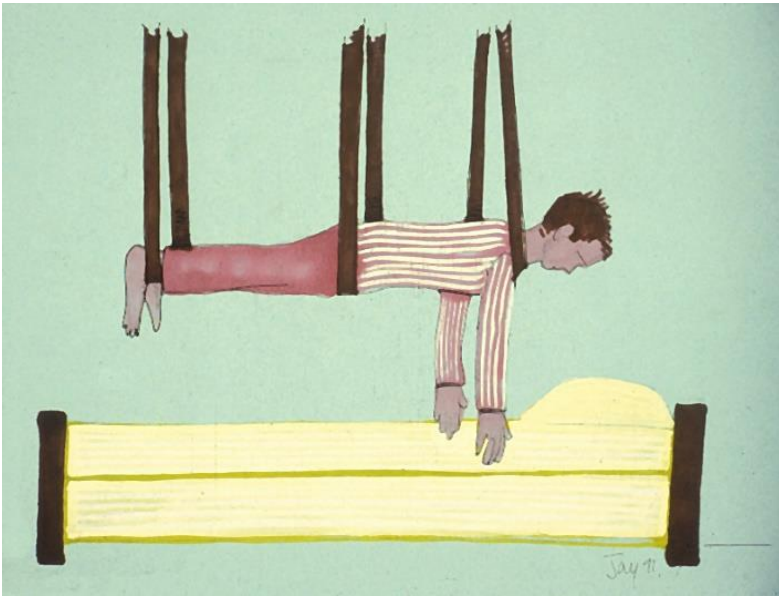


# Understanding The Why, The How and Care of the Acute Respiratory Distress Syndrome (ARDS) Patient in the Prone Position



**Kathleen Vollman**

ADVANCING NURSING THROUGH KNOWLEDGE & INNOVATION



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# Polling Question

## What is your position?

1. Critical care nurse
2. Progressive Care/Telemetry nurse
3. Educator
4. Chest Physiotherapist
5. Manager/Director
6. Clinical Nurse Specialist/Nurse Practitioner
7. Intensivist
8. Quality



# 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 like ventilated associated pneumonia (VAP) and pressure Ulcers with evidence-based strategies such as oral hygiene and protective dressings

# Prone Positioning Incidence

Prone positioning (PP) 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



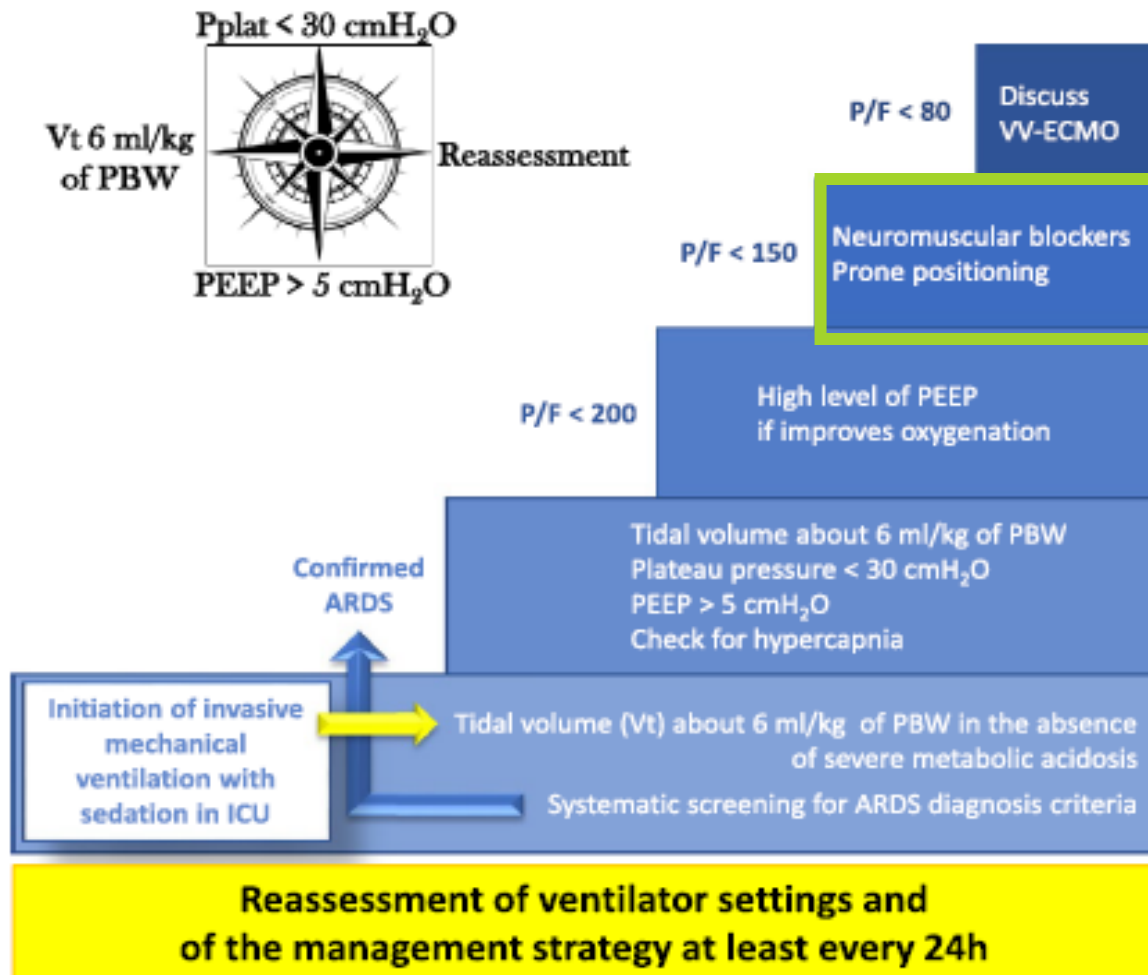
28% of ARDS COVID patients in the ICU are positioned prone.

Moore Z, et al. J Wound Care. 2020;29(6):312-320.

# The Berlin ARDS Definition

<b>TIMING</b>	Within 1 week of a known clinical insult or new/worsening respiratory symptoms		
<b>CHEST IMAGING (X-RAY OR CAT SCAN)</b>	Bilateral opacities—not fully explained by effusions, lobar/lung collapse, or nodules		
<b>ORIGIN OF EDEMA</b>	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		
	<b>MILD</b>	<b>MODERATE</b>	<b>SEVERE</b>
<b>OXYGENATION</b>	<200 PaO <sub>2</sub> /FiO <sub>2</sub> or ≤300 with PEEP/CPAP ≥5 cm H <sub>2</sub> O	<100 PaO <sub>2</sub> /FiO <sub>2</sub> or ≤200 with PEEP ≥5 cm H <sub>2</sub> O	≤100 PaO <sub>2</sub> /FiO <sub>2</sub> with PEEP ≥5 cm H <sub>2</sub> O
<b>MORTALITY</b>	27% (24% to 30%)	32% (29% to 34%)	45% (42% to 48%)

# Early management of ARDS in 2019



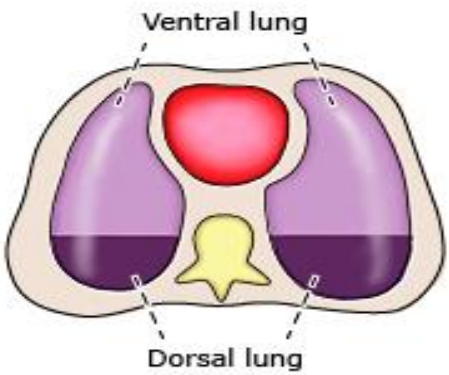
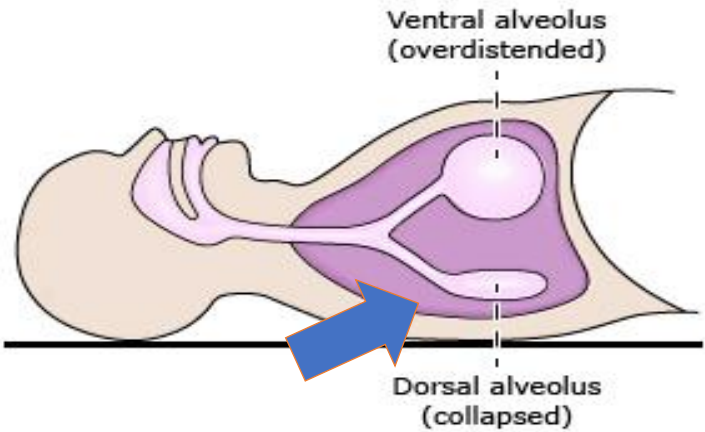

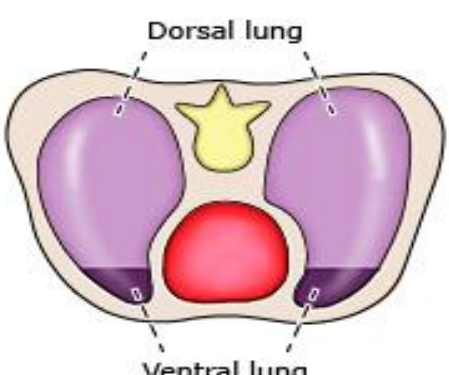
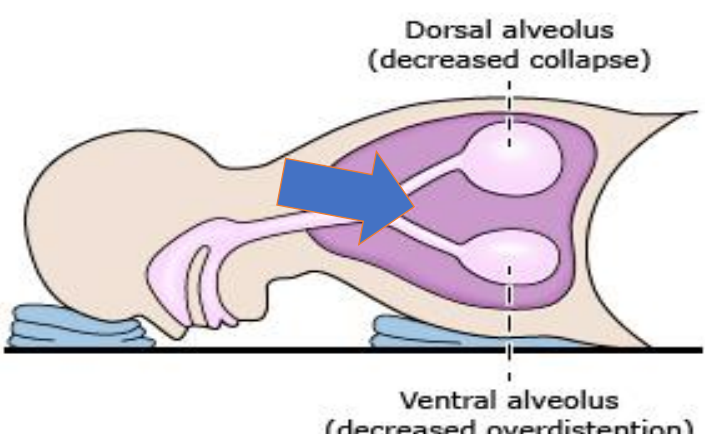

ARDS severity

<b>Veno-venous ECMO</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> In case of refractory hypoxemia or when protective ventilation can not be applied</li> <li><input type="checkbox"/> To be discussed with experienced ECMO centres</li> </ul>
<b>Neuromuscular blockers: continuous intravenous infusion</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Early initiation (within the first 48h of ARDS diagnosis)</li> </ul>
<b>Prone positioning methods :</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Applied for &gt;16h a day, for several consecutive days</li> </ul>
<b>Moderate or severe ARDS -&gt; High PEEP test (&gt; 12 cmH<sub>2</sub>O)</b> Use high levels if: <ul style="list-style-type: none"> <li><input type="checkbox"/> Oxygenation improvement</li> <li><input type="checkbox"/> Without hemodynamic impairment or significant decrease in lung compliance</li> <li><input type="checkbox"/> Maintain Pplat &lt; 30 cmH<sub>2</sub>O, continuous monitoring</li> </ul>
<b>ARDS diagnosis criteria</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> PaO<sub>2</sub>/FIO<sub>2</sub> ≤ 300 mmHg</li> <li><input type="checkbox"/> PEEP ≥ 5 cmH<sub>2</sub>O</li> <li><input type="checkbox"/> Bilateral opacities on chest imaging</li> <li><input type="checkbox"/> Not fully explained by cardiac failure or fluid overload</li> <li><input type="checkbox"/> Within a week of a known clinical insult</li> </ul>
<b>Might be applied</b> <ul style="list-style-type: none"> <li>&gt; Inhaled Nitric Oxide (iNO), when severe hypoxemia remains despite prone positioning and before considering VV-ECMO</li> <li>&gt; Partial ventilation support after early phase to generate tidal volume about 6 ml/kg and less than 8 ml/kg</li> </ul>
<b>No recommendation could be made</b> <ul style="list-style-type: none"> <li>&gt; ECCO<sub>2</sub>R</li> <li>&gt; Driving pressure</li> <li>&gt; Partial ventilation support at the early phase</li> </ul>
<b>Should probably not be done</b> <ul style="list-style-type: none"> <li>&gt; Systematic recruitment maneuvers</li> </ul>
<b>Should not be done</b> <ul style="list-style-type: none"> <li>&gt; HFOV</li> </ul>

# Why Prone Positioning?

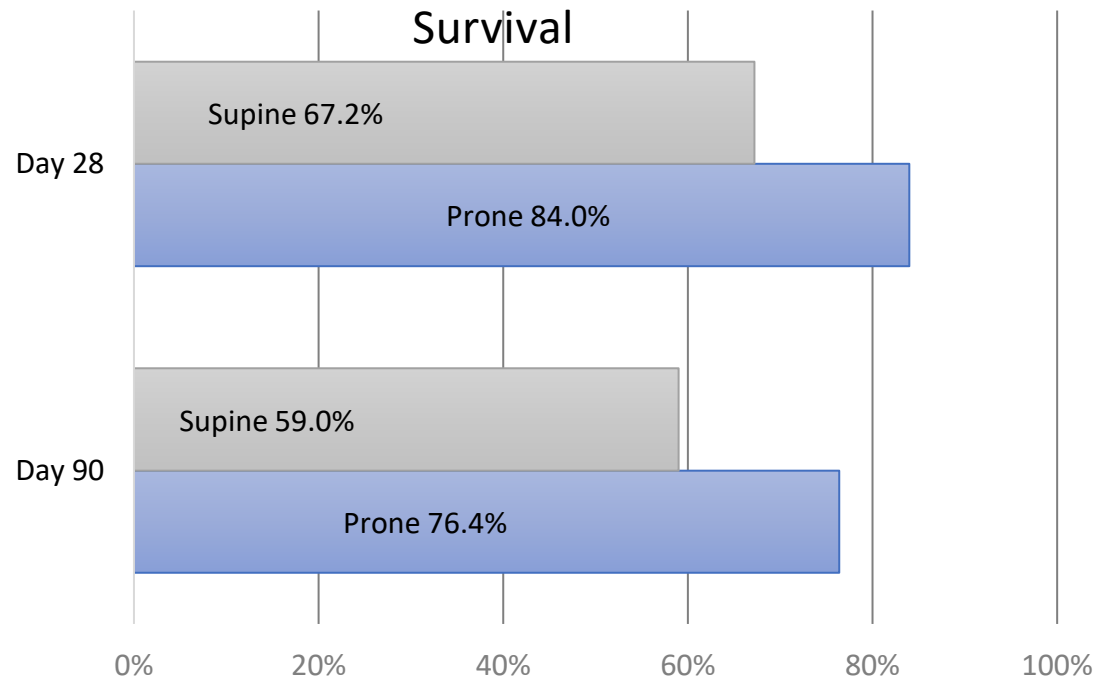
- Improves dependent aeration recruiting alveoli
- Reduces hyperinflation of nondependent regions dramatically
- Results in more homogenous lung aeration which reduces regional shear strain...less ventilator-induced lung injury (VILI)
- Decreases barotrauma and atelectrauma by recruiting and reducing overdistension that occurs with higher positive end-expiratory pressure (PEEP)
- ↓ PACO<sub>2</sub> relates to net increase in recruitment / ↓ in dead space
- Drains secretions



		PTP	Blood flow
<b>Supine position</b>			
 <p>Ventral lung</p> <p>Dorsal lung</p>	 <p>Ventral alveolus (overdistended)</p> <p>Dorsal alveolus (collapsed)</p>	<p>+++</p> <p>---</p>	<p>↓</p> 
<b>Prone position</b>			
 <p>Dorsal lung</p> <p>Ventral lung</p>	 <p>Dorsal alveolus (decreased collapse)</p> <p>Ventral alveolus (decreased overdistention)</p>	<p>+</p> <p>-</p>	<p>↑</p> 

Q&A

# 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**

# 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 $\text{PaO}_2/\text{FiO}_2$ ratio $\leq 100$ mmHg	ARDS patients ventilated with PEEP $\geq 10$ cmH <sub>2</sub> O	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)

# Case Study

Mr. Green is a 65-year-old male 90kg male 5 feet 10 inches. Patient has a 2-day history of fever and chills. His past medical hx is Hypertension and coronary artery disease. He presents to the Emergency room 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

△ ABG: (On 50% mask)

- pH 7.20
- PaCO<sub>2</sub> 28,
- PaO<sub>2</sub> 60,
- SaO<sub>2</sub> 93%
- Bicarb 13

△ Extremely labored breathing

△ 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?

# Polling Question

 What should be the next step in Mr. Green's care?

1. Initiate non-invasive ventilation
2. Initiate intubation
3. Change to 100% non-rebreather
4. Initiate high flow nasal cannula (HFNC)

# 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 H2O
- 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 60
- SaO2 91
- Bicarb 20
- P/F ratio 75

What should be our next step?

# Polling Question

What should be the next step in Mr. Green's care?

1. Switch to High Frequency Oscillation Ventilation (HFOV)
2. Initiate Extra Corporeal Membrane Oxygenation (ECMO)
3. Initiate prone positioning
4. Switch to Airway Pressure Release Ventilation (APRV)

# Who to Place in Prone Position?

- ▶ Patients with severe ARDS ( $\text{PaO}_2/\text{FiO}_2 < 150$  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)



# 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

Patients with massive hemoptysis

3

Patients with elevated intracranial pressure

4

5

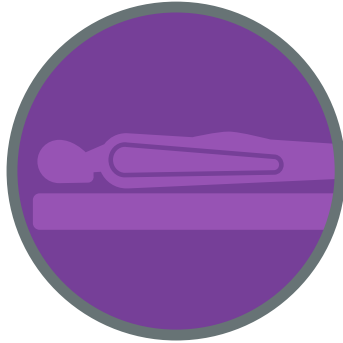
Patients at high risk of requiring CPR or defibrillation



# 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

# 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

Patients with pelvic fractures

**4**

Patients with external fixators

**5**

Patients with multiple traumatic injuries

**6**

**7** Patients with use of extracorporeal membrane oxygenation (ECMO)

**8** Patients with continuous renal replacement therapy (CRRT)

Patients with morbid obesity

# 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

# AACN Procedural Manual-7<sup>th</sup> ed

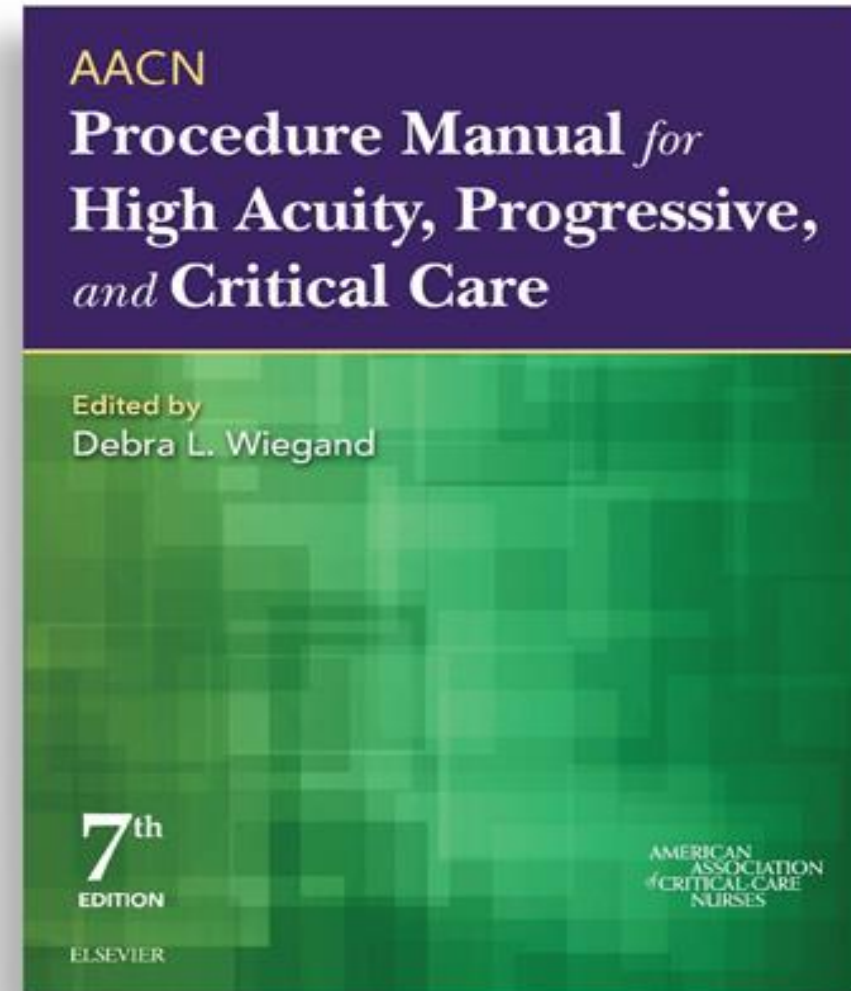
Chapter 18: Pronation Therapy

Authors

△ Kathleen Vollman

△ Jan Powers

△ Sharon Dickinson









Rotoprone



Prone positioner  
No longer sold



# Manual Proning

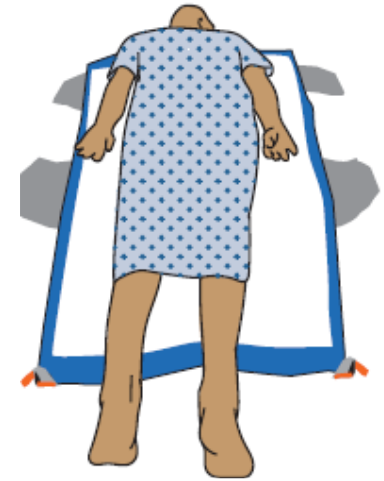
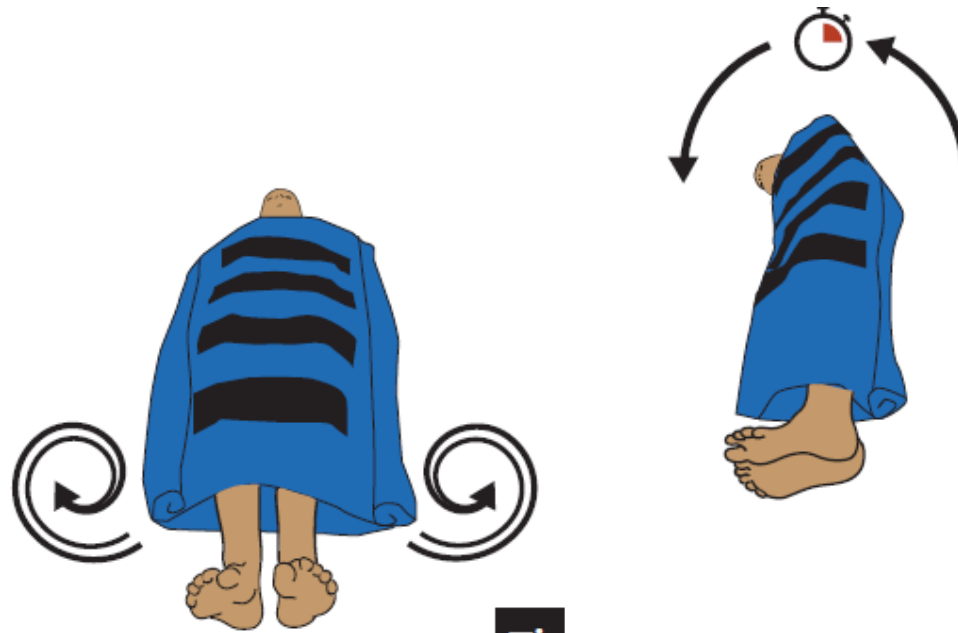




# Prone Positioning with Positioning Sheet

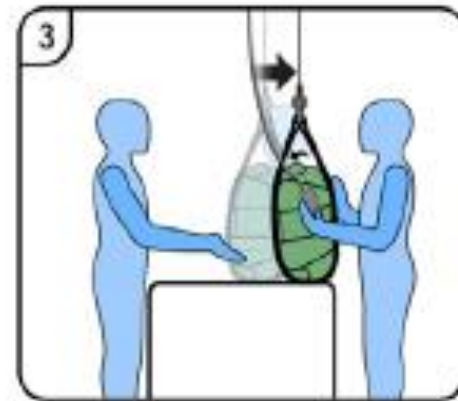
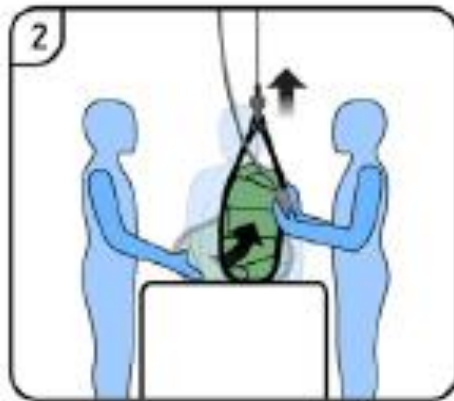
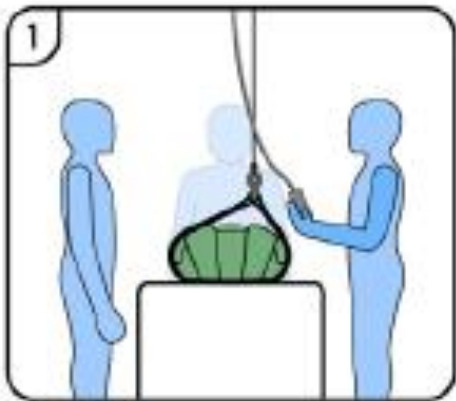
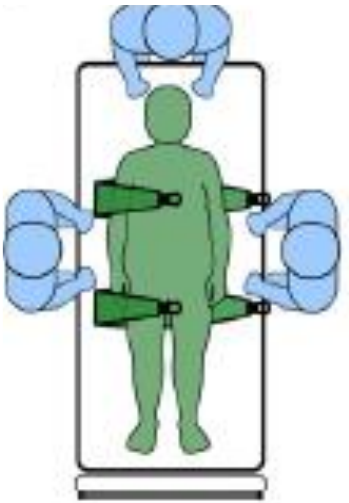


**Disposable Slide Sheets**

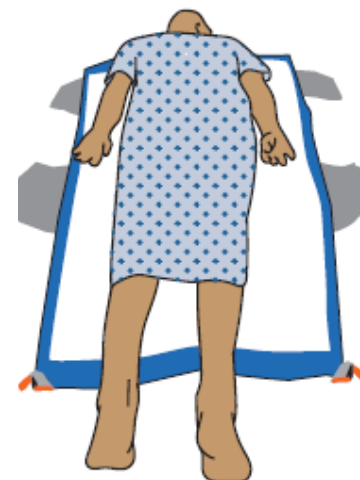
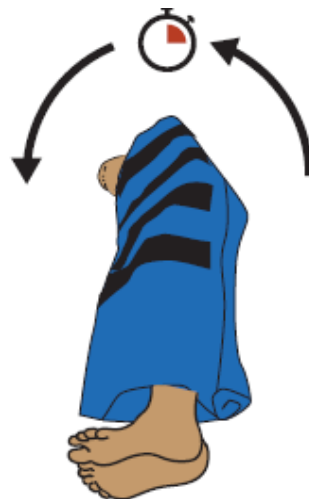


**Prevalon TAP Patient  
Repositioning System**

# Lift Assisted Prone Positioning



# Burrito Method Using a Turn & Position System



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
- ⚠ 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
- ⚠ Frequent oral hygiene and suctioning and as needed



# Significance of VAP in COVID Patients: A Systematic Review and Case Series

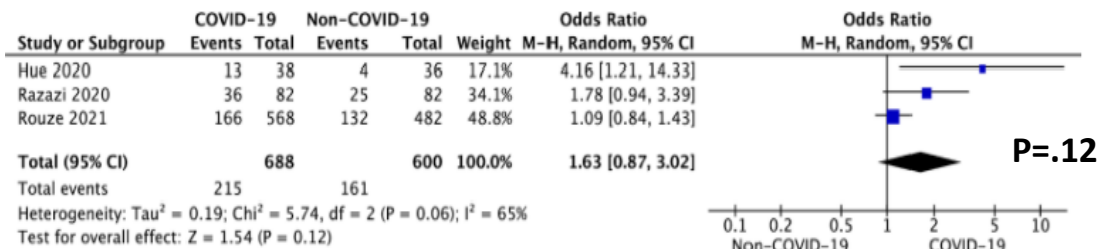
- Case series & systematic review (5 studies)
- COVID and Non COVID studies that measured VAP using the same methodology
- Outcome measures

△ Mortality during hospitalization

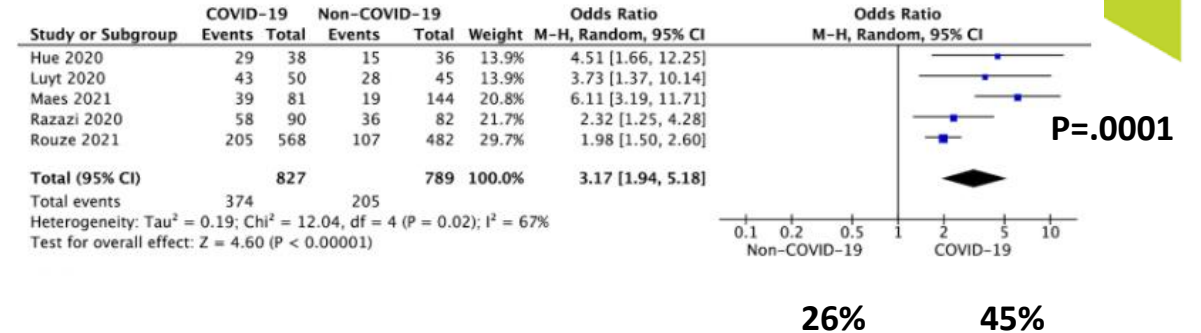
△ Secondary

- Mortality at ICU
- LOS
- VAP

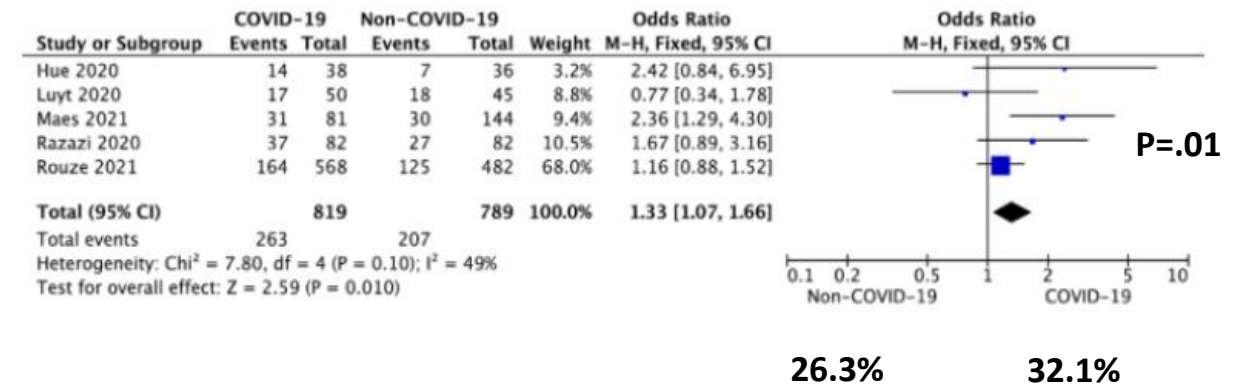
- Results: Mortality at 28 days



## VAP Rates



## ICU Mortality



# What to Remember

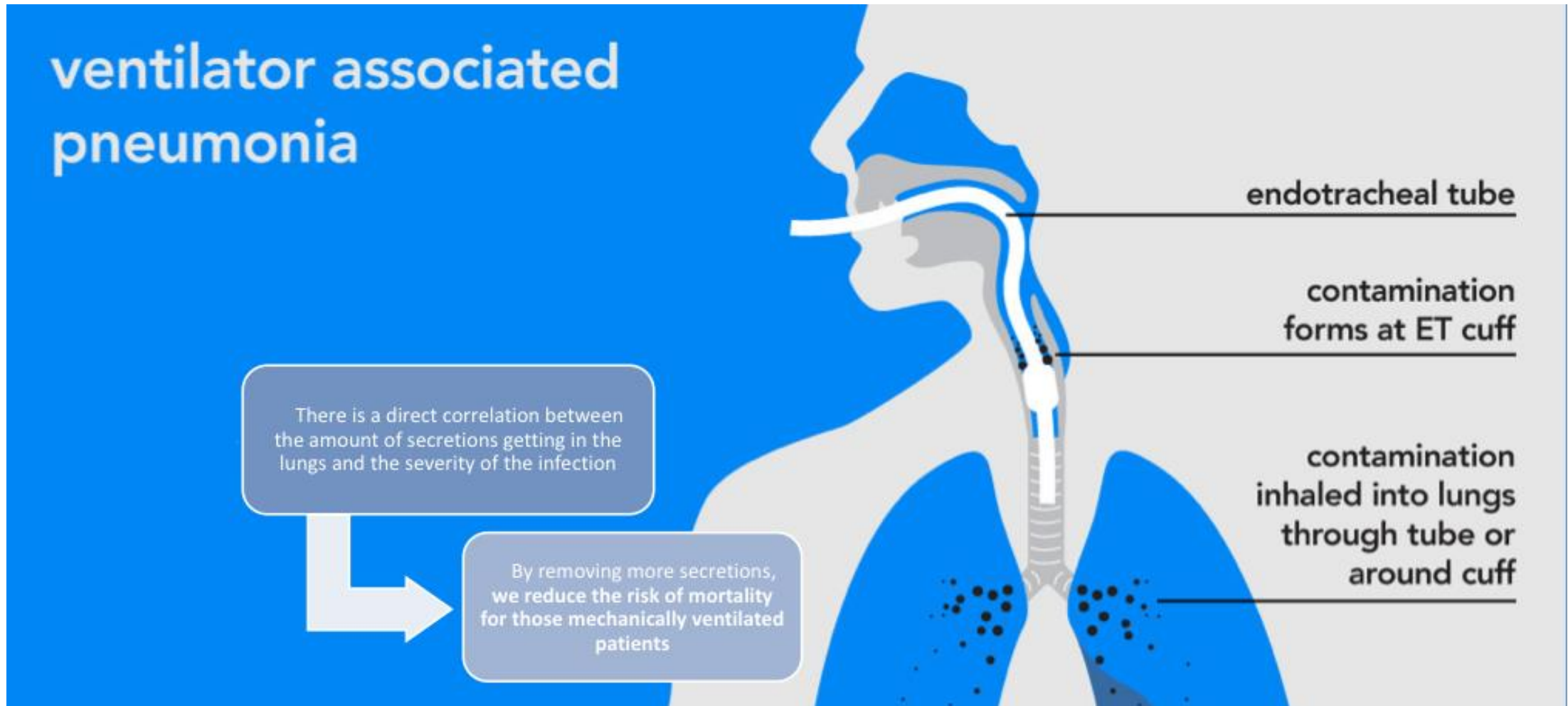


1. All patients with SARS-CoV-2 are at increased risk of bacterial infections
2. Infections in COVID-19 patients are often antibiotic resistant
3. The risk of bacterial infections is concentrated in the critically ill and mechanically ventilated population.

1. 50% of mechanically ventilated COVID-19 patients contract Ventilator-Associated Pneumonia (VAP)
2. COVID-19 + VAP = Increased Mortality
3. Thus VAP prevention in COVID-19 patients = decreased Mortality



# What to Remember





# What Does the Evidence Tell Us?



Brush  
CHG rinse alone  
CHG rinse in Combination  
Swab/Clean/Moisturize  
Suction

**All of the above**

Comprehensive Oral Care Program





# Literature Review: Oral Care Impact of VAP

## Comprehensive Oral Care:

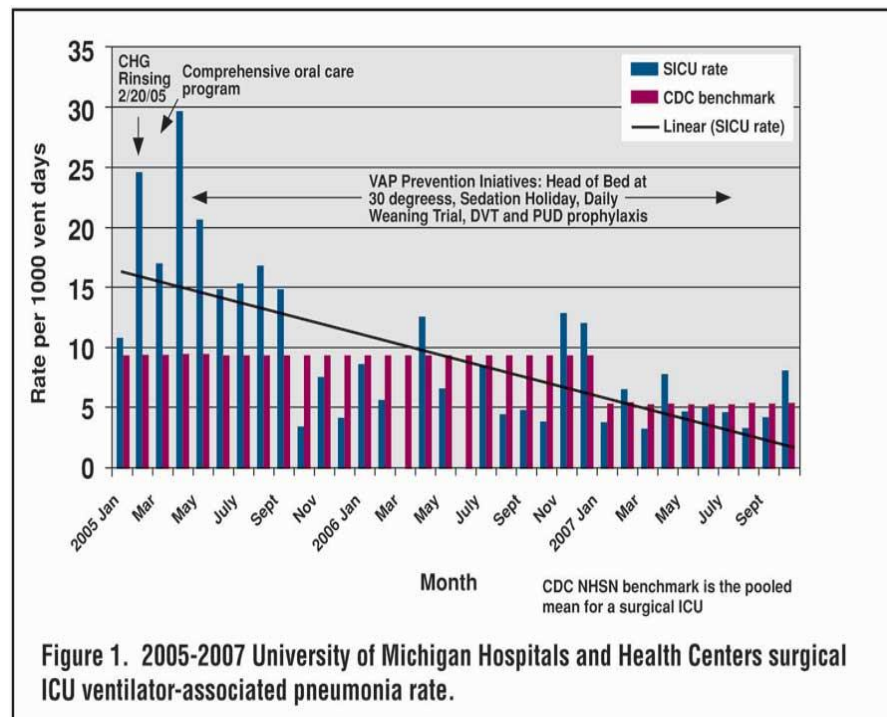
- Reduction in VAP from 5.6 to 2.2 (Schleder B. et al. J Advocate Health 2002;4(1):27-30)
- Reduction in VAP from 4.10 (2005) to (2.15) in 2006 with addition of CPC & comprehensive oral care. Vent bundle & rotational therapy already being performed
- Reduction in VAP from 12.0 to 8.0 ( $p=.060$ ) with 80% compliance, vent bundle already being performed, 1538 patients randomized to control or study group, Additional outcomes; < vent days ( $p=.05$ ), < ICU LOS ( $p=.05$ ) < time to VAP ( $p= <.001$ ) & reduction in mortality ( $p=.05$ ) (Garcia R et al AJCC, 2009;18:523-534)



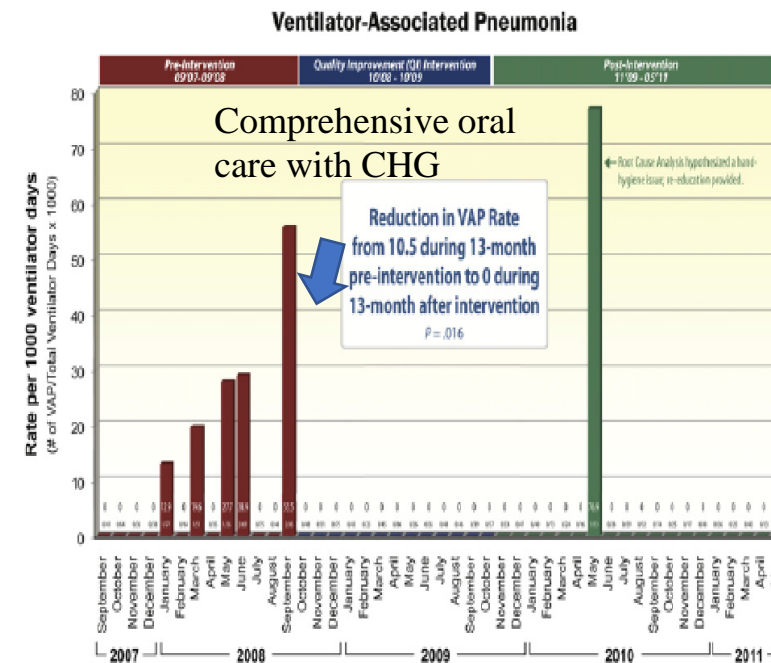
# Literature Review: Oral Care Impact of VAP

## Comprehensive Oral Care & CHG:

- Reduction in VAP to zero for 2 years, vent bundle, mobility, oral care & CHG with comprehensive education preformed (Murray TM et al. AACN Advanced Critical Care. 2007;18(2):190-199)



Dickinson S et al. SCCM Critical Connections, 02/2008



Heck K, et al. American Journal of Infection Control 40 (2012) 877-9

# Does CHG Oral Care Impact VAP and Mortality

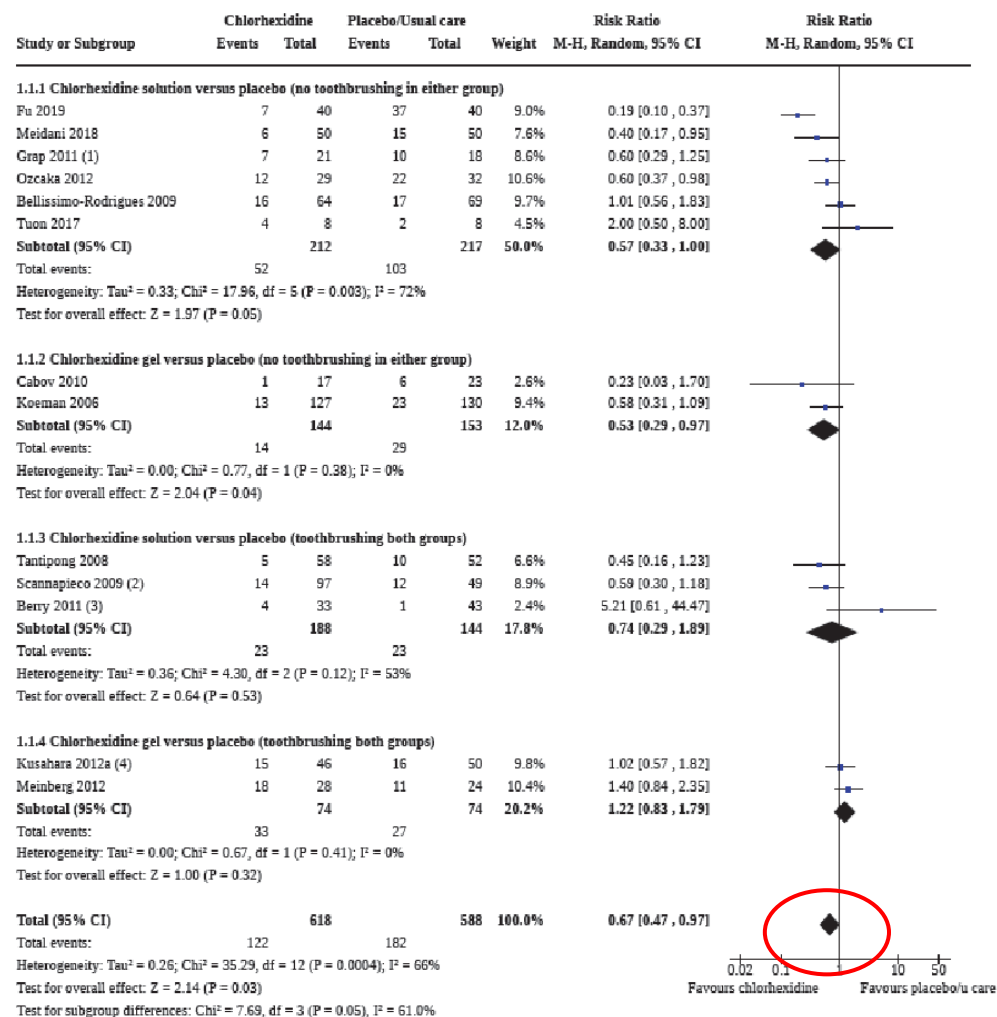


- Klompas Study-  
**Retrospective review**
  - △ Single center
  - △ Impact of vent bundle (5536 patients)
  - △ Connection of CHG with increase mortality on patients vented > 3 days

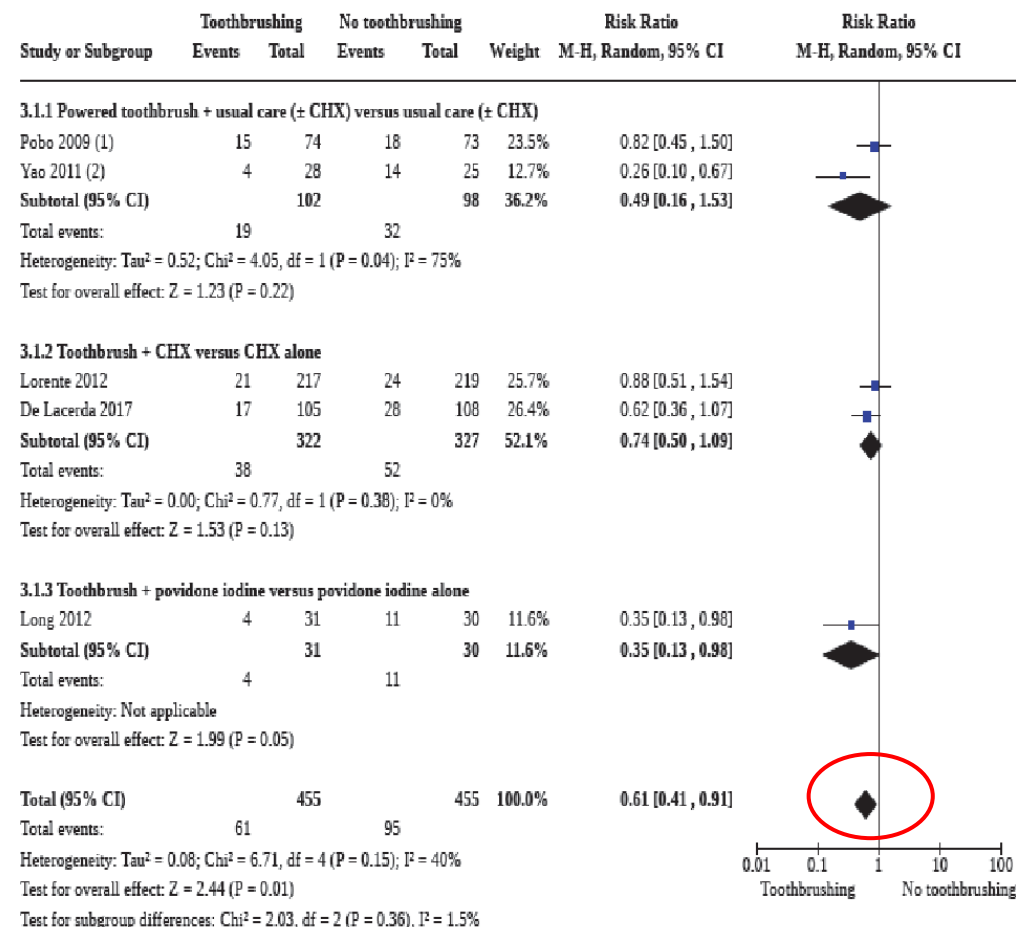
- Deschepper study: **Retrospective Review**
  - △ Hospital wide retrospective cohort (82,274 patients)
  - △ 11,133 patients received CHG oral care
  - △ Divided into low exposure-cumulative dose < 300 mg (8080 pts)
  - △ High exposure > 300 mg (3053 pts)
  - △ 300 mg CHG is equivalent to 1 bottle of 250ml of oral care soln at .12%-covers 5-6 days at 3 times a day)
- In the sickest group CHG low or high exposure was not a risk for increased mortality
- Showed improvement on mortality in ICU patients ventilated < 96hrs and not harm if vented > 96 hrs
- Greatest risk for mortality increase is use in non-ICU patients.

# Cochrane Meta-Analysis 2020 of RCT's

Analysis 1.1. Comparison 1: Chlorhexidine versus placebo/usual care, Outcome 1: Incidence of VAP

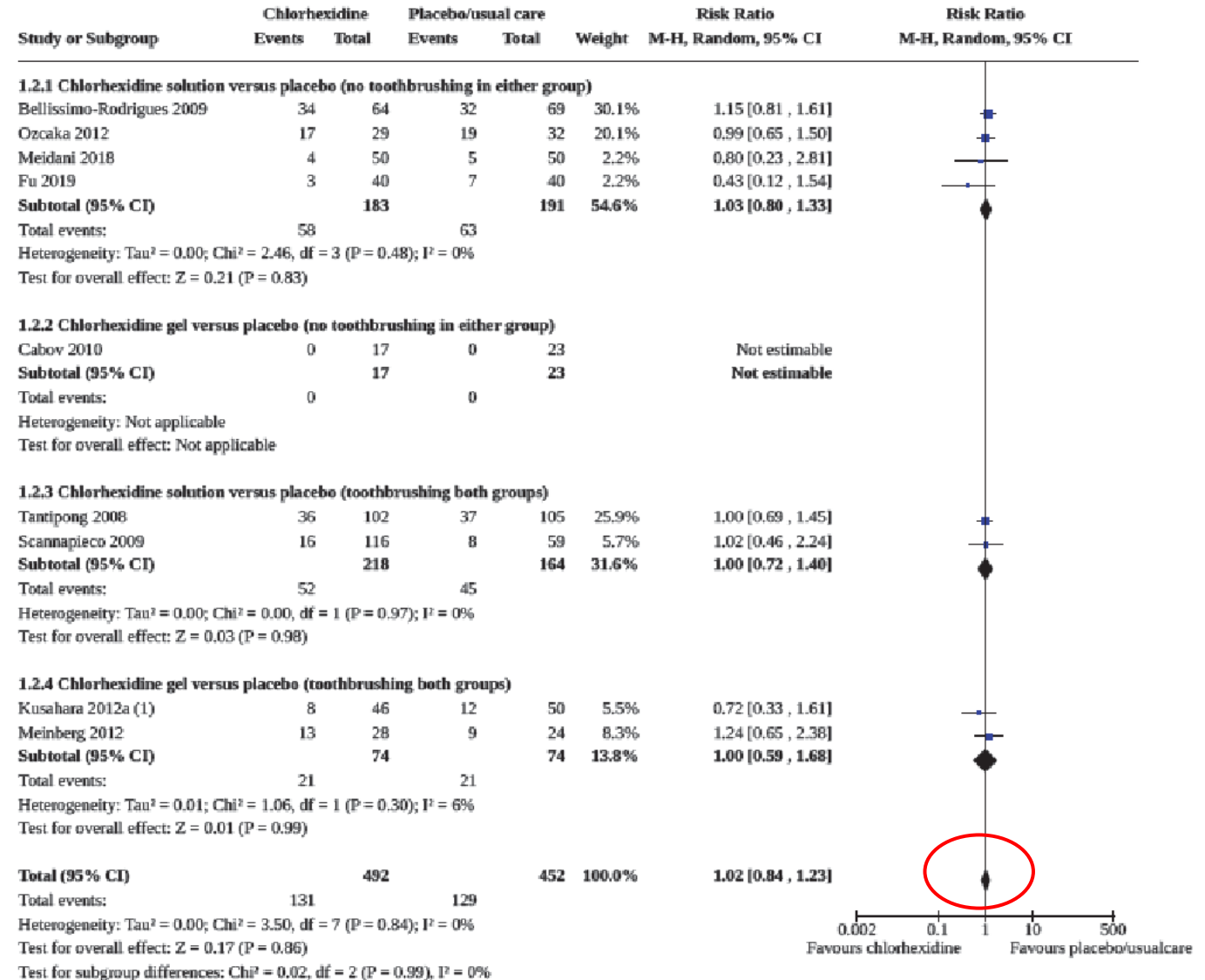


Analysis 3.1. Comparison 3: Toothbrushing versus no toothbrushing, Outcome 1: Incidence of VAP



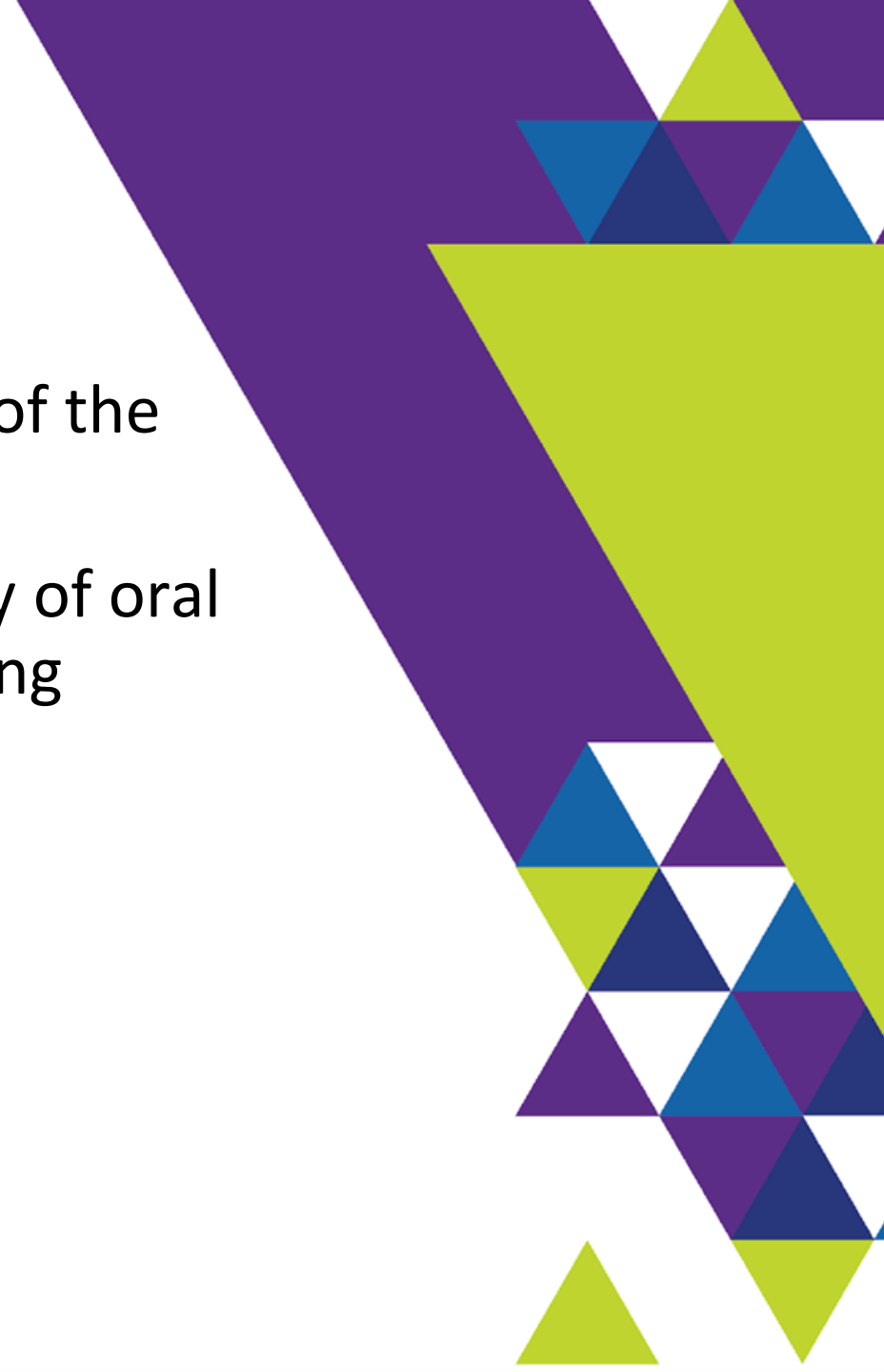
# Impact on Mortality

## Analysis 1.2. Comparison 1: Chlorhexidine versus placebo/usual care, Outcome 2: Mortality



## It is More than CHG

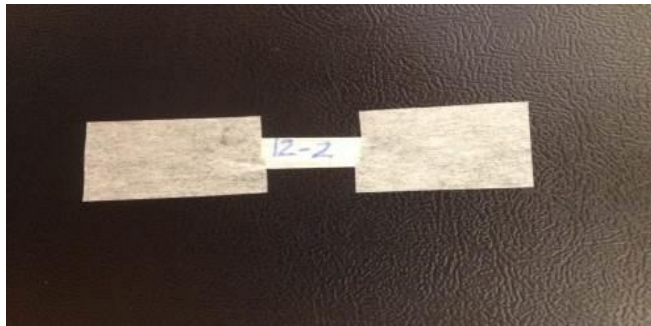
- .12% CHG application 2x daily is a small part of the oral care equation
- It is the comprehensive and frequent delivery of oral hygiene, including toothbrushing and cleansing



# Maintenance Care

Consider floating 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**



# Maintenance Care—Other Things to Consider

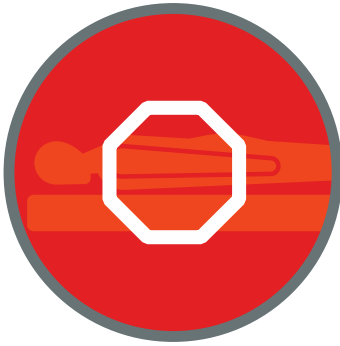
- Consider pillows, use of liter bags of IV fluids or fluidizer positioner to align the head and neck
- Use silicone preventive dressing under ECMO cannulas



*Image courtesy of Sharon Dickinson*



# When to Stop Prone Positioning?



Research supports stopping prone positioning when  $\text{PaO}_2/\text{FiO}_2$  has remained  $>150$  mmHg 4 hours after supinating (with PEEP  $<10$  cm  $\text{H}_2\text{O}$  and  $\text{FiO}_2 <0.6$ )

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



# Polling Question



What complications have occurred with use of the prone position at your hospital?  
Check all that apply

1. Airway obstruction
2. Accidental extubation
3. Pressure injuries
4. Loss of invasive lines
5. Loss of tubes
6. Cardiac arrest
7. Hemodynamic instability
8. Ocular injuries
9. Brachial plexus injuries
10. VAP

Adverse Events	No. of Trials Reporting the Outcome	Events/Prone	Events/Supine	Treatment Effect (Random-Effect Model)		Number Needed to Treat/Number Needed to Harm	Heterogeneity	
				OR (95% CI)	p		I <sup>2</sup> (%)	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 <sup>a</sup>	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



	Screen for ARDS severity
✓	
✓	
✓	
✓	
✓	



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

	Mild	Moderate	Severe
Oxygenation	$< 200 \text{ PaO}_2/\text{FiO}_2$ or $\leq 300$ with PEEP/ CPAP $\geq 5 \text{ cm H}_2\text{O}$	$< 100 \text{ PaO}_2/\text{FiO}_2$ or $\leq 200$ with PEEP $\geq 5 \text{ cm H}_2\text{O}$	$\leq 100 \text{ PaO}_2/\text{FiO}_2$ with PEEP $\geq 5 \text{ cm H}_2\text{O}$



✓	Screen for ARDS severity
✓	Prevent Pressure Injuries
✓	
✓	
✓	



# Pressure Injury Risk in the Prone Patient

## Incidence

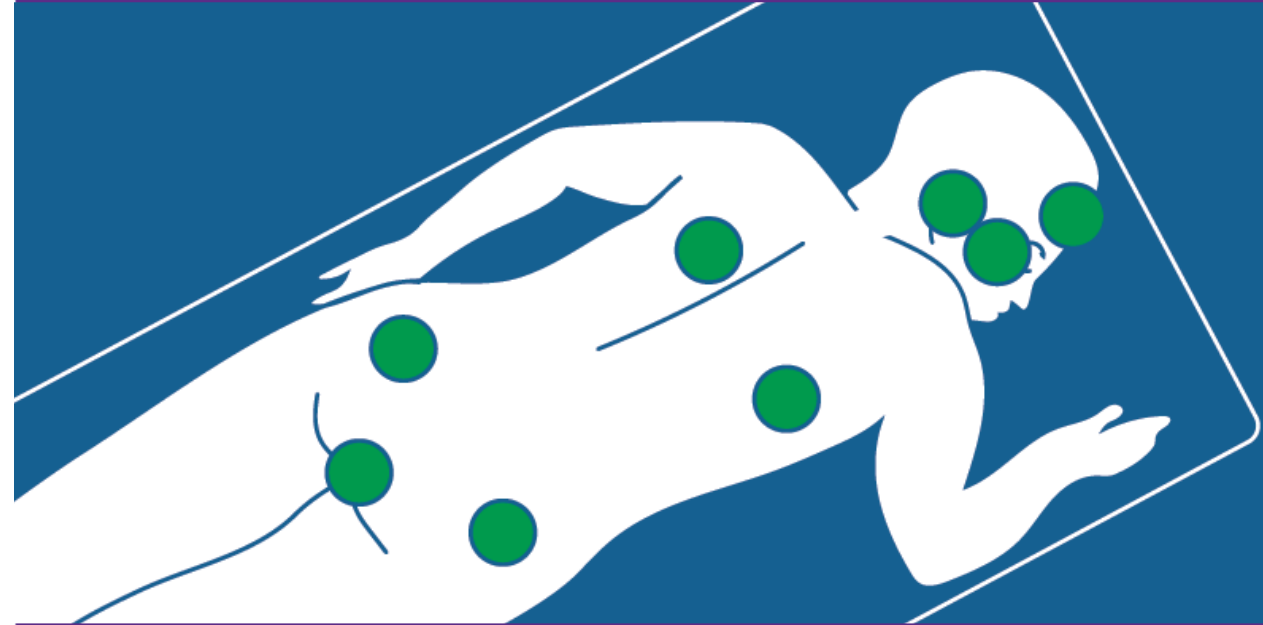
- △ Prone position for ARDS increased odds of pressure injury
  - Ranges 1.22- 1.37 (95% CI 1.05 to 1.79)
  - PI 37% more common in prone pts
- △ High rates being reported in COVID patients





# Pressure Injury Prevention: Prone Positioning

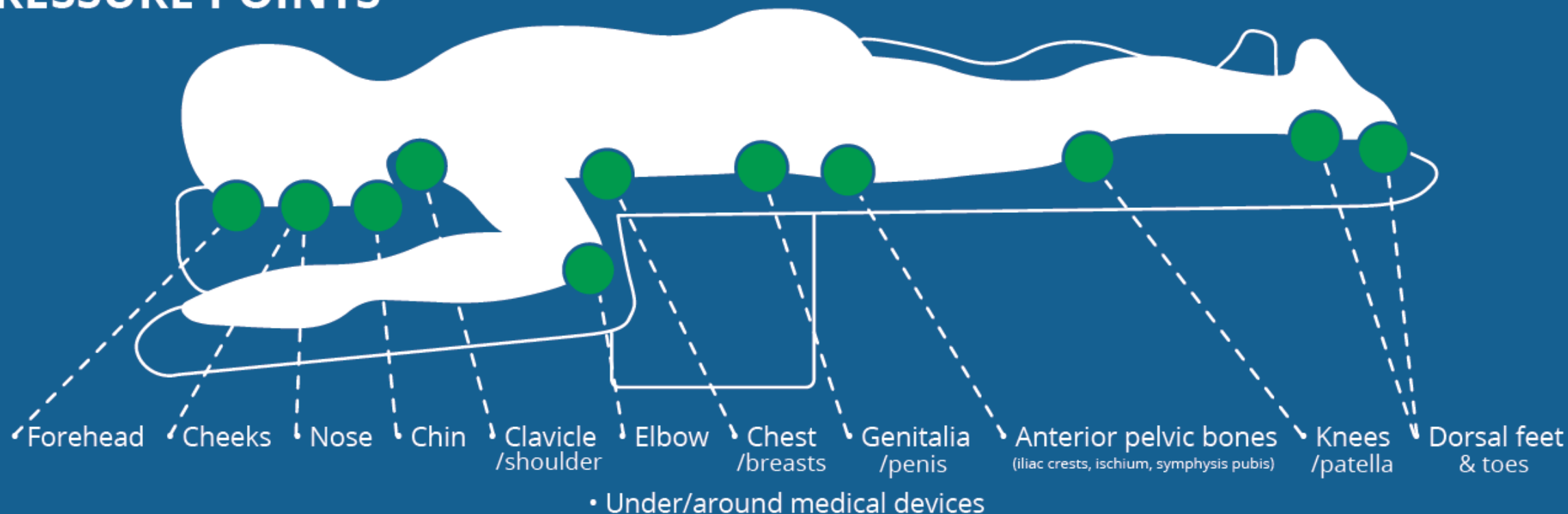
- ▲ Redistribution surface
- ▲ Positioning devices to offload pressure points (Do not use ring or donut-shaped positioning devices)
- ▲ Avoid shear and friction during the turning process
- ▲ Small micro turns while prone/swimmer position shifts q 2-4 hrs
- ▲ Assess skin with when doing small positioning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



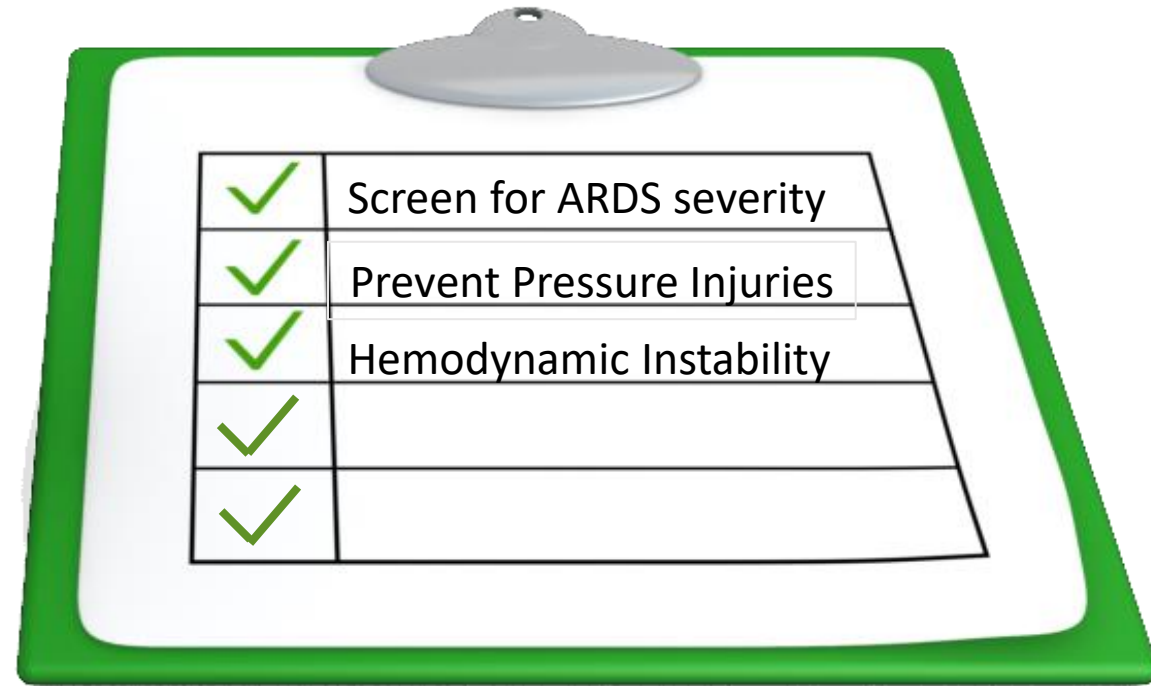
Green areas represent pressure sources while lying prone

# Prophylactic Dressings for Prone Position PI Prevention

## PRESSURE POINTS



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



# The Role of Hemodynamic Instability in Positioning

- ▶ Lateral turn results in a 3%-9% decrease in  $\text{SVO}_2$ , 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

A green clipboard with a silver clip at the top holds a white sheet of paper with a checklist. The checklist has five rows. The first four rows have a green checkmark in the left column and a text box in the right column. The fifth row has an empty checkbox in the left column and an empty text box in the right column.

✓	Screen for ARDS severity
✓	Prevent Pressure Injuries
✓	Hemodynamic Instability
✓	NMBA use
<input type="checkbox"/>	

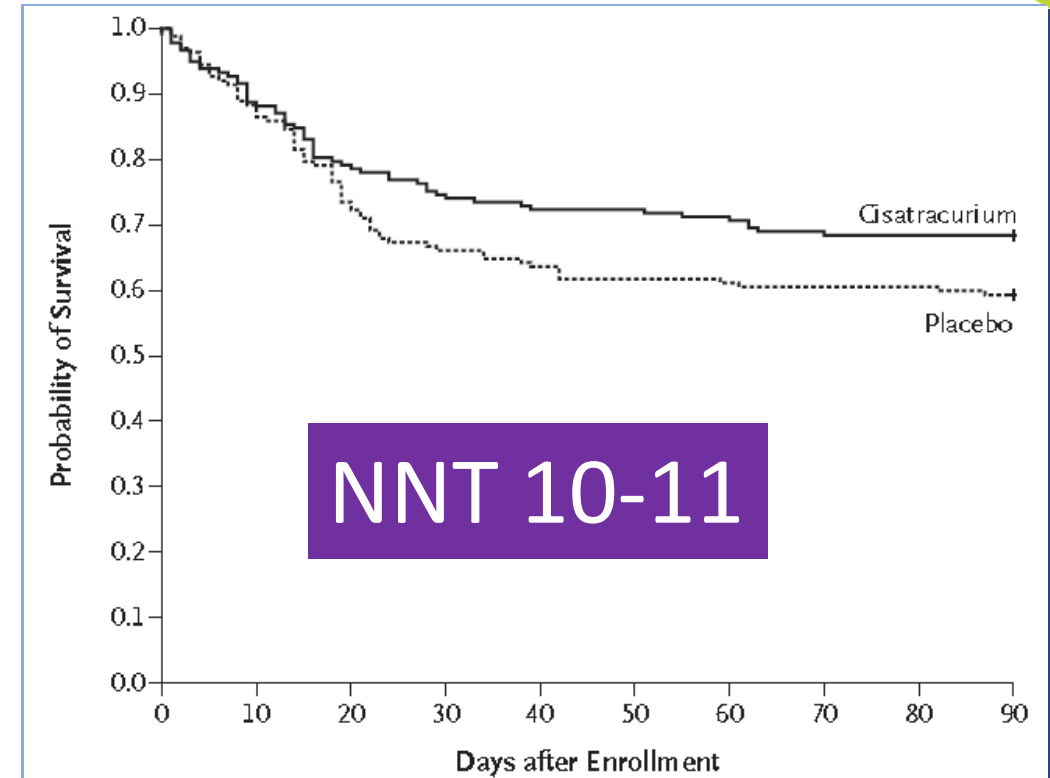


# Neuromuscular Blockade in Early ARDS

- ▶ Multicenter, double blind trial
- ▶ 340 patients with ARDS within 48hrs of admitted to ICU
- ▶ ARDS defined as P/F ratio of  $< 150 \geq$  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



# ROSE Trial: Re-evaluation of Systemic Early Neuromuscular Blockade

- Protocol: moderate to severe ARDS < 48hrs / P/F ratio < 150 with  $\geq$  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 19<sup>th</sup> 2019

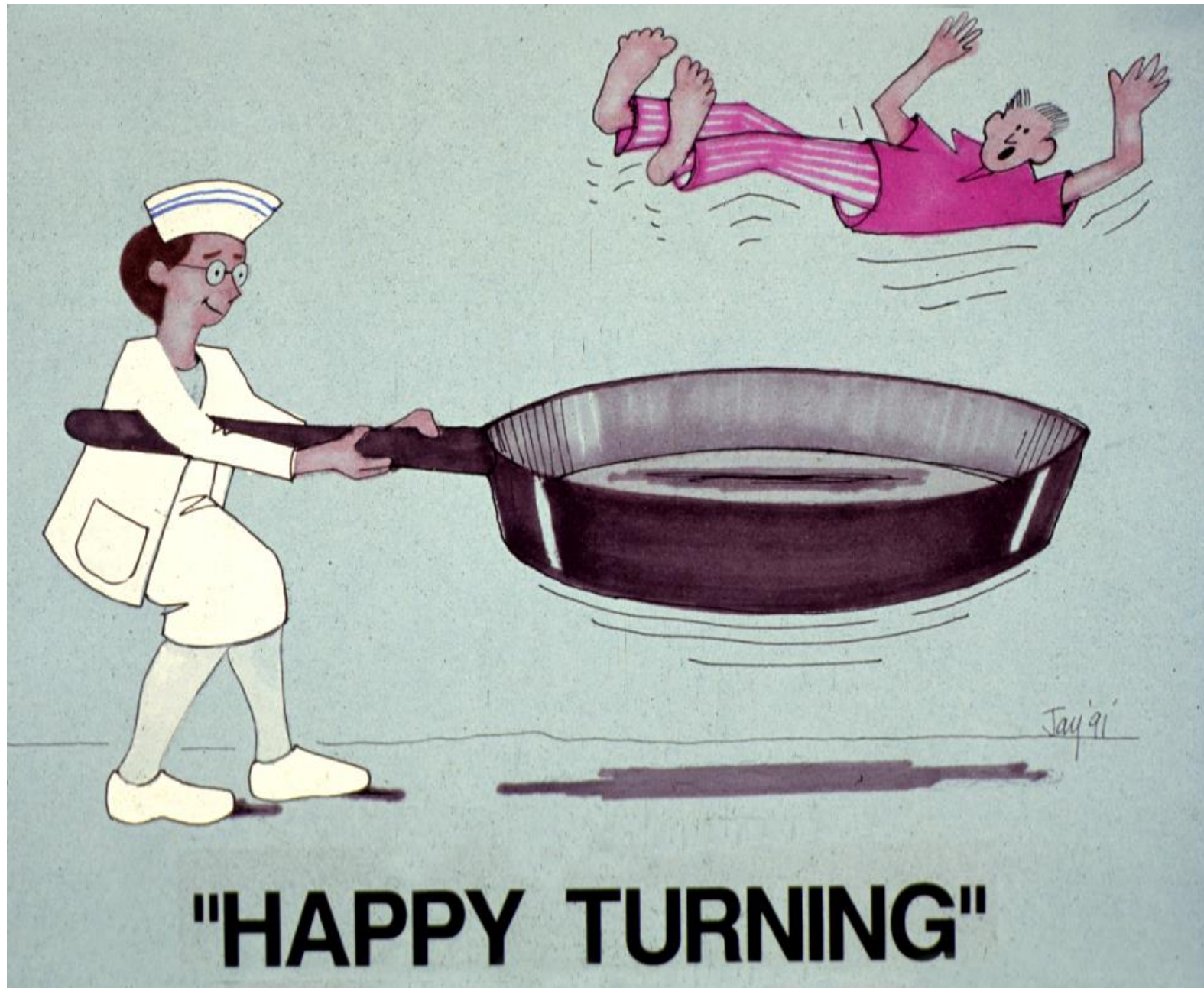
Prone Positioning used 15.8%. Equal use in both groups



# 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





**"HAPPY TURNING"**





**Kathleen Vollman**

ADVANCING NURSING THROUGH KNOWLEDGE & INNOVATION



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