His past medical hx is HTN. He presents to the ED with a fever 39.5°C complaining of inability to catch his breath.
- His initial vital signs:
  - HR 120/min
  - RR 40/min
  - BP 90/65
  - O2 sat of 92% on room air.
  - He is placed on 50% mask

- Initial labs:
  - ABG: (On 50% mask)
    - pH 7.28
    - PaCO2 30,
    - PaO2 60,
    - SaO2 93%
    - Bicarb 16
  - Lactic acid: 3.5
  - WBC's: 24,000 with a left shift
  - Platelets: 75,000
  - Electrolytes WNL
  - Chest x-ray shows bilateral infiltrates

What should happen next?

Case Study

- Intubated and transferred to the ICU
- Settings on mechanical ventilation
  - Vt 528, AC 28, FiO2 of 1.0, PEEP 8cm, Plat pressures 38cm H20
- ABG's: 7.34, 35, 70, 94, 18
  - P/F ratio is 70
- PEEP increased incrementally over next 12 hours to 14cm
- FiO2 at 80%
- Plateau pressures 35cm H2O mmHg

- ABGs:
  - Ph 7.35
  - PaCO2 34
  - PaO2 78
  - SaO2 95
  - Bicarb 20
  - P/F ratio 98

What should be our next step?

Who to Place in Prone Position?

- Patients with severe ARDS (PaO_2/FiO_2 <150 mmHg)
  - Per ATS/SCCM Mechanical Ventilation for ARDS guidelines, a strong recommendation for prone positioning for >12 hours /day
- Patients early in the course (12–24 hours)

Scholten EL, et al. Chest. 2017;151(1):215-224.
Bein T, et al. Intensive Care Med.2016;42:699-711).
Fan E, et al. Am J Respir Crit Care Med. 2017:195(9):1253-1263

Who Not to Place in Prone Position?

1. Patients with facial/neck trauma or spinal instability
2. Patients with recent sternotomy or large ventral-surface burn
3. Patients with massive hemoptysis
4. Patients with elevated intracranial pressure
5. Patients at high risk of requiring CPR or defibrillation

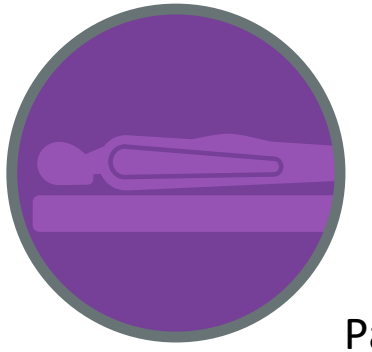
Scholten EL, et al. *Chest*. 2017;151(1):215-224.

Relative Considerations

- ENT: raised intraocular pressure or recent ophthalmic surgery, facial trauma, or recent oral maxillofacial surgery in last 15 days
- Cardiac: severe hemodynamic instability, unstable cardiac rhythms, ventricular assist device, intra-aortic balloon pump, recent sternotomy, new pacemaker < 48 hours
- Pulmonary: hemoptysis, unstable airway (double lumen endotracheal tube), new tracheostomy < 15 days, bronchopleural fistula, lung transplant
- Abdomen: second or third trimester pregnancy, grossly distended abdomen, ischemic bowel, abdominal compartment syndrome, recent abdominal surgery or stoma, extensive inguinal or abdominal soft tissue injury
- Musculoskeletal: chest wall abnormalities, kyphoscoliosis, or advanced arthritis
- Skin: burns on more than 20% body surface

Mitchell DA, et al. AACN Advanced Critical Care, 2018;29(4):415-425
Vollman K, et al. AACN Procedure Manual for High Acuity, Progressive, and Critical Care. 7th ed. St Louis, MO: Elsevier; 2017:142-163.

Patients Who Have Been Placed in the Prone Position Successfully



1. Patients with open abdomens
2. Patients with intracranial pressure monitoring
3. Patients with hemodynamic instability
4. Patients with pelvic fractures
5. Patients with external fixators
6. Patients with multiple traumatic injuries
7. Patients with use of extracorporeal membrane oxygenation (ECMO)
8. Patients with continuous renal replacement therapy (CRRT)
9. Patients with morbid obesity

Vollman KM. Crit Care Nurs Clin North Am. 2004;16(3):319-336.
Schiller HJ, et al. Chest. 1996;110:142S.29.
Goettler CE, et al. Crit Care. 2002;6(5):452-455
Mitchell DA, et al. AACN Advanced Critical Care, 2018;29(4):415-425

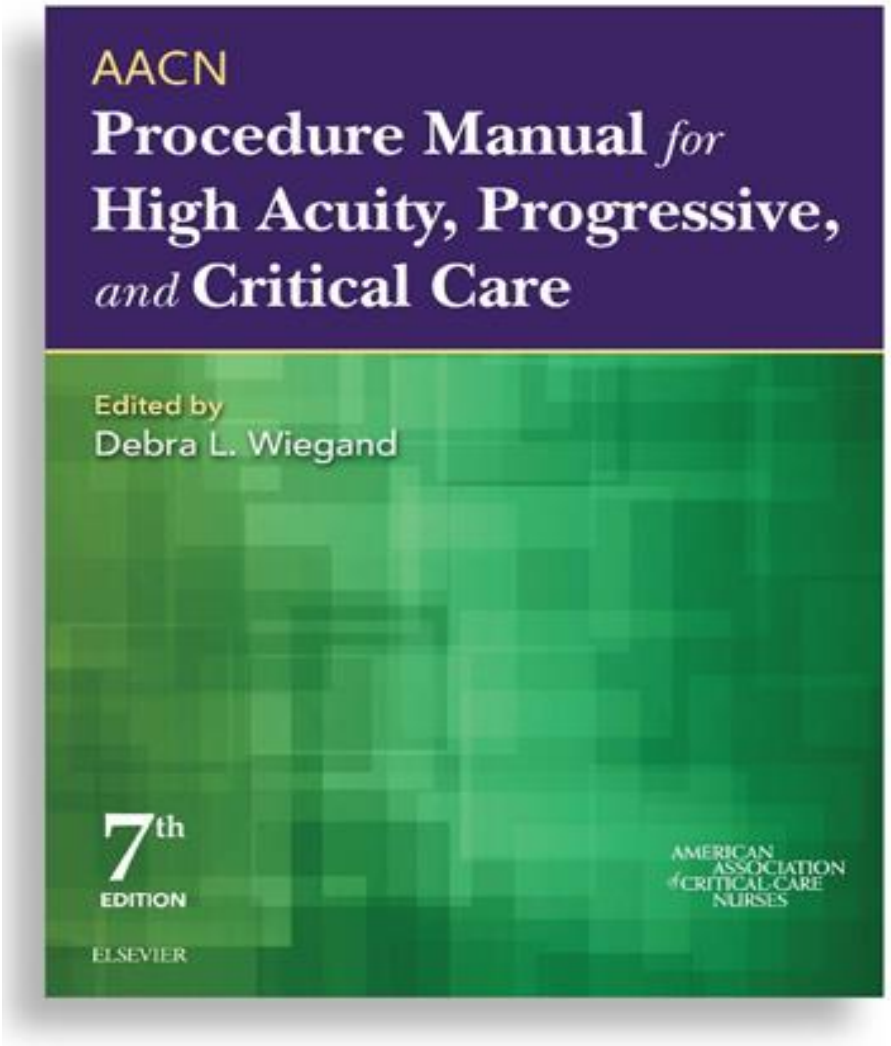
Pre-Prone Position Process

- Patient and family education
- Gather staff and supplies, obtain pre prone measurements
- Preoxygenate, empty stomach (1hr), suction endotracheal tube/oral cavity,
- Secure the endotracheal tube and lines (remove ET holders if in use)
- Position tubes inserted above the waist to the **top of the bed**
- Position tubes inserted below the waist to the **foot of the bed** (except chest tubes)
- Empty ileostomy/colostomy bags before the turn
- Placement of prophylactic dressings in high pressure/shear risk areas (forehead, chin, chest, elbow, pelvic, knees, dorsal feet)
- Ensure the tongue is inside patient's mouth and eyes are closed
- Develop an exit strategy for instability while in the prone position

Scholten EL, et al. Chest. 2017;151(1):215-224.
Dickinson S, et al. Crit Care Clin. 2011;27(3):511–523.
Vollman KM, et al. AACN Procedural Manual. 2016:142-163

AACN Procedural Manual-7th ed

- Chapter 18: Pronation Therapy
- Authors
  - Kathleen Vollman
  - Jan Powers
  - Sharon Dickinson



Rotoprone

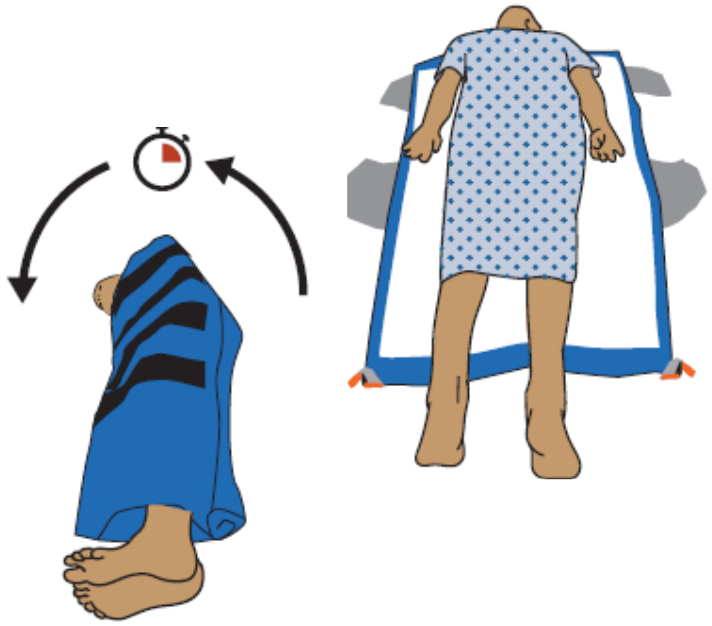
Prone positioner

No longer sold

Manual Proning

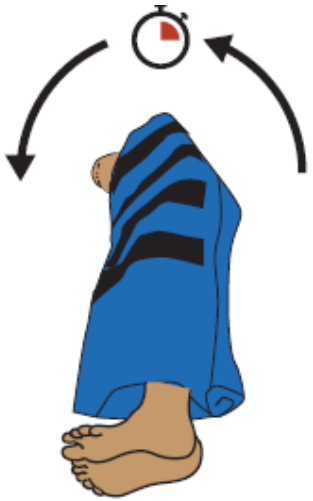
Manual Prone Positioning

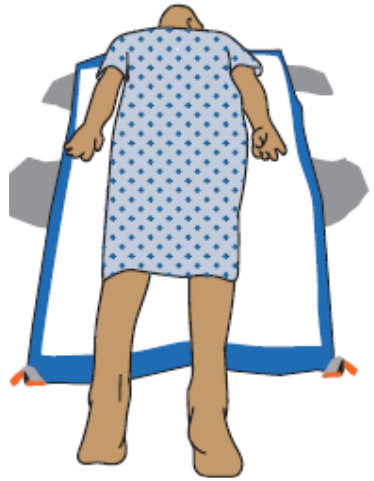
Disposable Slide Sheets



Prevalon AirTAP Patient Repositioning System

Burrito Method





Chest and/or pelvic support can be done by placing a pillow/wedge before completing the turn.

Positioning Schedule & Maintenance Care

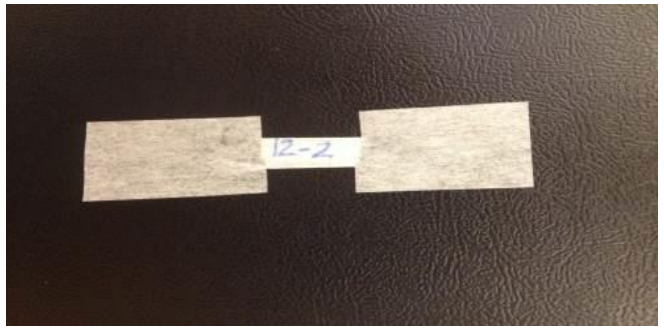
- Consider every 16hrs uninterrupted (more frequent turn back may cause decruitment)
- Obtain post prone measurements
- Frequent oral hygiene and suctioning and as needed, restart feeding
- Move head slightly every hour or q 2-ensure ET tube is not kinked
- ROM of arms every 2 hours/change position of the arms (Swim position)
- Support feet in correct anatomical alignment
- If hemodynamic monitoring, level the zero-reference point at the right atrium
- Consider time periods in reverse trendelenburg to address facial edema and reduce risk of vomiting

Vollman KM, Dickenson S, Powers J. AACN Procedural Manual, Chapter 19;2016:142-163
Mitchell DA, et al. AACN Advanced Critical Care, 2018;29(4):415-425

Maintenance Care

Float the nasogastric tube to prevent pressure injuries

- Taping
  - Obtain 3 inches of 1 inch wide paper tape
  - Make two ¼ inch cuts 1 inch apart on each side of tape

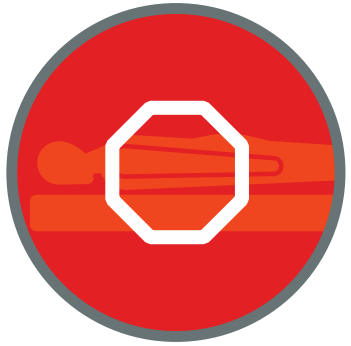


Step 1: Cut tape

Step 2 : Secure to Nose

Images courtesy of Sharon Dickinson

When to Stop Prone Positioning?



Research supports stopping prone positioning when PaO_2/FiO_2 has remained >150 mmHg 4 hours after supinating (with PEEP <10 cm H_2O and FiO_2 <0.6)

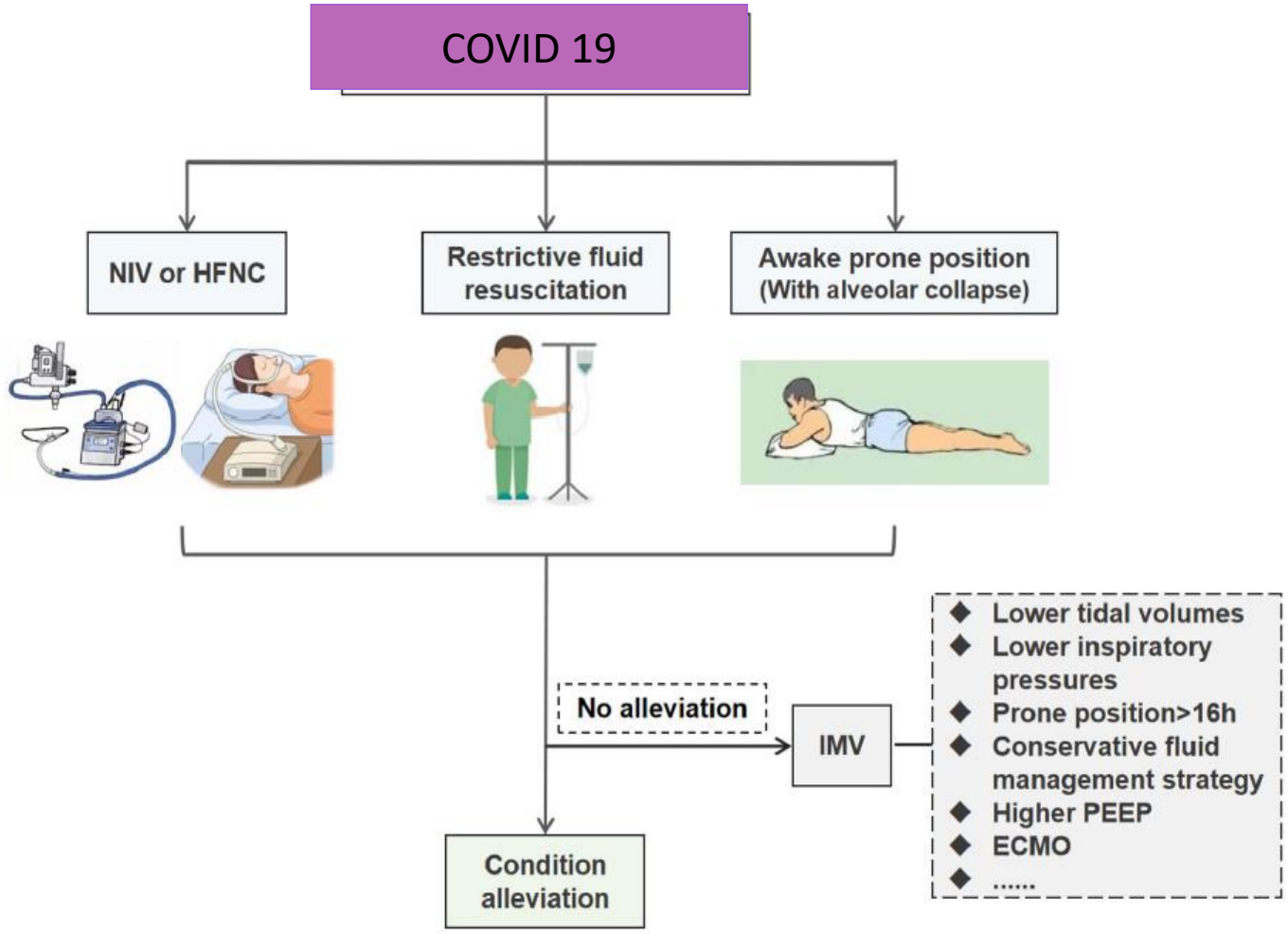
If there is no response after 48 hours, question whether prone positioning should continue

Scholten EL, et al. *Chest*. 2017;151(1):215-224.

Prone Positioning for Awake Patients

- Non-Intubated on NC, HFNC, & NIV
- Hypoxemic, non- hypercapnic
- Low saturations

Consider prone positioning 2-8 hrs. 2 to 3x daily



Ding L, et al. Crit Care, 2020;24:28
Sun Q, etal Annals of Intensive Care, 2020:10:33


What are the
Challenges & Issues

Adverse Events	No. of Trials Reporting the Outcome	Events/Prone	Events/Supine	Treatment Effect (Random-Effect Model) OR (95% CI)	p	Number Needed to Treat/Number Needed to Harm	Heterogeneity I² (%)	p
Ventilator-associated pneumonia	6	120/567	128/513	0.76 (0.44–1.33)	0.343	26	34.4	0.192
Pressure ulcers	6	294/698	218/646	1.49 (1.18–1.89)	0.001	12	0.0	0.617
Major airway problem[a]	9	255/1,104	180/1,063	1.55 (1.10–2.17)	0.012	16	32.7	0.167
Unplanned extubation	7	113/1,091	98/1,050	1.17 (0.80–1.73)	0.421	98	25.5	0.234
Selective intubation	2	12/642	5/615	2.73 (0.29–25.46)	0.378	95	55.9	0.132
Endotracheal tube obstruction	4	130/823	77/802	2.16 (1.53–3.05)	<0.001	16	0.0	0.580
Loss of venous or arterial access	4	36/407	22/397	1.34 (0.29–6.26)	0.712	30	75.5	0.007
Thoracostomy tube dislodgement or kinking	4	14/407	14/397	1.14 (0.35–3.75)	0.827	1,154	42.6	0.175
Pneumothorax	4	29/513	33/462	0.77 (0.46–1.30)	0.333	67	0.0	0.528
Cardiac arrest	3	104/718	119/675	0.74 (0.47–1.17)	0.197	32	30.3	0.238
Tachyarrhythmia or bradyarrhythmia	3	115/663	102/634	1.08 (0.78–1.50)	0.643	80	8.8	0.334

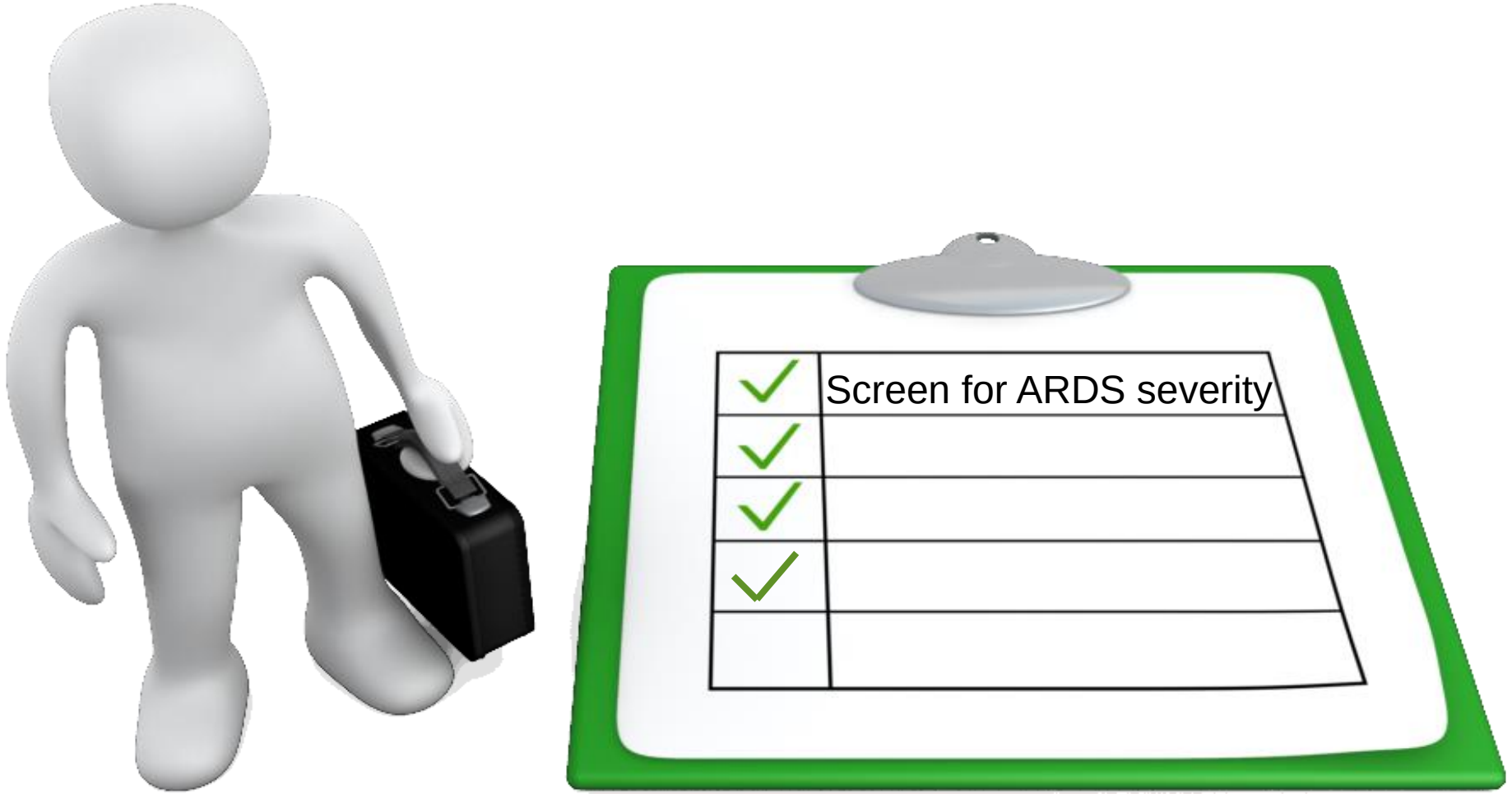
11.9% complication rate

Lee JM, et al. Crit Care Med, 2014;42(5):1252-1262

Potential Complications

- Temporary increase in oral and tracheal secretions occluding airway
- Endotracheal tube (ETT) migration or kinking
- Vascular catheter kinking
- Elevated intraabdominal pressure
- Increased gastric residuals
- Facial pressure ulcers, facial edema, lip trauma from ETT
- Brachial plexus injury (arm extension)
- Hemodynamic instability

Scholten EL, et al. *Chest*. 2017;151(1):215-224.


Screen for ARDS severity

Does your ICU have a process for assessing P/F ratios routinely?

	Mild	**Moderate**	**Severe**
Oxygenation	< 200 PaO_2/FiO_2 or ≤ 300 with PEEP/ CPAP ≥ 5 cm H_2O	< 100 PaO_2/FiO_2 or ≤ 200 with PEEP ≥ 5 cm H_2O	≤ 100 PaO_2/FiO_2 with PEEP ≥ 5 cm H_2O


Screen for ARDS severity
Prevent Pressure Injuries

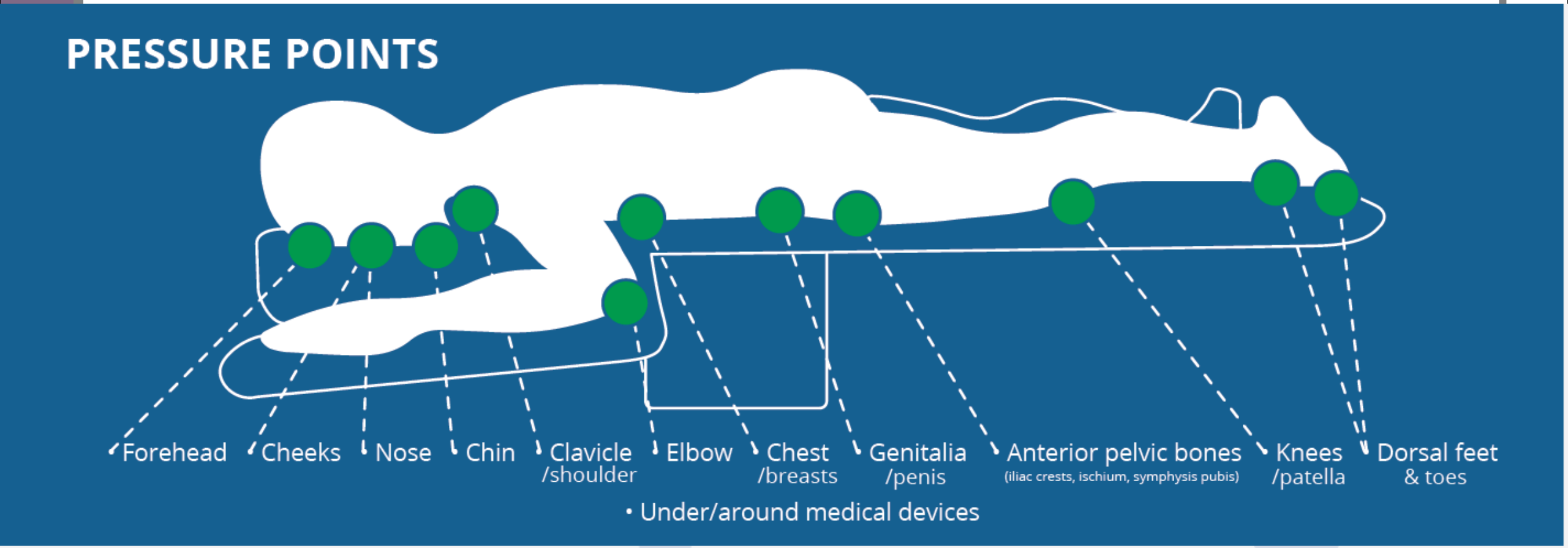
Pressure Injury Prevention: Prone Positioning

- Redistribution surface
- Positioning devices to offload pressure points (Do not use ring or donut-shaped positioning devices)
- Avoid shear and friction during the turning process
- Small micro turns while prone/swimmer position shifts q 2-4 hrs
- Assess skin with when doing small positioning shifts
- Placement of prophylactic dressings over all potential pressure injury risk areas

Green areas represent pressure sources while lying prone

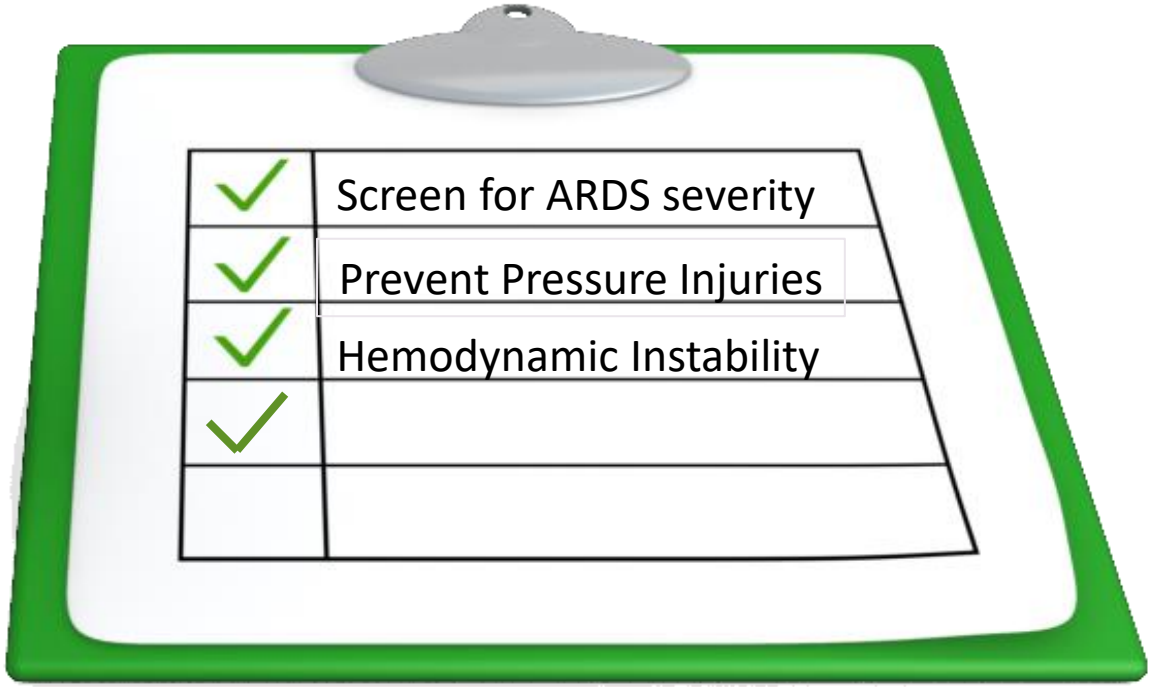
https://cdn.ymaws.com/npiap.com/resource/resmgr/online_store/posters/npiap_pip_tips_-_proning_202.pdf NPIAP 2020

Prophylactic Dressings for Prone Position PI Prevention



Upon returning to supine position, assess skin including under the dressings

https://cdn.ymaws.com/npiap.com/resource/resmgr/online_store/posters/npiap_pip_tips_-_proning_202.pdf NPIAP 2020


Screen for ARDS severity
Prevent Pressure Injuries
Hemodynamic Instability

The Role of Hemodynamic Instability in Positioning

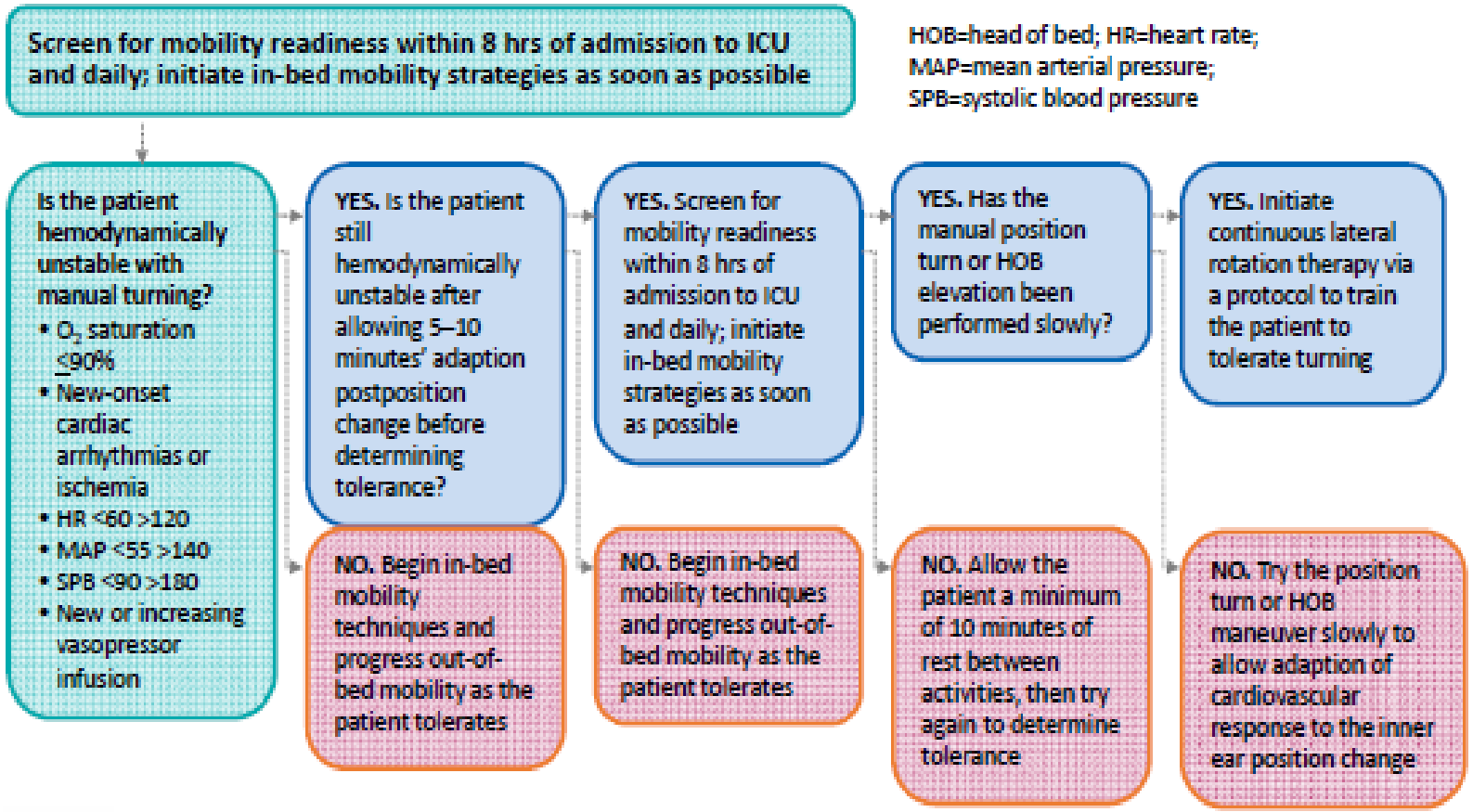
- Lateral turn results in a 3%-9% decrease in SVO_2, which takes 5-10 minutes to return to baseline
- Appears the act of turning has the greatest impact on any instability seen
- Minimize factors that contribute to imbalances in oxygen supply and demand

- Factors that put patients at risk for intolerance to positioning:
  - Elderly
  - Diabetes with neuropathy
  - Prolonged bed rest
  - Low hemoglobin and cardiovascular reserve
  - Prolonged gravitational equilibrium

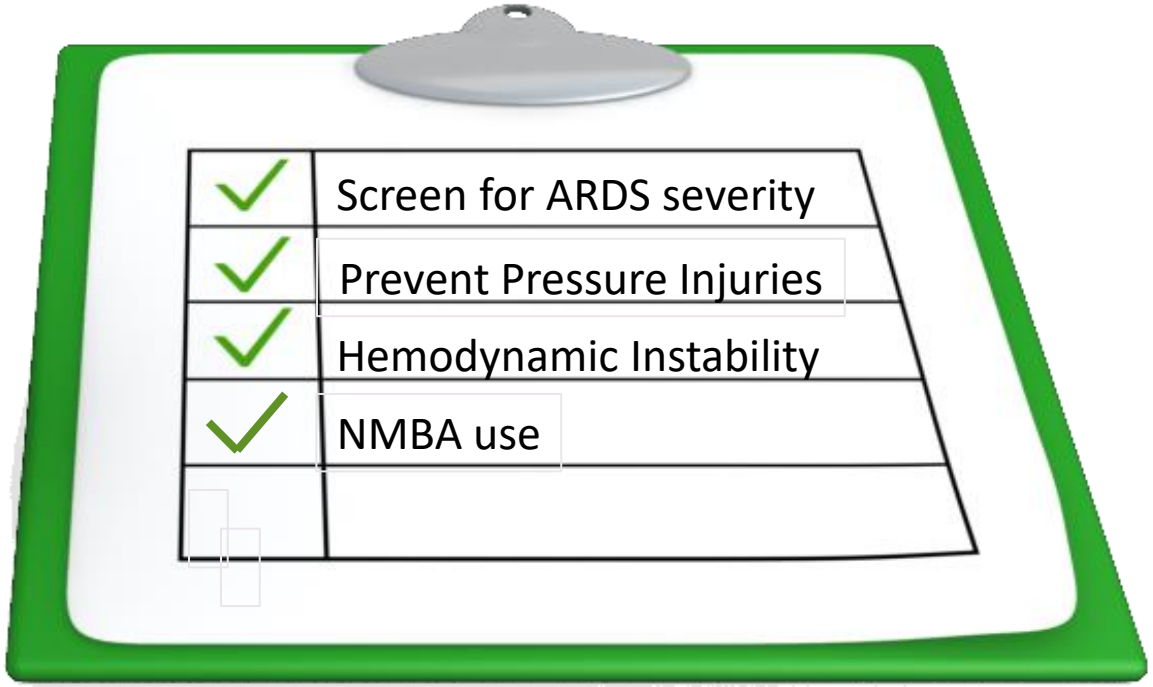
Right ventricular function improves in PP/ ↑ preload & CI

Winslow EH, et al. Heart Lung. 1990;19:557-561.
Price P. Dynamics. 2006;17:12-19.
Vollman KM. Crit Care Nurs Q. 2013;36:17-27
Ruste M et al. Ann Intensive Care, 2019;8:120
Zochios V, et al. J of Cardio & Vascular Anesth, 2018;32:2248-2251

Addressing Hemodynamic Stability



Vollman KM. *Crit Care Nurse*. 2012;32:70-75; Vollman KM. *Crit Care Nurs Q*. 2013;36:17-27.

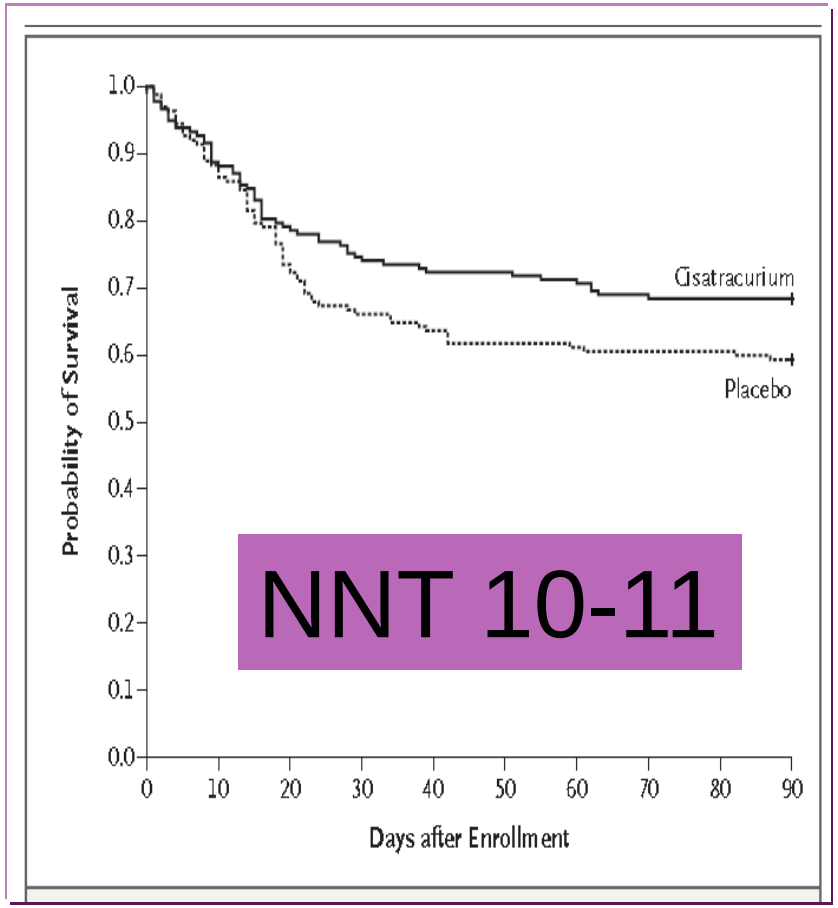

Screen for ARDS severity
Prevent Pressure Injuries
Hemodynamic Instability
NMBA use

Neuromuscular Blockade in Early ARDS

- Multicenter, double blind trial
- 340 patients with ARDS within 48hrs of admitted to ICU
- ARDS defined as P/F ratio of < 150 ≥ PEEP 5cm & Vt of 6-8 ml/kg PBW
- Randomized to receive 48hrs of cisatracurium or placebo
- Study did not use train of 4

Results:

- After risk adjustment NMB group showed improved mortality at 90 days (31.6% vs. 40.7%)
- Also significant at 28 days
- ↑time off vent
- No difference in muscle weakness



Papazian L, et al. N Engl J Med. 2010;363(12):1107-16

ROSE Trial: Re-evaluation of Systemic Early Neuromuscular Blockade

- Protocol: moderate to severe ARDS < 48hrs / P/F ratio < 150 with ≥ PEEP 8 cm
- Cisatracurium for 48hr or usual care
- Protocol changed mid-study, removed RM

The ROSE trial at 90-day follow-up in patients with moderate-to-severe ARDS, 42.5% of the intervention group and 42.8% of the control group died before hospital discharge (between group difference -0.3%, 95% CI -6.4 to 5, *P*=0.93), -study stopped early.

Angus D, et al NEJM May 19th 2019

Prone Positioning used 15.8%. Equal use in both groups

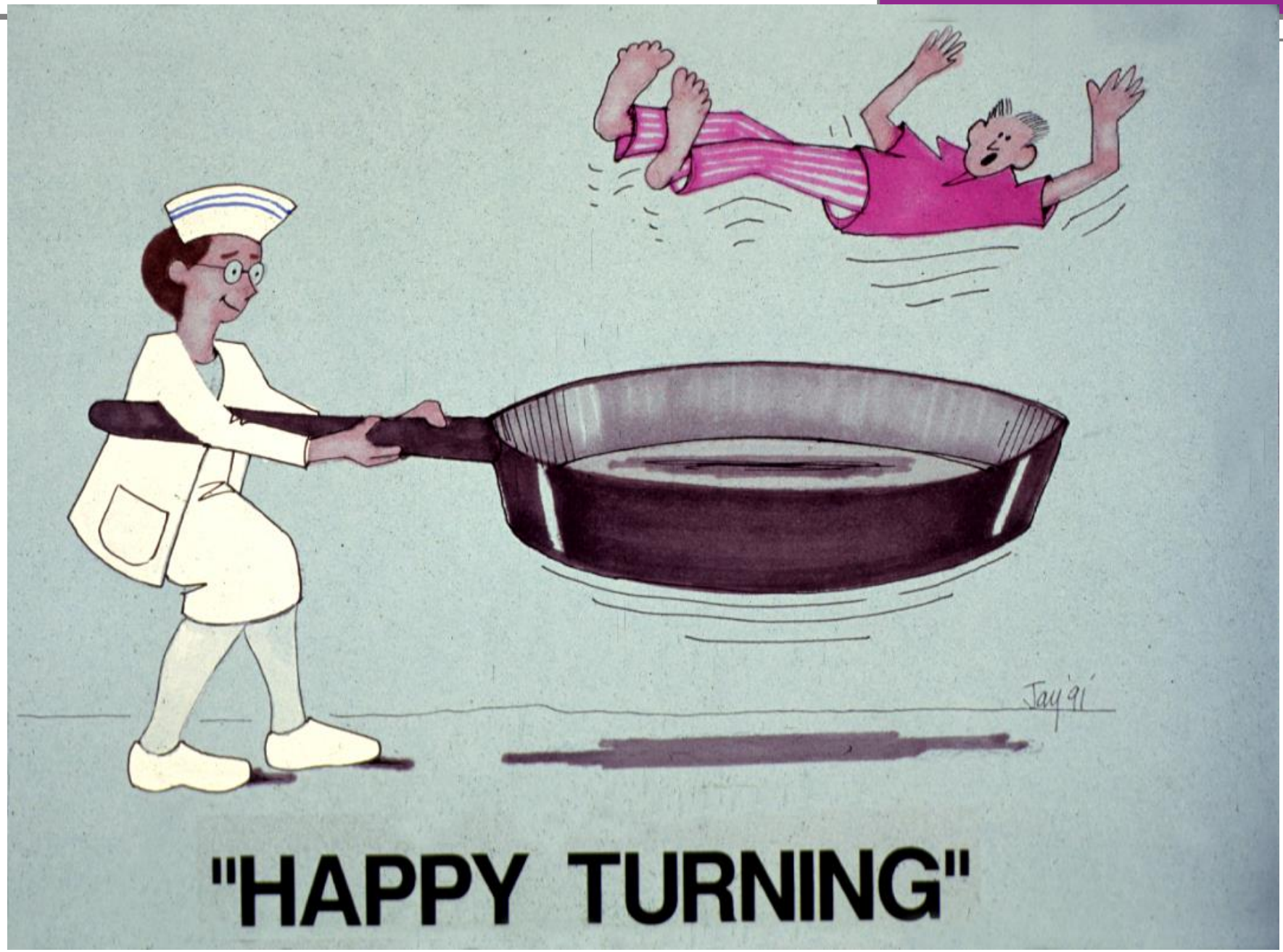
Questions That Remain

- What is optimal PEEP management in the prone position?
- Does effective prone positioning necessitate neuromuscular blockades for several days?
  - And, what impact does that have on ICU-acquired weakness?
- How do we incorporate what we learned about the impact of prone positioning during the COVID 19 pandemic into our practice?
- What is the role of awake non-intubated proning post COVID 19?

Scholten EL, et al. *Chest*. 2017;151(1):215-224.

Summary

- Use the prone positioning
- Implement early—don't wait
- Develop a process or protocol to minimize complication risk
- Training all providers to mastery is critical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