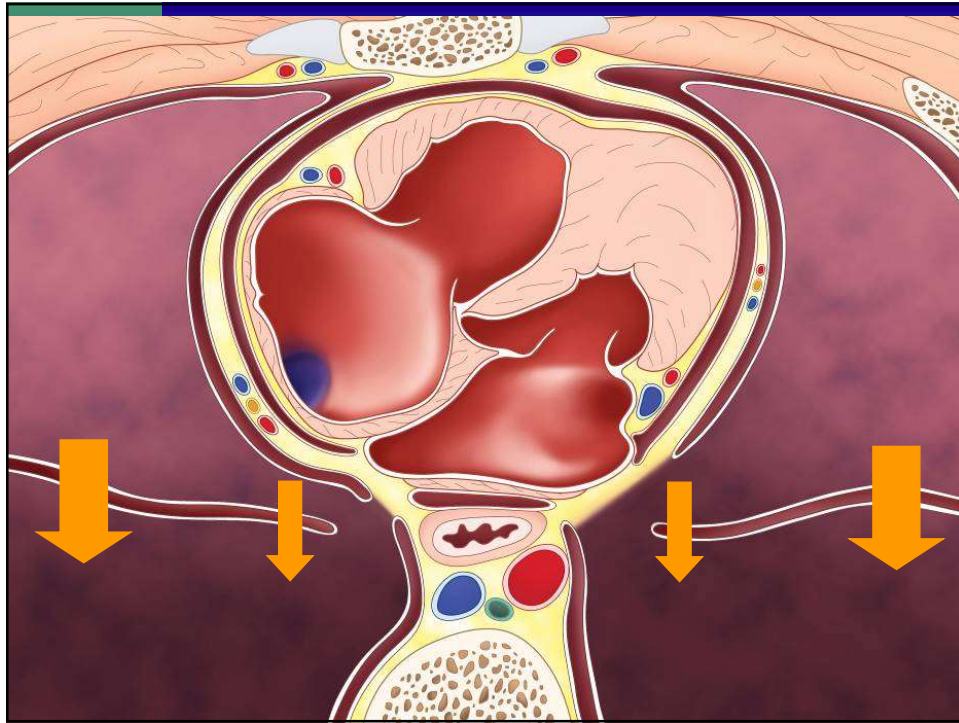




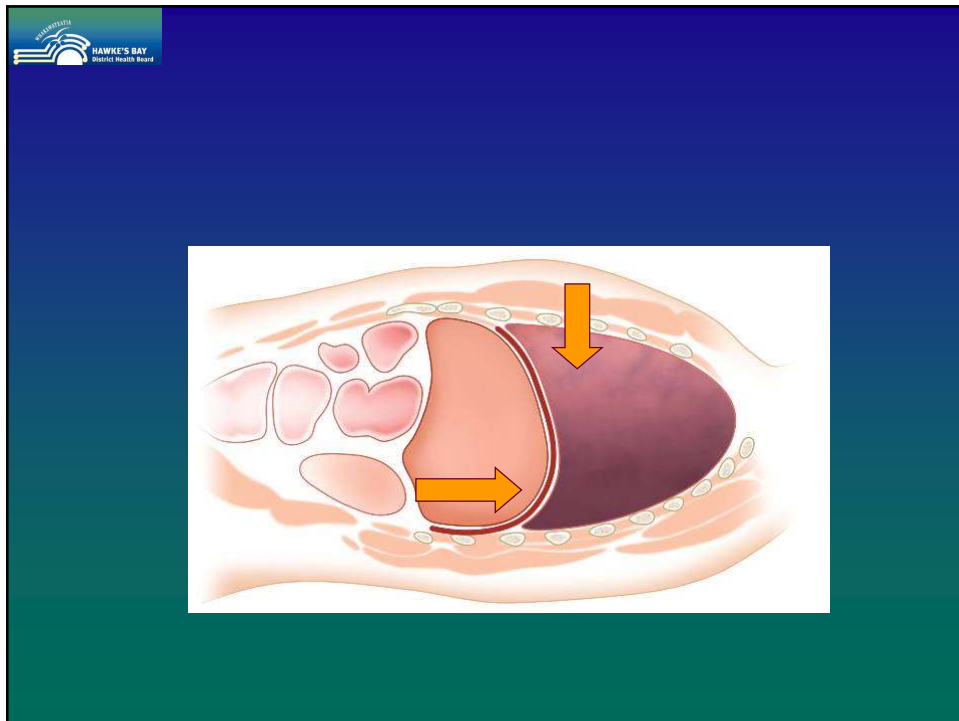
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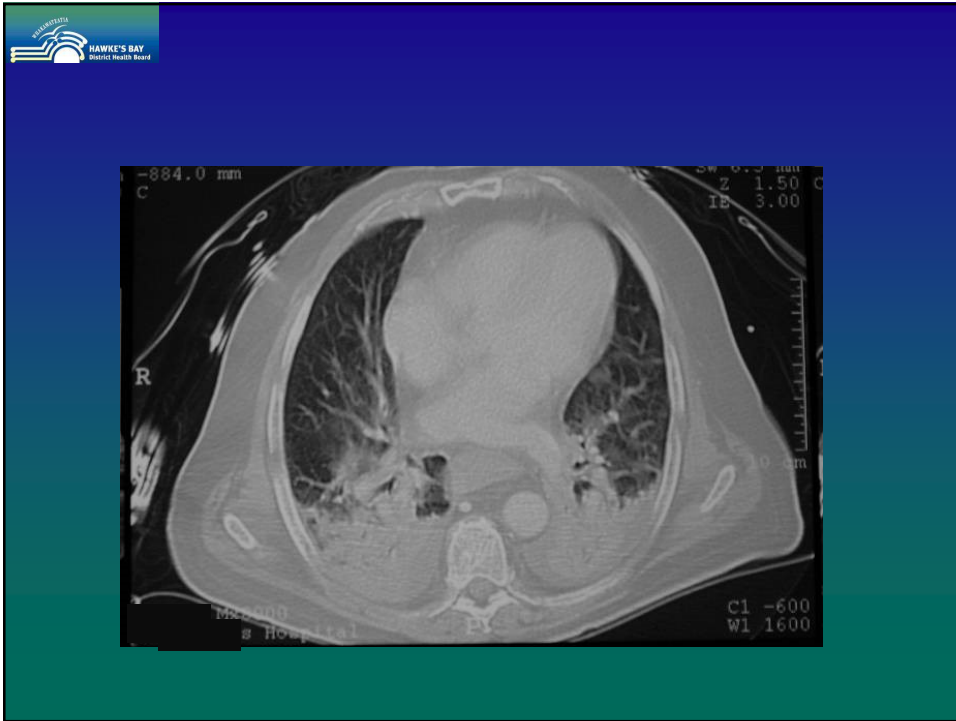
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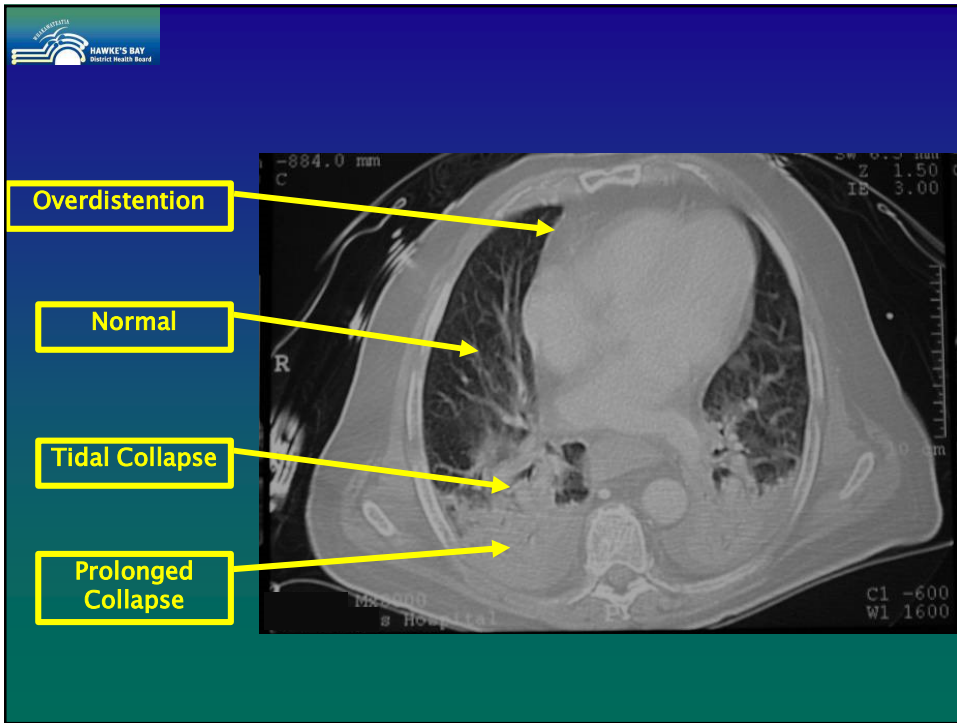
Recruitment

Consolidation:
Fluid occlusion of
non collapsed
airways

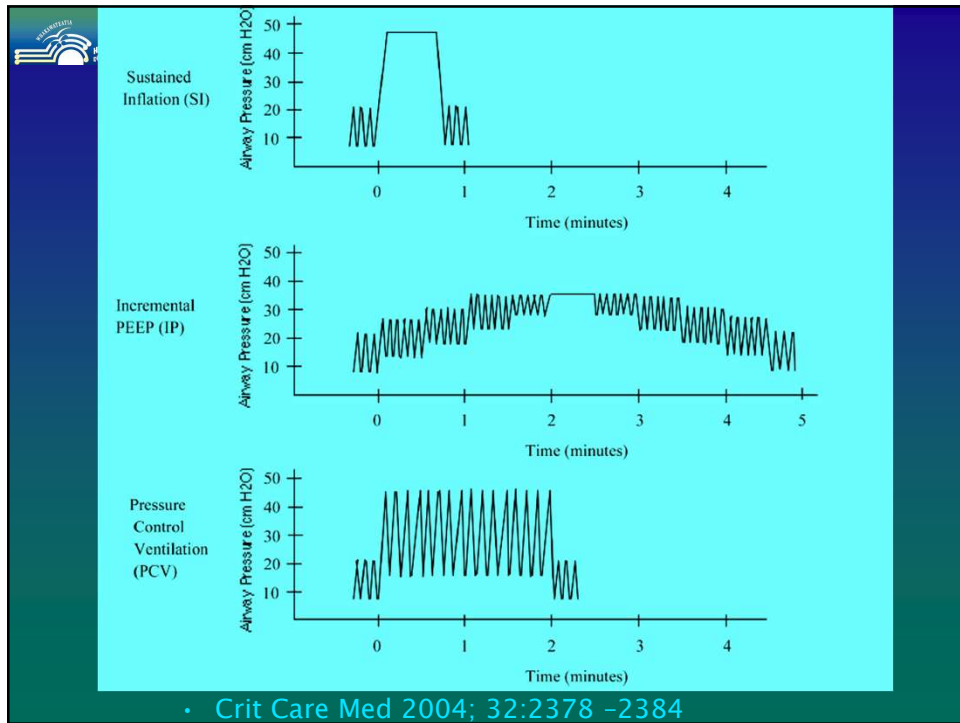
Atelectasis:
Collapsed
compliant airways/
alveoli

The diagram illustrates the process of lung recruitment. On the left, there are two airway models: a large, rounded one filled with a dark, granular substance representing fluid (consolidation) and a smaller, collapsed one. On the right, a single large, rounded airway is shown filled with a lighter, granular substance representing air. Two red arrows point from the left state to the right state, indicating the transition from consolidation and atelectasis to recruitment.

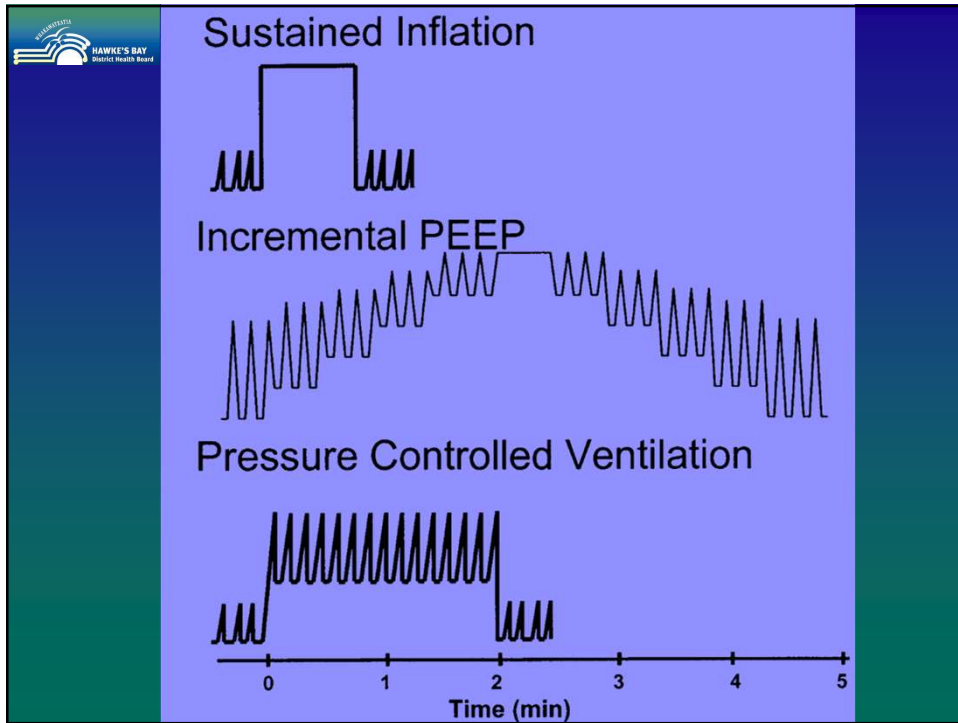
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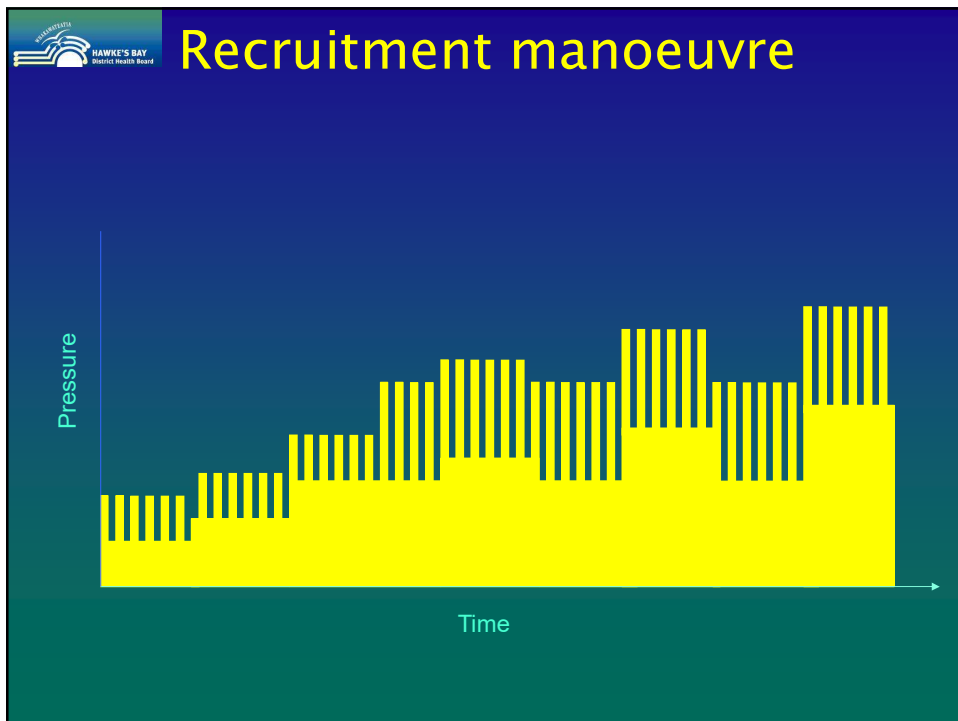
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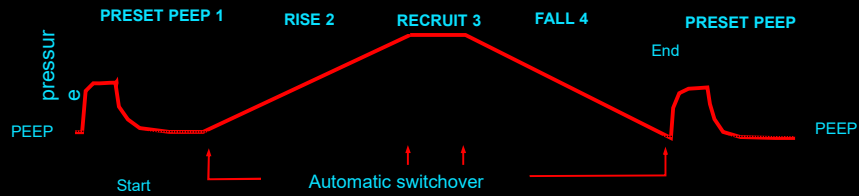


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10

Automated Recruitment Tool : 4 phases



- Phase 1: Prolonged expiration to a preset P-start (current PEEP)
- Phase 2: Linear pressure increase P-start to P-Top(3cmH₂O/sec)
- Phase 3: Keep pressure at P-top "RECRUIT time" period
- Phase 4: Linear pressure decrease from P-top to the preset end PEEP

11

12



13

HAWKES BAY District Health Board The Recruitment paradox

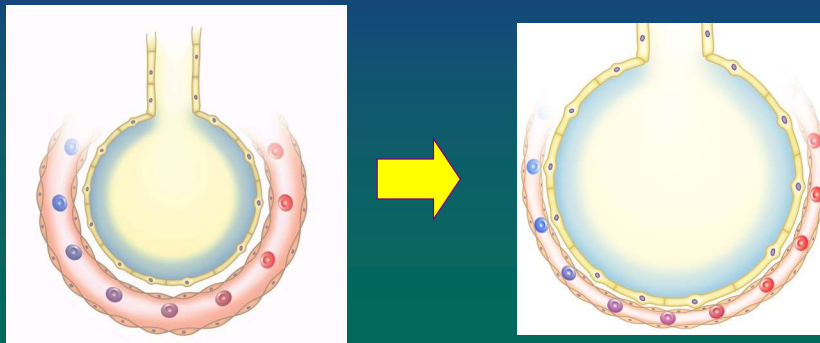
- Increased pressure will give increased volume
- Assumption : increased volume is “reopened alveoli”

The diagram illustrates the recruitment paradox. On the left, a cross-section of an alveolus is shown with a large central air space and a thin wall. A yellow arrow points to the right, where the same cross-section is shown with a larger central air space and a thicker wall, representing the state after increased pressure and volume, where alveoli are reopened.

14

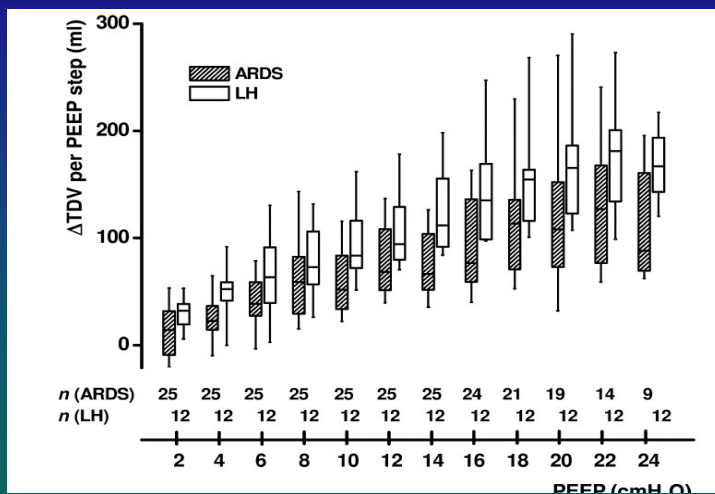
The Recruitment paradox

- Increased pressure will give increased volume
- Assumption : increased volume is “reopened alveoli”
- Possibly Over distended healthy alveoli



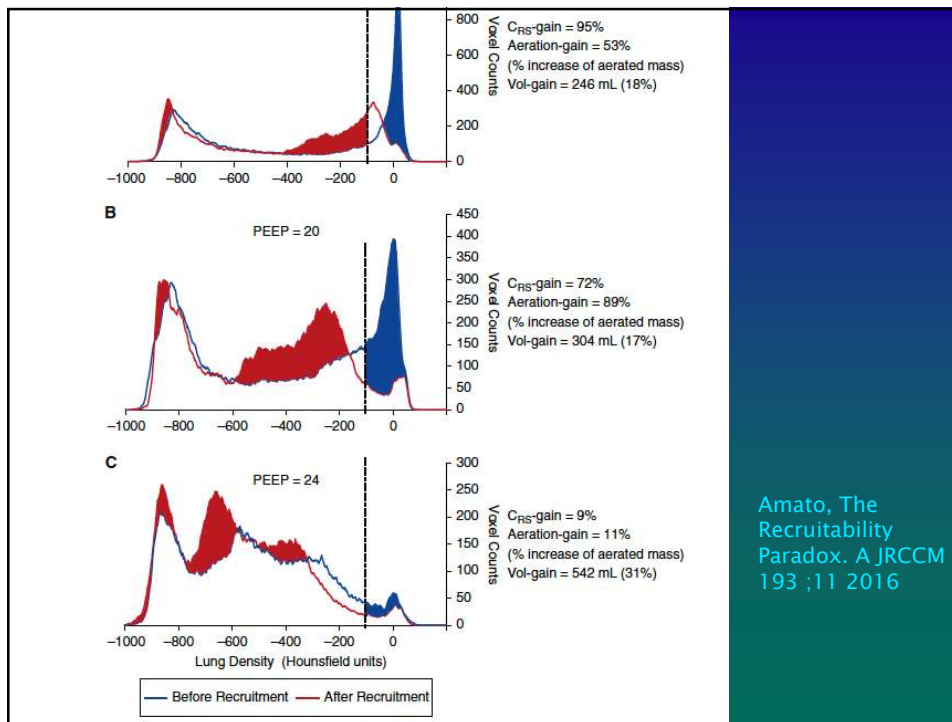
15

Recruitment: Healthy vs ARDS Lungs



Stahl, C.A., et al Determination of 'recruited volume' following a PEEP step is not a measure of lung recruitability (2015) Acta Anaesthesiologica Scandinavica. 59 (1). pp. 35-46.

16



Amato, The
 Recruitability
 Paradox. A JRCCM
 193 ;11 2016

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How much recruitability

- **Respiratory mechanics-based methods measure gas**
 - entering previously empty pulmonary
 - gas entering already open units.
 - provide information on overall improvement of inflation
 - but do not measure the collapsed and/or recruitable lung tissue.
 - Chiumello, D., et al (2016). Lung recruitment assessed by respiratory mechanics and computed tomography in patients with acute respiratory distress syndrome: What is the relationship? *American Journal of Respiratory and Critical Care Medicine*, 193(11), 1254–1263.

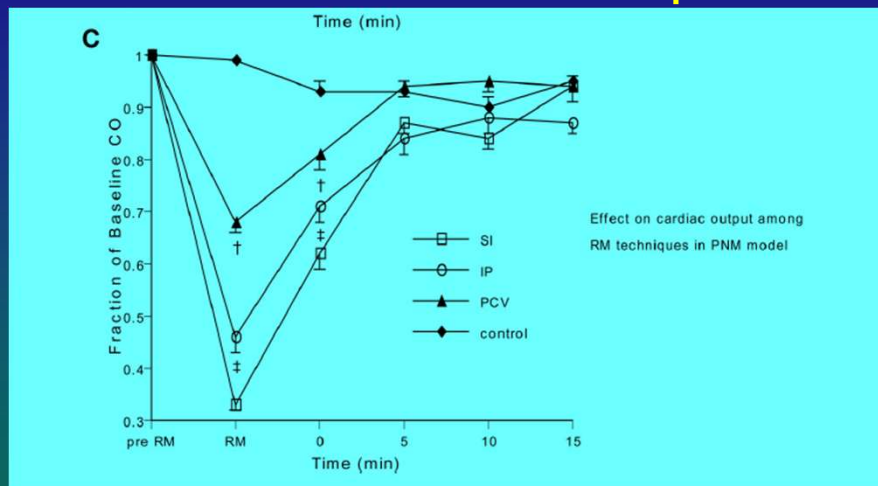
18

- **recruitability has been assessed**
 - assessing the severity of ARDS,
 - planning recruitment maneuvers
 - setting adequate PEEP levels

- **no compelling reason yet to attempt to quantitate lung “recruitability” as part of clinical care in ARDS**
 - Chiumello, D., et al (2016). Lung recruitment assessed by respiratory mechanics and computed tomography in patients with acute respiratory distress syndrome: What is the relationship? *American Journal of Respiratory and Critical Care Medicine*, 193(11), 1254–1263

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Effect on cardiac output



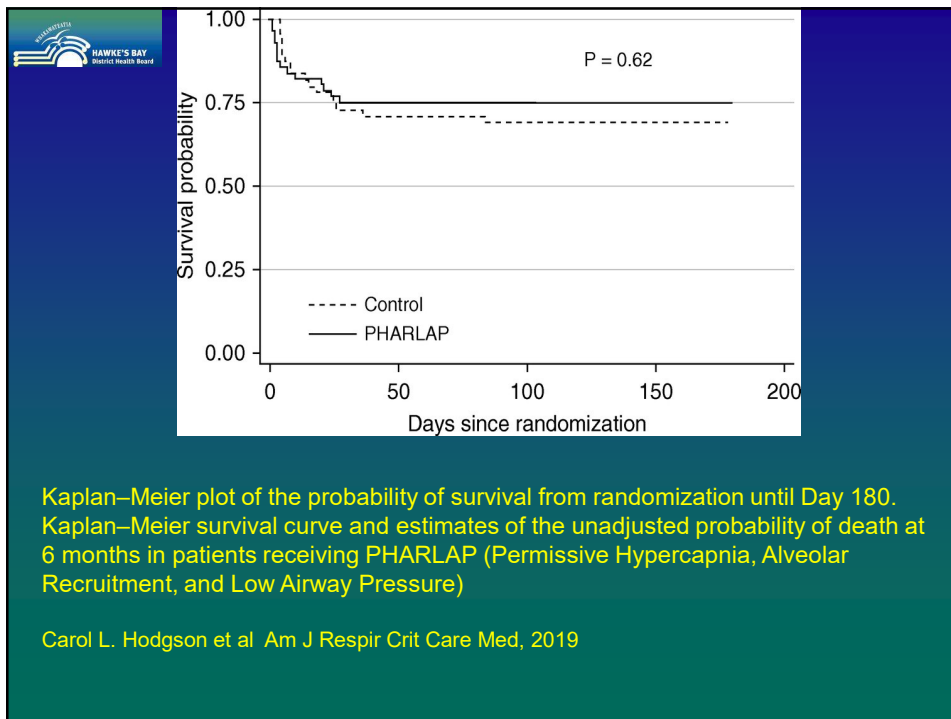
Lim, SC Adams AB, Simonson DA, Dries DJ, Broccard AF, Hotchkiss, JR, Marini JJ. **Transient hemodynamic effects of recruitment maneuvers in three experimental models of acute lung injury** *Crit Care Med* 2004;32:2378–2384

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Recruitability?

- **Increased EELV may**
 - not be recruitment of previously nonaerated lung units,
 - But further distension of previously open lung units.
 - While EELV alone may not be sufficient to assess PEEP response, identifying recruited volume created by additional PEEP have more relevance. EELV combined with measurement of compliance may be useful
- **Freebairn R, Mistry R, Park M.** Positive End Expiratory Pressure. In: Freebairn R, Kulkarni A, editors. Evidence Based Core topics in Critical Care Medicine 2019. 1. New Delhi, India: JAYPEE BROTHERS MEDICAL PUBLISHERS; 2019. p. 303-10
- **Chiumello, D., et al (2016).** Lung recruitment assessed by respiratory mechanics and computed tomography in patients with acute respiratory distress syndrome: What is the relationship? *American Journal of Respiratory and Critical Care Medicine*, 193(11), 1254-1263.

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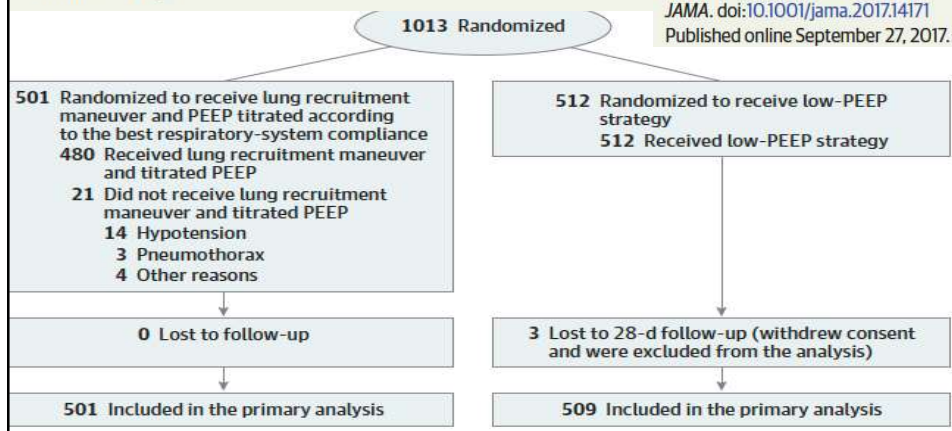


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Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs Low PEEP on Mortality in Patients With Acute Respiratory Distress Syndrome A Randomized Clinical Trial

INTERVENTIONS An experimental strategy with a lung recruitment maneuver and PEEP titration according to the best respiratory-system compliance (n = 501; experimental group) or a control strategy of low PEEP (n = 509). All patients received volume-assist control mode until weaning.

JAMA. doi:10.1001/jama.2017.14171
Published online September 27, 2017.

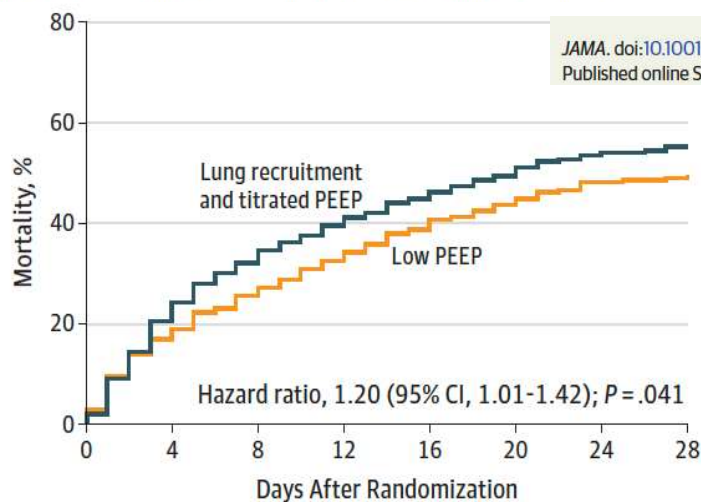


23

Effect of Lung Recruitment and Titrated Positive End-Expiratory Pressure (PEEP) vs Low PEEP on Mortality in Patients With Acute Respiratory Distress Syndrome A Randomized Clinical Trial

Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators

JAMA. doi:10.1001/jama.2017.14171
Published online September 27, 2017.



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Does it help to Know ???

- PEEP increment most patients had a Vrec > 150 ml measured with VP curve.
- Vrec was not associated with ICU mortality.
- Certainty of evidence overall very low
 - all studies identified were observational
- Publication bias in studies showing Vrec and mortality,
- Existing literature insufficient to determine if Vrec relates to outcome.

Intensive Care Med (2020) 46:2212–2225

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Does it help to Know ???

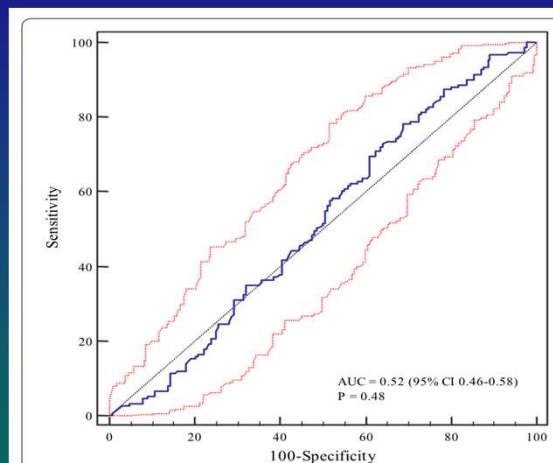
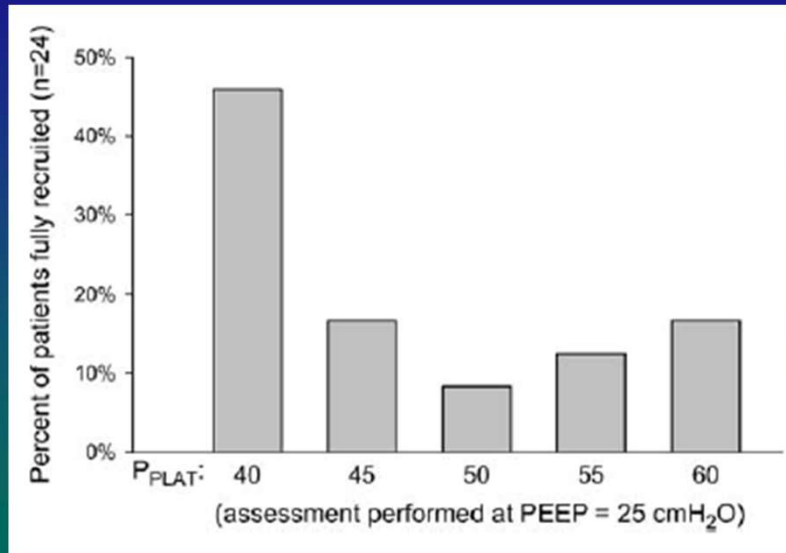


Fig. 6 Receiver operating curve (ROC) (continuous blue line) of recruited volume for assessing mortality. Area under curve (AUC) of the ROC curve with 95% confidence intervals (broken red lines) is displayed. The broken black line is the identity line

Intensive Care Med (2020) 46:2212–2225

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How much Pressure?



Borges. AJRCCM 2006

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Association of Positive End-Expiratory Pressure and Lung Recruitment Selection Strategies with Mortality in Acute Respiratory Distress Syndrome: A Systematic Review and Network Meta-analysis

Certainty of evidence	Ranking category	Intervention	Reference	Risk ratio (95% CrI)	Posterior probability of benefit
High confidence (Moderate to high certainty)	Probably more effective than lower PEEP	Higher PEEP without LRM	Lower PEEP	0.77 (0.60 – 0.96)	99%
	Probably more effective than lower PEEP	Higher PEEP with brief LRM	Lower PEEP	0.83 (0.67 – 1.02)	96%
	May result in little or no difference in outcome in comparison to lower PEEP	Pes-guided	Lower PEEP	0.77 (0.48 – 1.22)	87%
	Probably harmful compared to higher PEEP without LRM	Higher PEEP with prolonged LRM	Higher PEEP without LRM	1.37 (1.04 – 1.81)	1%
Low confidence (Low certainty)	May result in little or no difference in outcome in comparison to lower PEEP	Higher PEEP with prolonged LRM	Lower PEEP	1.06 (0.89 – 1.22)	23%
	May result in little or no difference in outcome in comparison to higher PEEP without LRM	Higher PEEP with brief LRM	Higher PEEP without LRM	1.07 (0.79 – 1.48)	32%

Figure 4. Grading of recommendations assessment, development and evaluation network ranking and degree of certainty for the association of different positive end-expiratory pressure selection strategies with all-cause mortality. Dark blue represents high certainty of evidence; light blue represents moderate certainty of evidence; red represents low certainty of evidence. Posterior probabilities of benefit refer to the probability of any mortality benefit (i.e., risk ratio < 1). CrI = credible interval; LRM = lung recruitment maneuver; PEEP = positive end-expiratory pressure; Pes-guided = esophageal pressure-guided PEEP selection strategy.

Am J Respir Crit Care Med Vol 205, Iss 11, pp 1300–1310, Jun 1, 2022

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Recruitment

- Evidence based Outcome
 - Primum non nocere
 - If it's harmful do NOT do this
- If you want to do something that works to HELP patients to get better
 - We need
 - Indications (prophylactic vs rescue)
 - Contraindications(CO/ Barotrauma)
 - Techniques
 - Duration
 - Intensity
 - Frequency

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