BaltAnestIC 2023
11th International Baltic Congress of Anaesthesioogy and Intensive care
September 28–30, 2023, Tartu, Estonia Estonian National Museum

WHEN THE FLUIDS ARE BECOMING DELETERIOUS FOR THE ORGANS:

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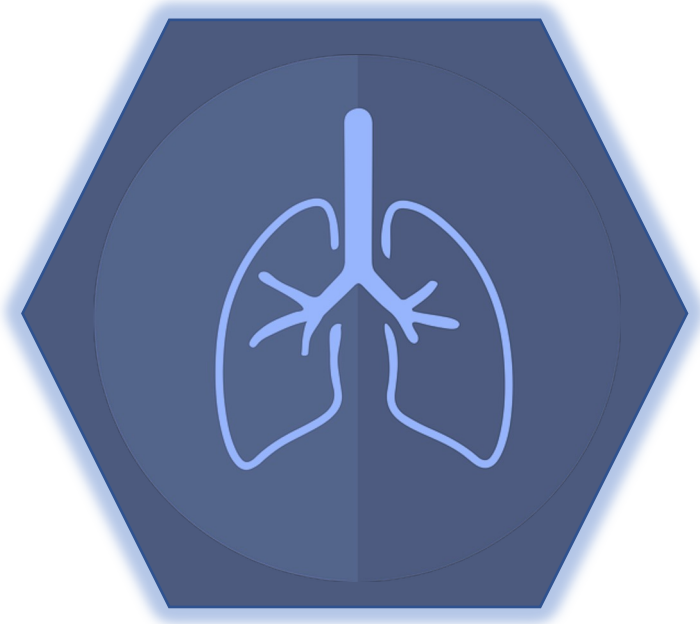
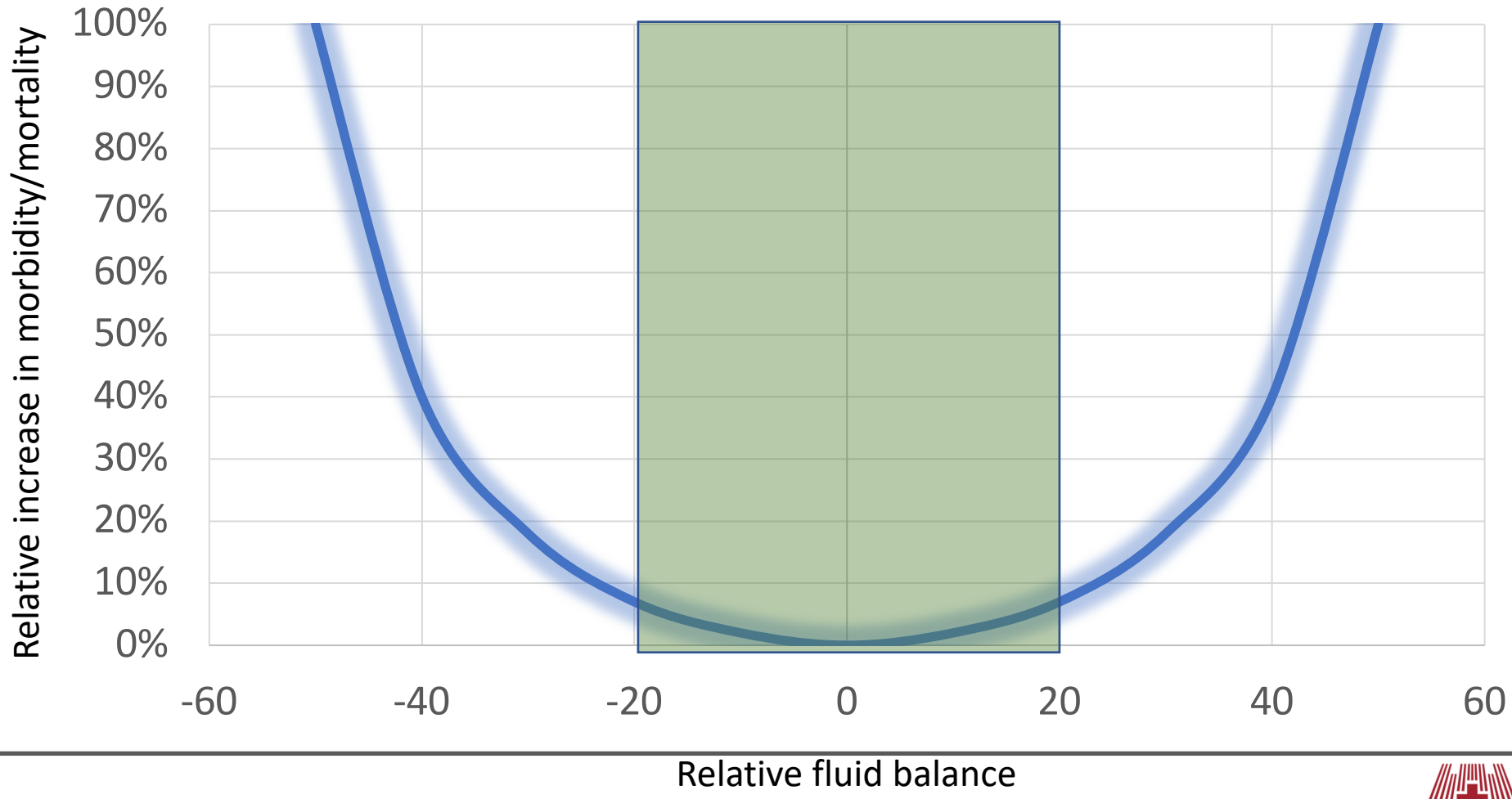
Vilnius University Hospital Santaros Klinikos

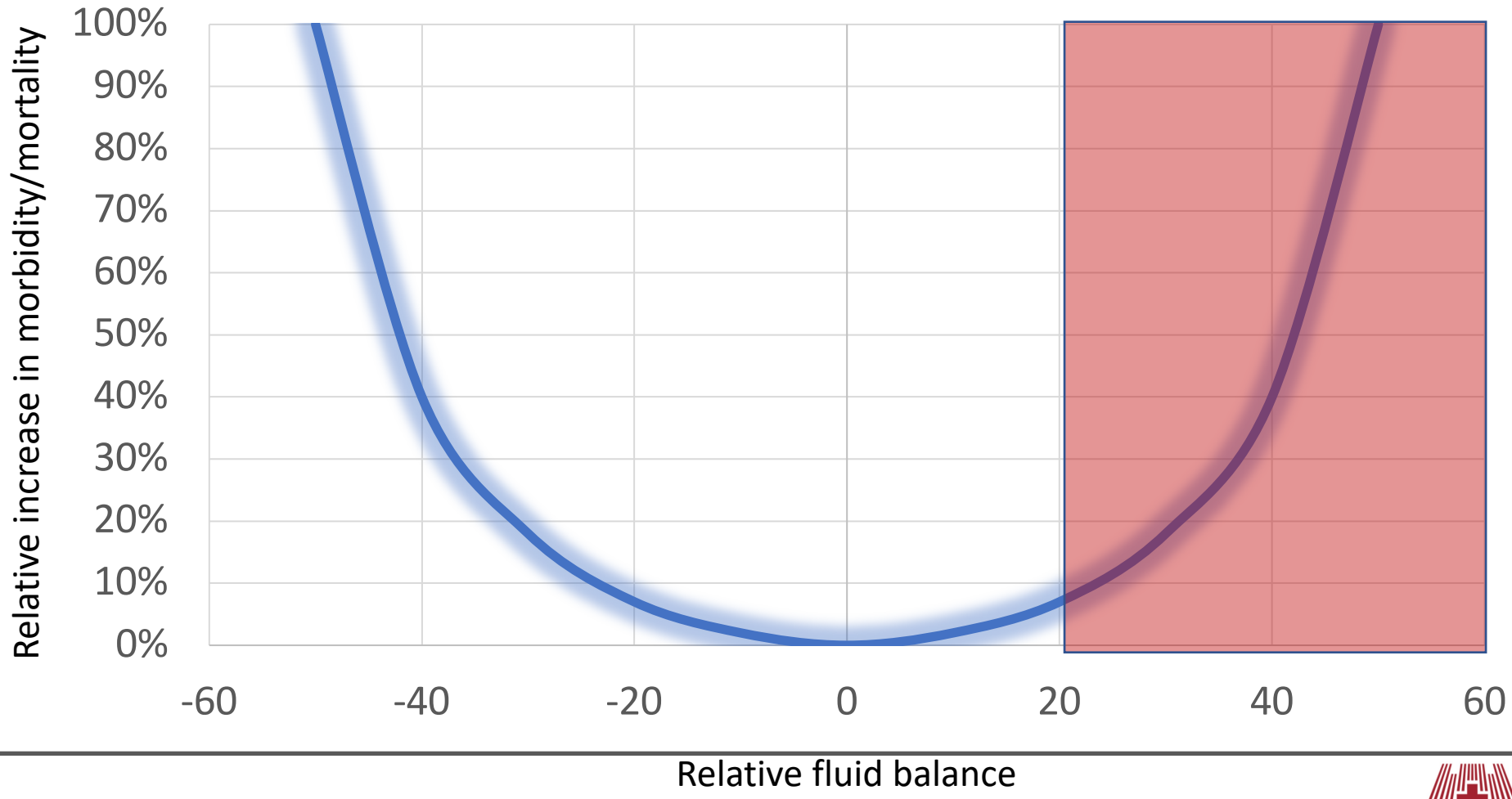


Vilniaus universiteto ligoninė
SANTAROS KLINIKOS

The lung evidence of the U-shaped mantra



The lung evidence of the “wet-side”



The lung evidence of the “wet-side”

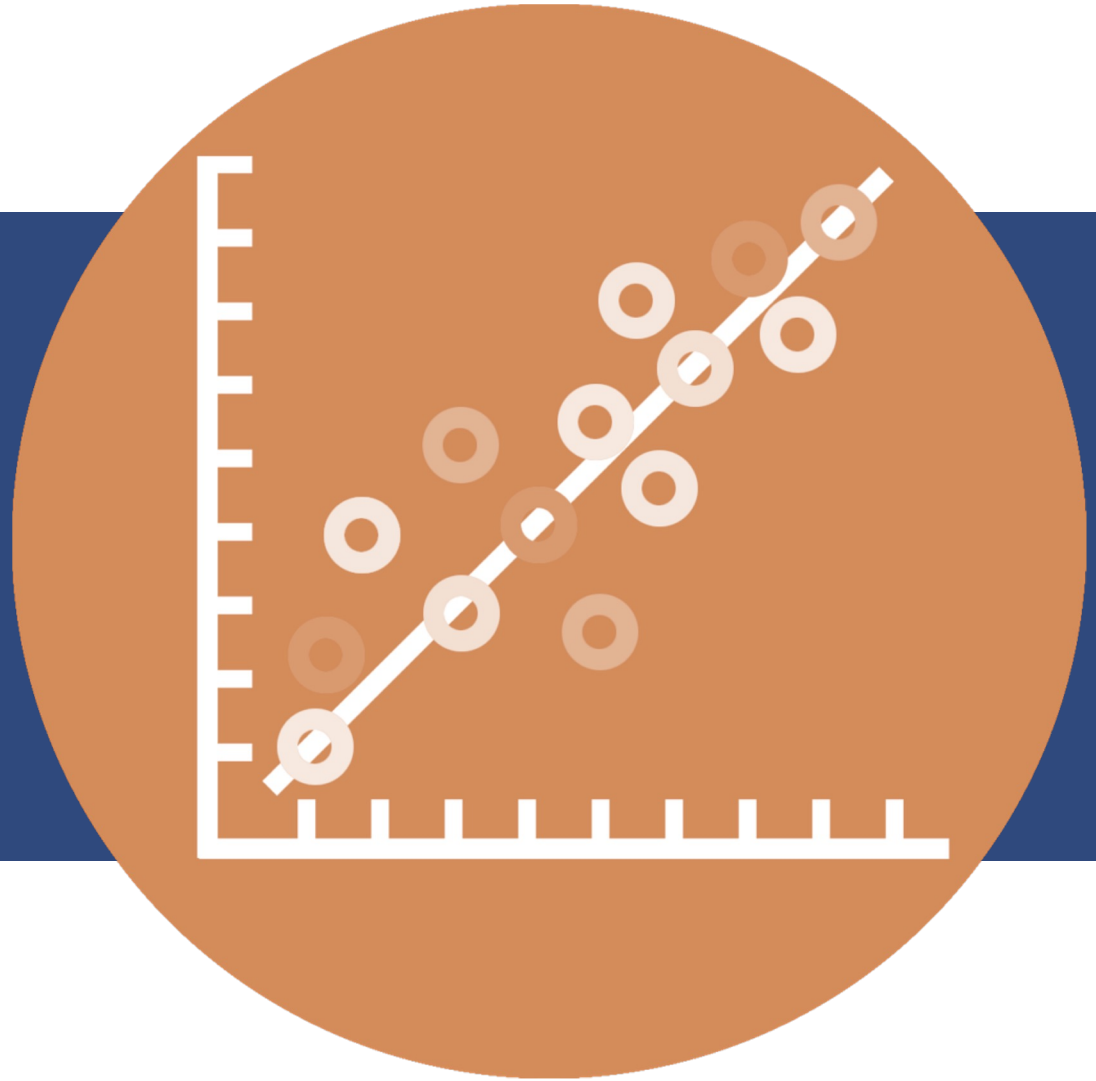
Positive FB is **ASSOCIATED** with:

Worse P/F, Cst, ΔP, EVLW, etc.

Longer time on Mechanical ventilation

Higher weaning failure rates

Higher mortality

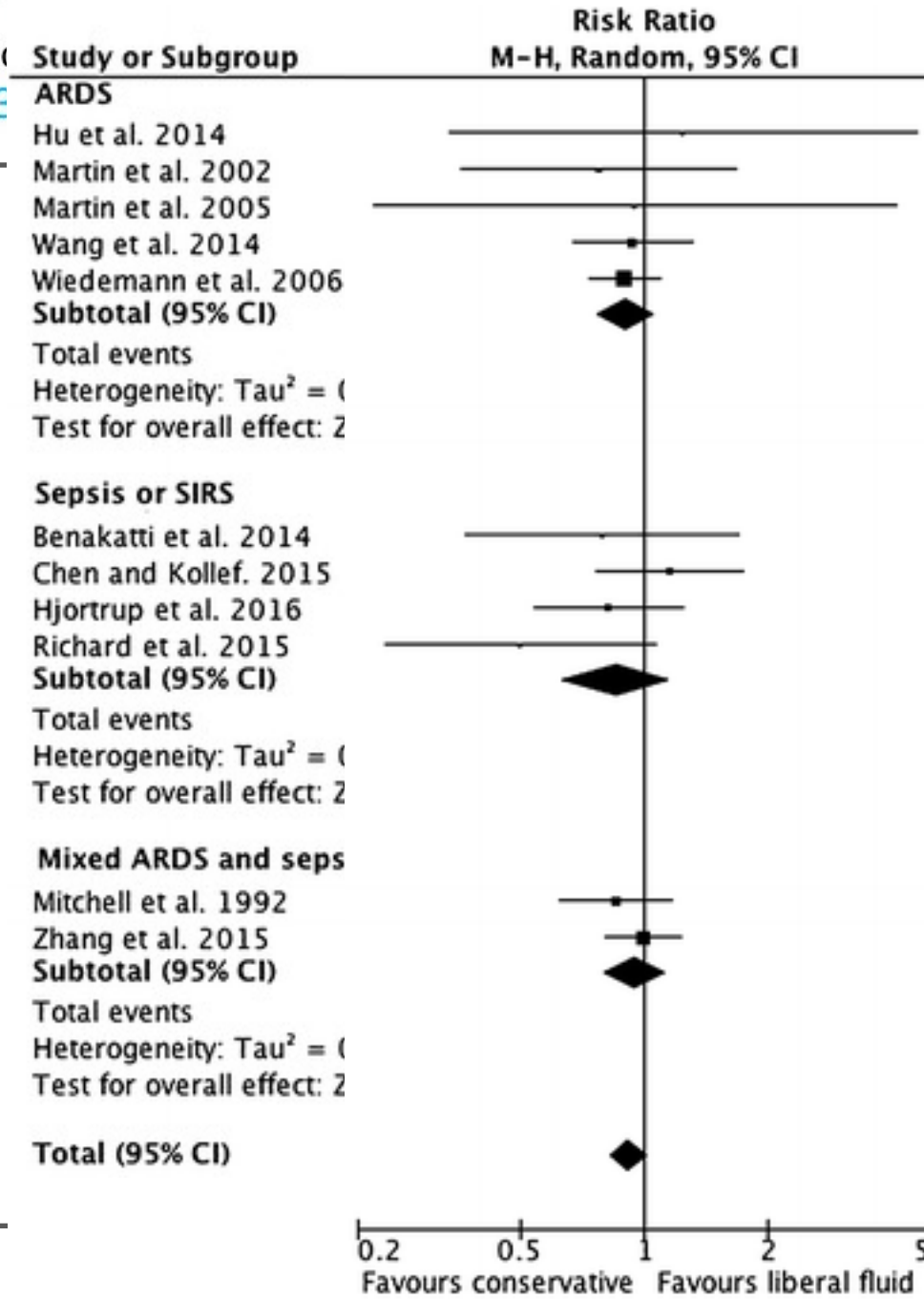


Association, causation, intervention

ARDS

- Conservative fluid management and/or **de-resuscitation**

- Shorter ICU LOS
- More ventilator free days
- But impact on mortality is not significant/definitive



Silversides, J.A., et al. Conservative fluid management or deresuscitation for patients with sepsis or acute respiratory distress syndrome following the resuscitation phase of critical illness: a systematic review and meta-analysis. Intensive Care Med 43, 155–170 (2017).

Lung ultrasound guided fluid therapy

- Lung ultrasonography-guided management, exclusively or in concert with other diagnostic modalities, is associated with a reduced cumulative fluid balance.

Heldeweg MLA, et al. Effects of Lung Ultrasonography-Guided Management on Cumulative Fluid Balance and Other Clinical Outcomes: A Systematic Review. Ultrasound Med Biol. 2021 May;47(5):1163-1171.

Lung ultrasound guided fluid therapy

- Lung ultrasonography-guided management, exclusively or in concert with other diagnostic modalities, is associated with a reduced cumulative fluid balance.
- No consistent effect on clinical outcomes.
  - Lower length of stay in the guided group (Mozzini et al., 2018; Öhman et al., 2018).
  - Fewer days of mechanical ventilation in the guided group (Pontet et al., 2019).
  - Lower hospital mortality (Baker et al., 2020; Wang et al., 2018)

Heldeweg MLA, et al. Effects of Lung Ultrasonography-Guided Management on Cumulative Fluid Balance and Other Clinical Outcomes: A Systematic Review. Ultrasound Med Biol. 2021 May;47(5):1163-1171.

Crystalloid Liberal or Vasopressors Early (CLOVERS)

- Prevention and Early Treatment of Acute Lung Injury (PETAL) network, started in 2018
- Crystalloid resuscitation first (liberal fluid group)
  - 2 L infusion upon enrollment.
  - 500ml fluid boluses (triggers) until 5 L (or signs of volume overload)
  - "Rescue vasopressors" after 5 L of fluid (or other predefined rescue criteria)
- Vasopressors first (restrictive fluid group)
  - Norepinephrine to maintain MAP 65-75 mmHg
  - "Rescue fluids" in 500ml boluses (predefined criteria)

https://petalnet.org/studies/public/clovers last accessed: 11/12/2022

Crystalloid Liberal or Vasopressors Early (CLOVERS)

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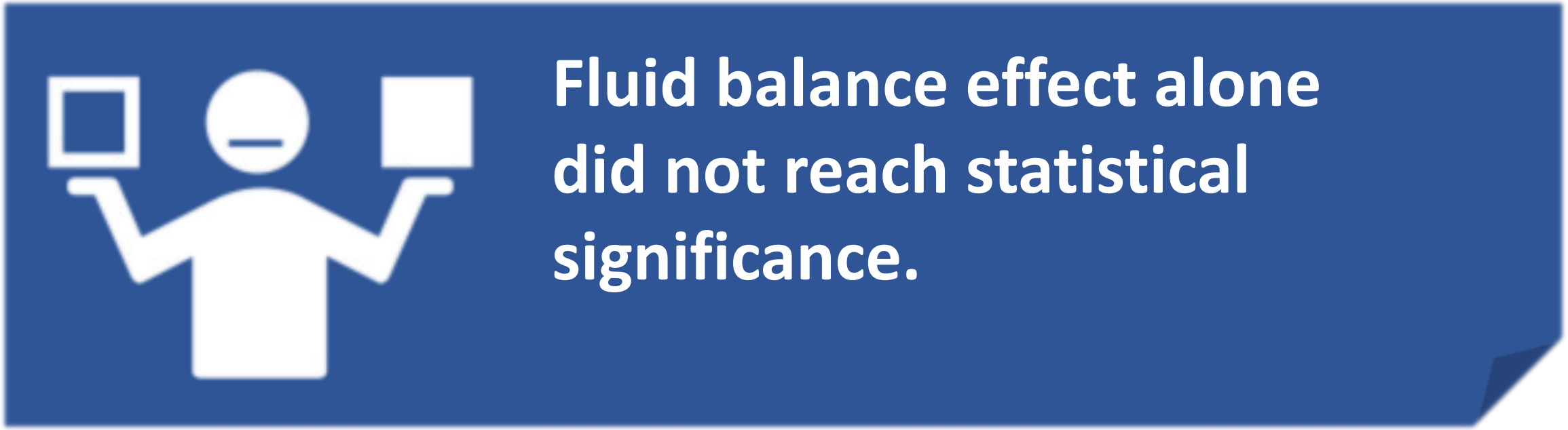
ECMO

- A more negative cumulative daily fluid balance was strongly associated with improved pulmonary compliance (2.72 ml/cmH2O per 1 L negative fluid balance);
- A more negative mean daily fluid balance was associated with improved pulmonary compliance (4.37 ml/cmH2O per 1 L negative fluid balance)
- Survivors were younger and had:
  - lower mean daily fluid balance (-0.33 L vs. -0.07 L)
  - lower cumulative fluid balance up to day 14 (-4.60 L vs. -1.00 L)

McCanny P, et al. Fluid Balance and Recovery of Native Lung Function in Adult Patients Supported by Venovenous Extracorporeal Membrane Oxygenation and Continuous Renal Replacement Therapy. ASAIO J. 2019

ECMO



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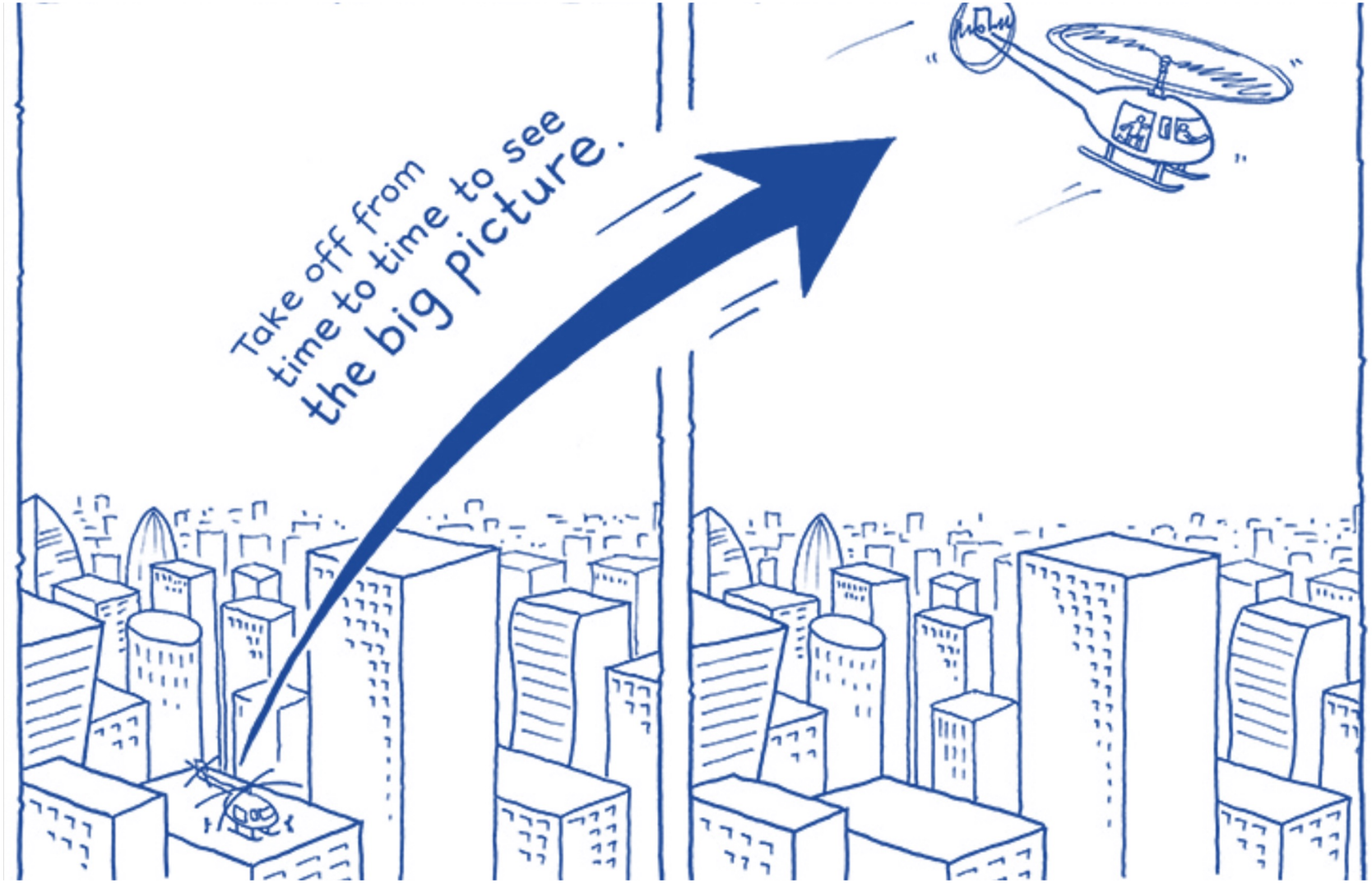

Take off from time to time to see the big picture.

Protocol v Standard care

- The Fluids After Bypass Study (n=715)
  - No difference in ICU length of stay, development of organ dysfunction, quality of life, or disability-free survival at any time points.
  - Hospital mortality was higher in the intervention group (4% vs 1.4%; p = 0.04).
- Patients in the intervention group:
  - received less bolus fluid (median [interquartile range], 1,000 mL [250-2,000 mL] vs 1,500 mL [500-2,500 mL]; p < 0.0001)
  - had a lower overall fluid balance (median [interquartile range], **319** mL [-284 to 1,274 mL] vs **673** mL [38-1,641 mL]; p < 0.0001)

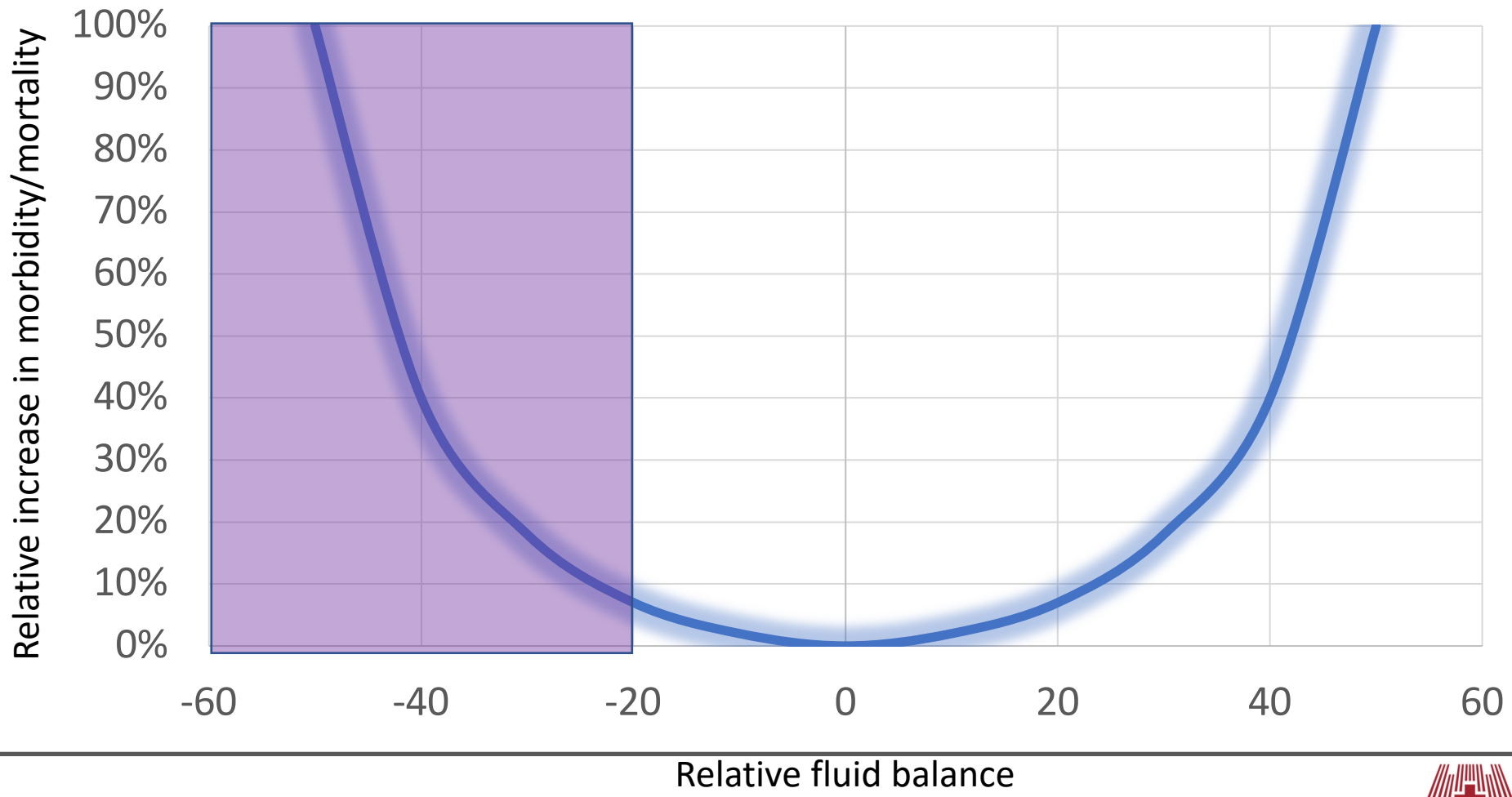
Parke RL, et al. Fluids After Bypass Study Investigators. A Multicenter, Open-Label, Randomized Controlled Trial of a Conservative Fluid Management Strategy Compared With Usual Care in Participants After Cardiac Surgery: The Fluids After Bypass Study. Crit Care Med. 2021

Protocols did not win because we became better!

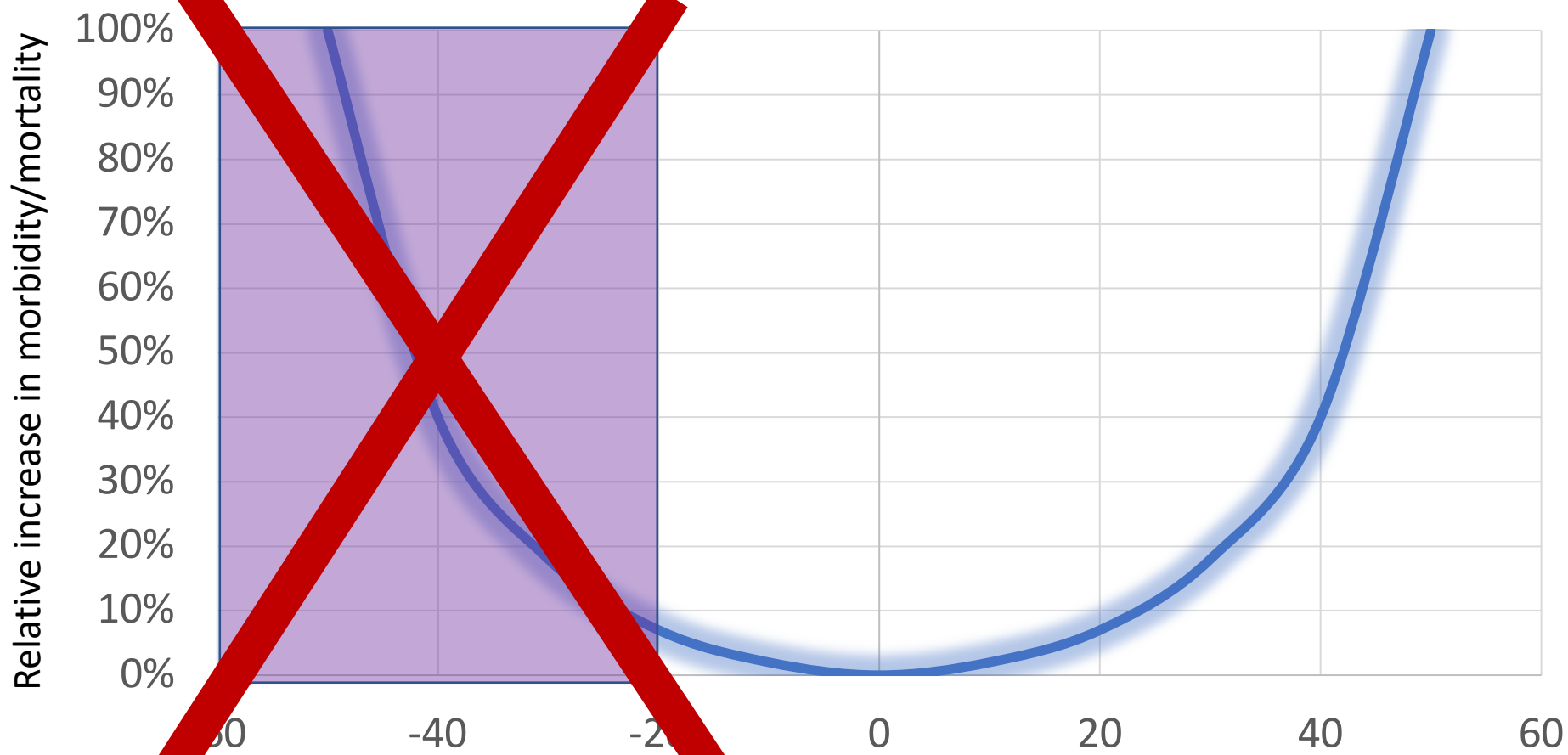
Positive fluid balance […] is widely recognized as a surrogate measure of illness severity and thus may be less amenable to practice change.

Yoo MS, et al. Association of Positive Fluid Balance at Discharge After Sepsis Management With 30-Day Readmission. *JAMA Netw Open.* 2021

The lung: is there the “dry-side”?



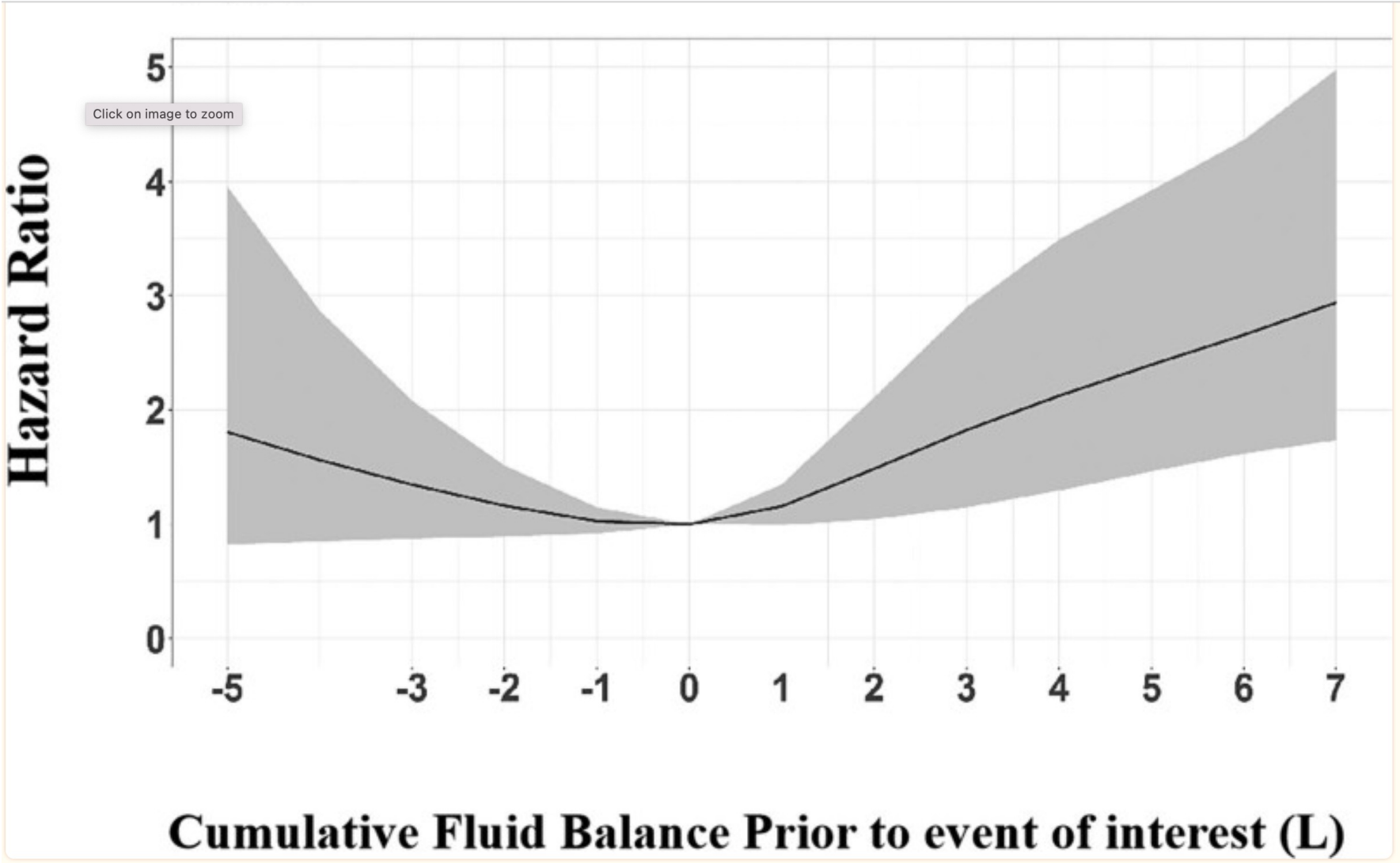
No ICU evidence of harm!!!



Should there be a speed limit to fluid removal?

A signal of harm with aggressive fluid offloading

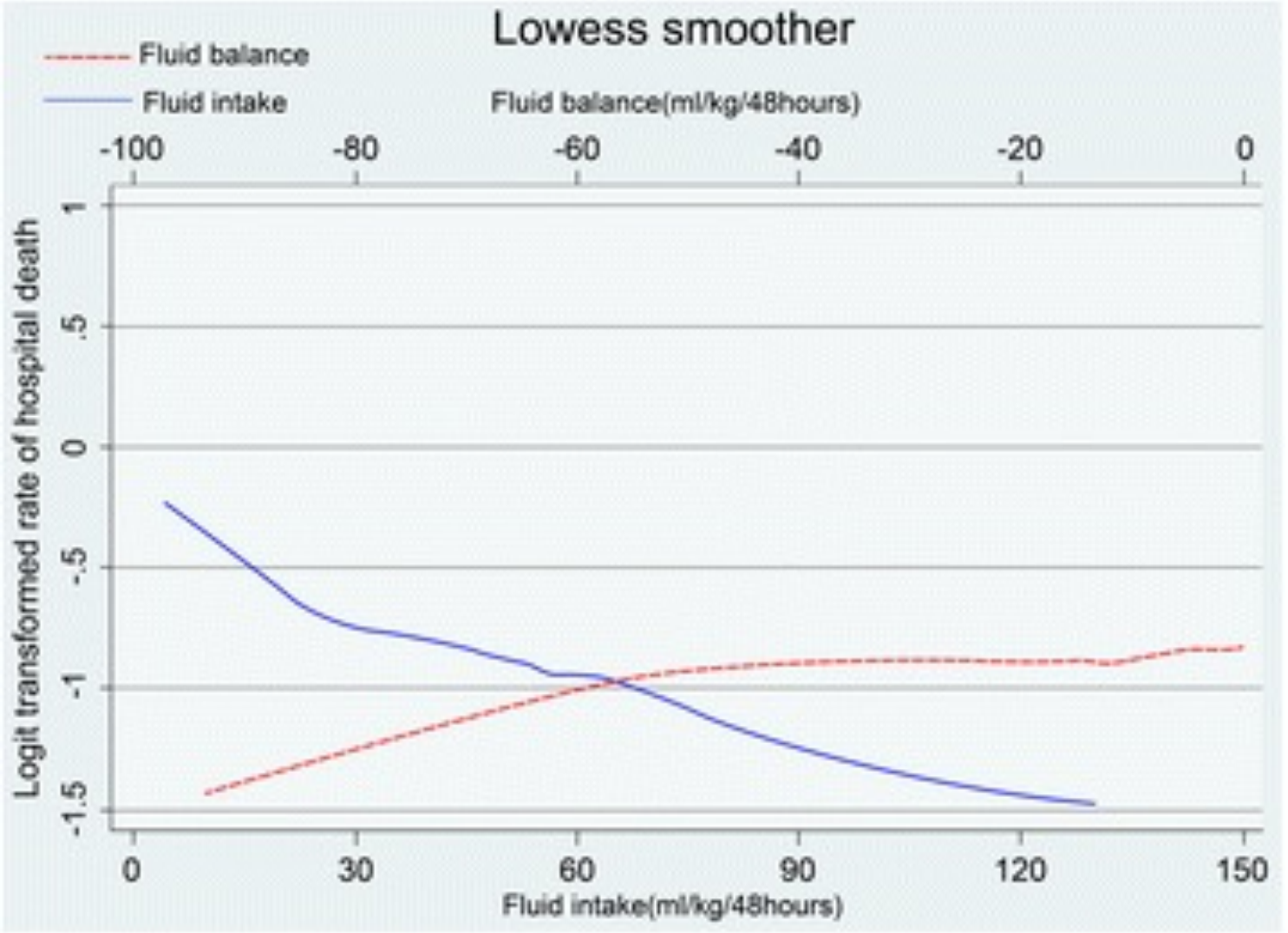
1,528 ventilator-associated event cases with 3,038 matched controls



Wang W, Zhu S, He Q, Wang M, Kang Y, Zhang R, Ji P, Zou K, Klompas M, Zong Z, Sun X. Fluid Balance and Ventilator-Associated Events Among Patients Admitted to ICUs in China: A Nested Case-Control Study. Crit Care Med. 2022 Feb 1;50(2):307-316.

A signal of harm if FB is already negative

(n=2068)

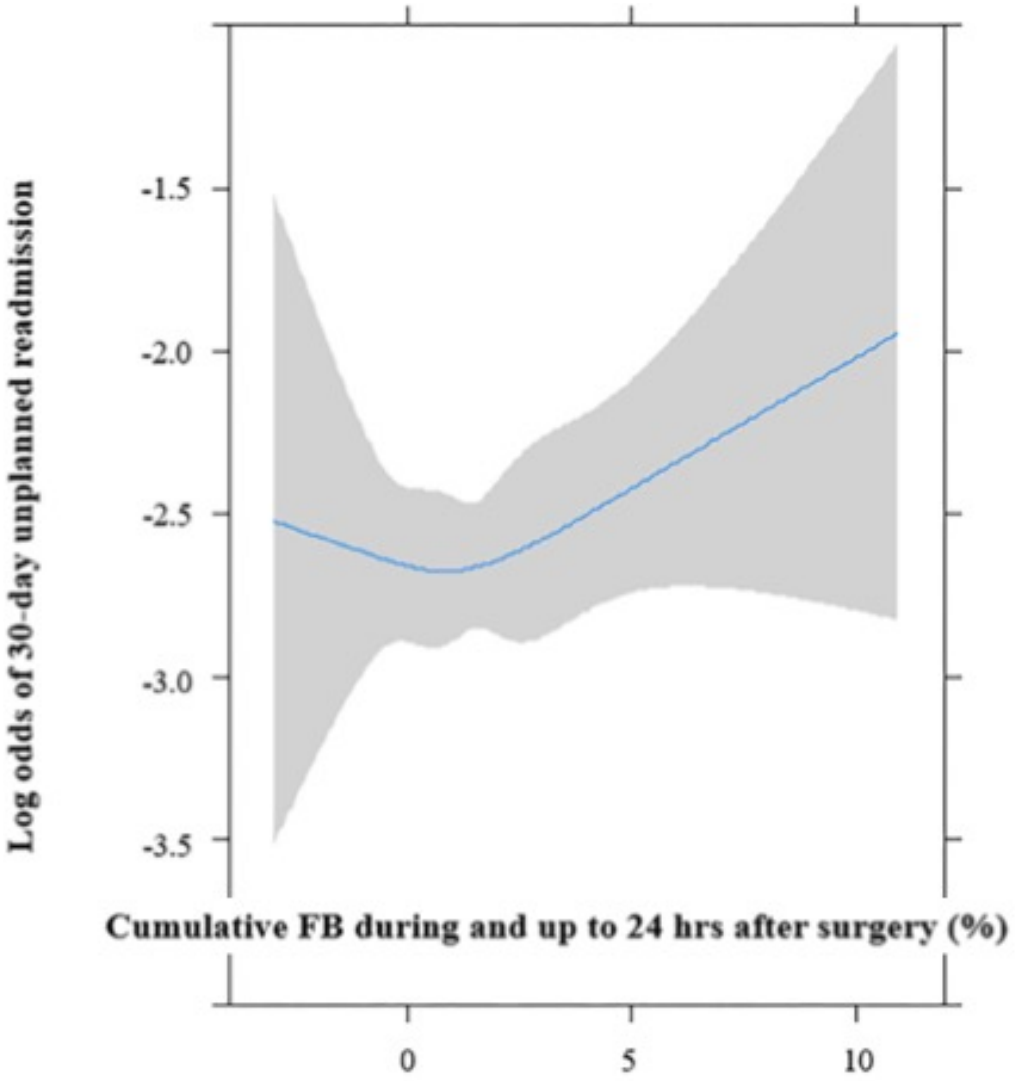


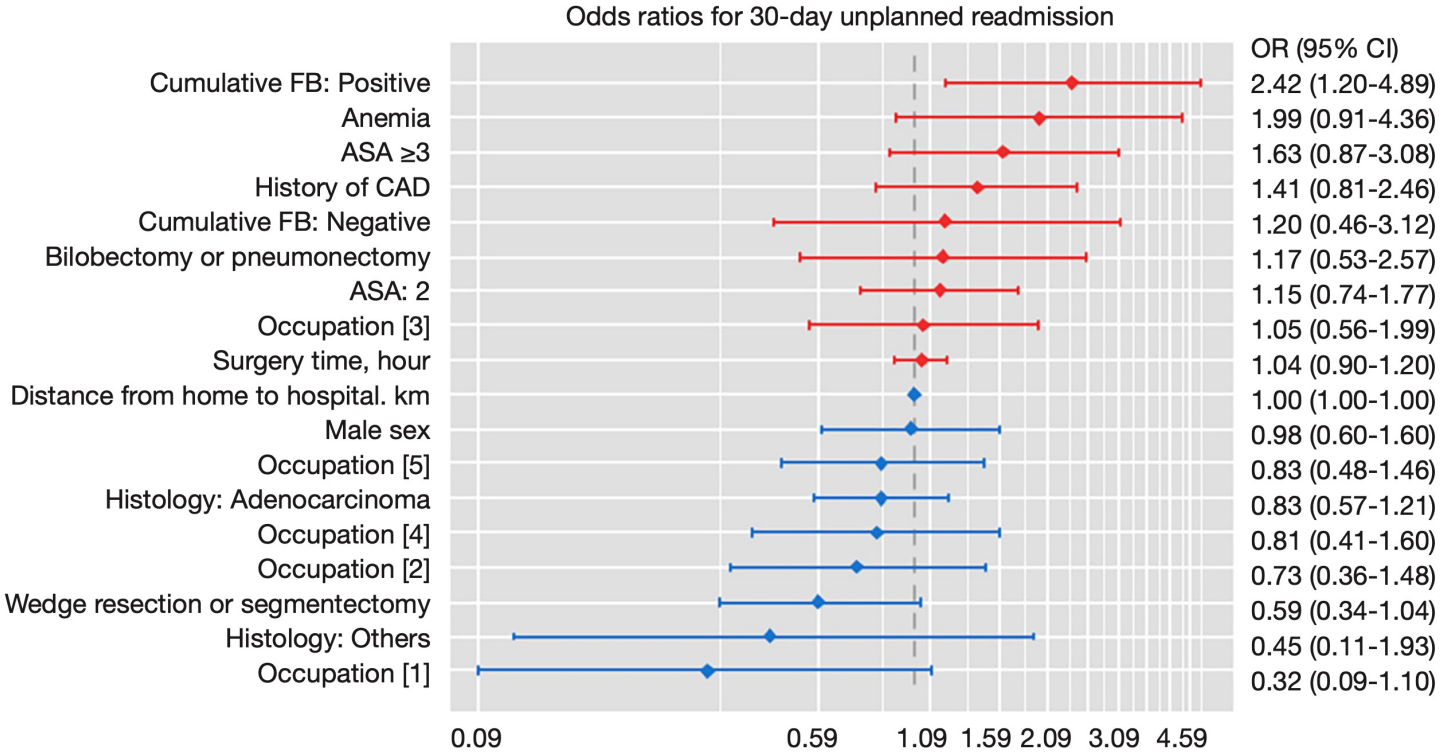
Shen, Y., Huang, X. & Zhang, W. Association between fluid intake and mortality in critically ill patients with negative fluid balance: a retrospective cohort study. Crit Care 21, 104 (2017).

What happens after ICU

The most common cause for ICU readmission was respiratory insufficiency or failure, accounting for 18% to 59% of all readmitted patients

Mcneill H, Khairat S. Impact of Intensive Care Unit Readmissions on Patient Outcomes and the Evaluation of the National Early Warning Score to Prevent Readmissions: Literature Review. JMIR Perioper Med. 2020 May 8;3(1):e13782.





Oh TK, et al. Perioperative fluid balance and 30-day unplanned readmission after lung cancer surgery: a retrospective study. J Thorac Dis 2020

Healthy volunteers

- Exercise and fluid restriction induced mild dehydration
  - 2.7 ± 0.7% and 2.5 ± 0.4% body mass loss respectively

- Dehydration across all four trials resulted in:
  - Reduction in FVC (152 ± 143 mL, $P < 0.01$)
  - Increase in RLV (216 ± 177 mL, $P < 0.01$) and FRC (130 ± 144 mL, $P < 0.01$)

Marshall H, et al. Systemic but not local rehydration restores dehydration-induced changes in pulmonary function in healthy adults. J Appl Physiol. 2021

Healthy volunteers

Changes were normalized by
fluid consumption
but not nebulization.

Marshall H, et al. Systemic but not local rehydration restores dehydration-induced changes in pulmonary function in healthy adults. J Appl Physiol. 2021

Pneumonia - the single RCT

- Hospitalised adults with CAP:
  - individualised education programme,
  - conventional information.
- Secondary outcomes suggested:
  - Improved fluid intake >1.5 L/day (RR 1.88)
  - Improved physical activity and smoking
- Primary composite outcome: additional healthcare visits and re-hospitalisation within 30 days of hospital discharge

Increase fluid intake, decrease alcohol, cease smoking, adhere to medications, update vaccines and manage pneumonia.

No effect on drug therapy, pneumococcal or influenza vaccinations or alcohol cessation.

Adamuz, et al. Impact of an educational program to reduce healthcare resources in community-acquired pneumonia: the EDUCAP randomized controlled trial. PLoS One. 2015

Pneumonia - the single RCT

43% in control group

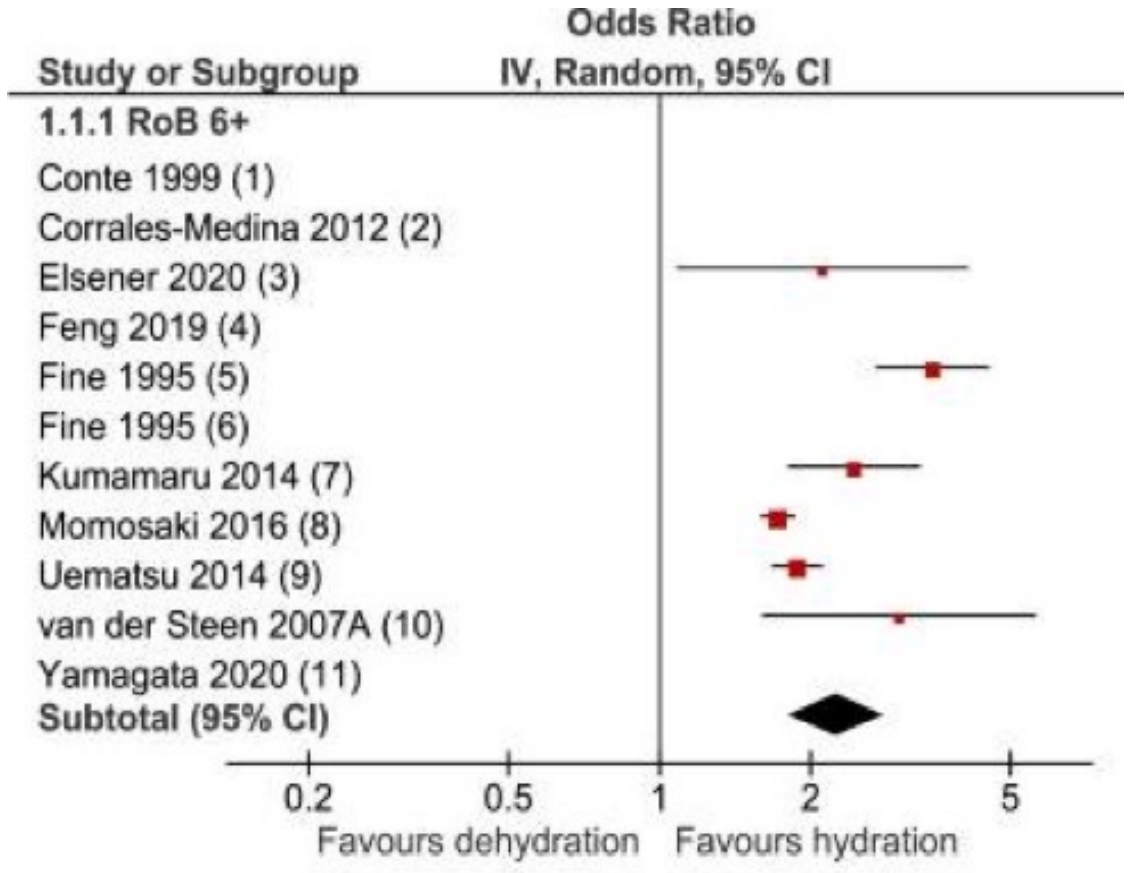
24% in intervention group

RR 0.55 (95% CI 0.36 to 0.83)

- Primary composite outcome: additional healthcare visits and re-hospitalisation within 30 days of hospital discharge

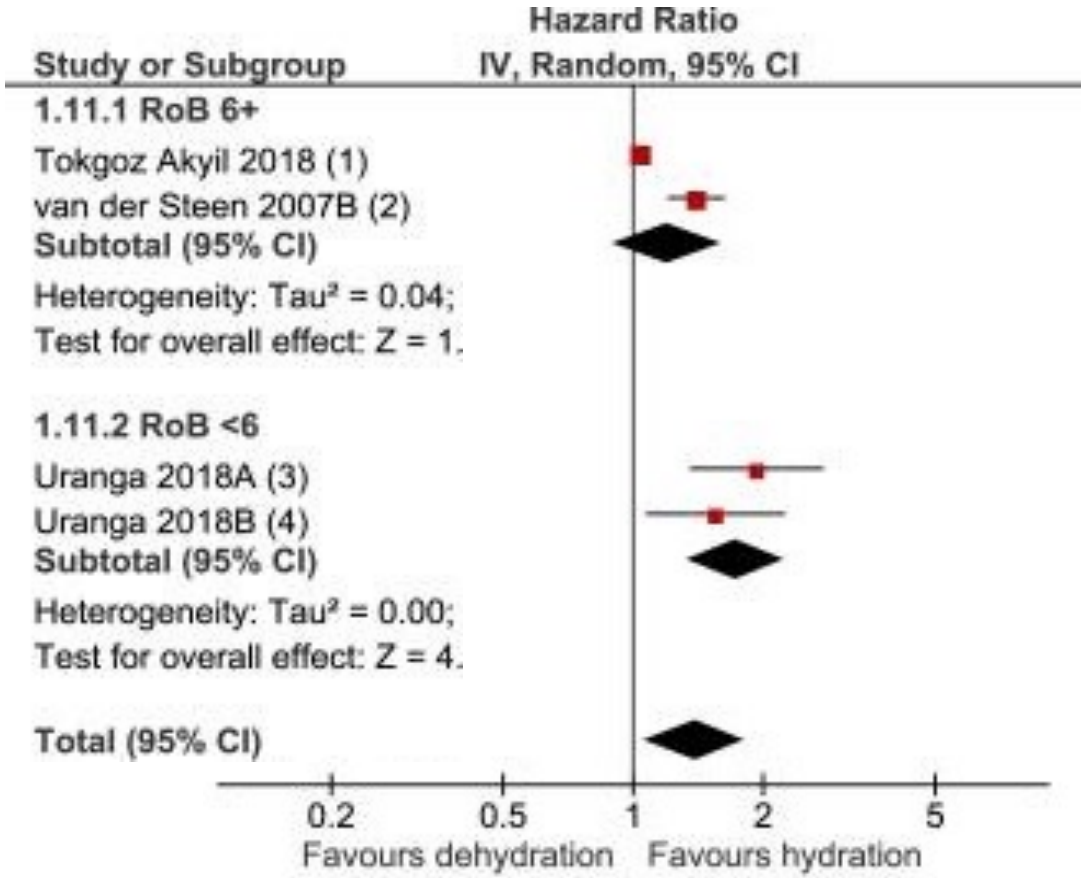
Adamuz, et al. Impact of an educational program to reduce healthcare resources in community-acquired pneumonia: the EDUCAP randomized controlled trial. PLoS One. 2015

Pneumonia: mid-term mortality



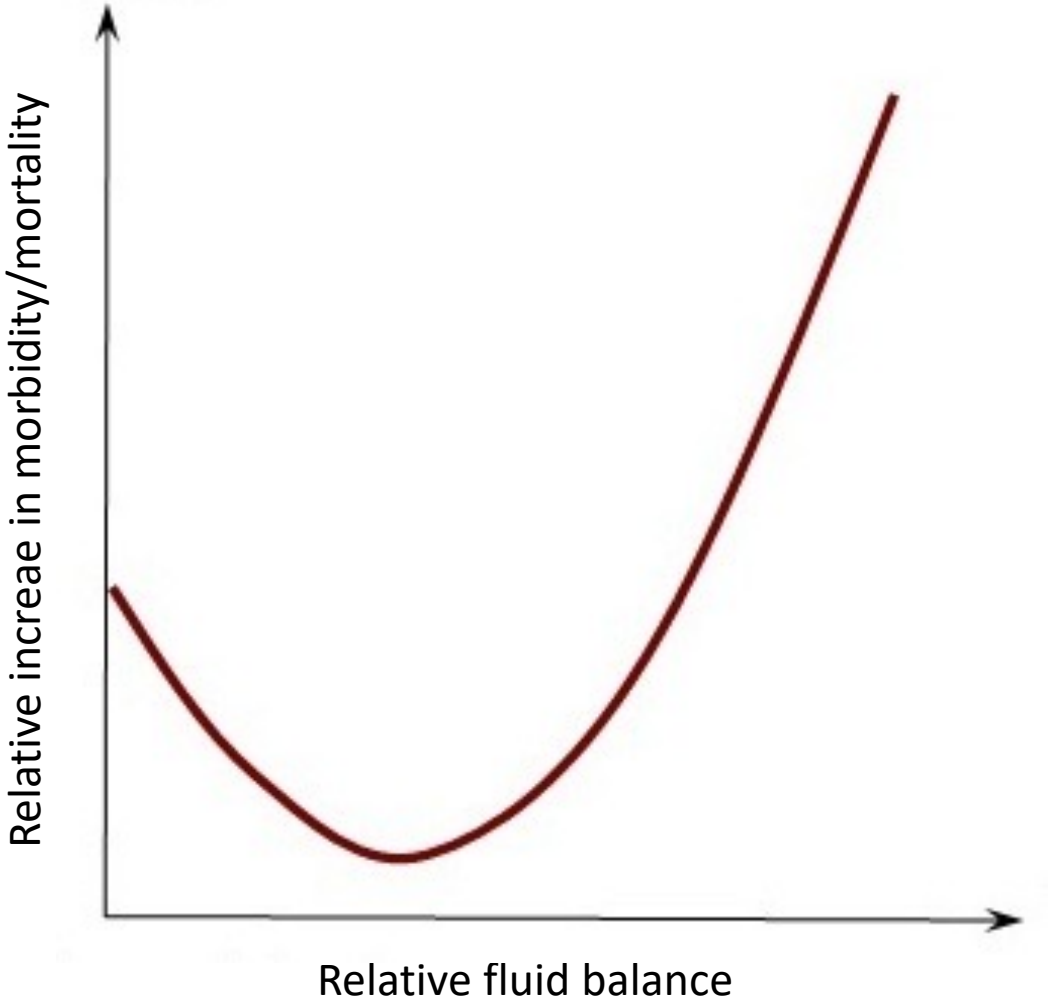
Hooper L, et al. Effects of fluid and drinking on pneumonia mortality in older adults: A systematic review and meta-analysis. Clin Nutr ESPEN. 2022

Pneumonia: long-term mortality



Supporting hydration and reversing dehydration has the potential to have rapid positive impacts on pneumonia outcomes.

Hooper L, et al. Effects of fluid and drinking on pneumonia mortality in older adults: A systematic review and meta-analysis. Clin Nutr ESPEN. 2022



Fluids and lungs

- More like a “J” shaped curve
- Drier isn’t always better
- Be mindful of long-term outcomes

Hooper L, et al. Effects of fluid and drinking on pneumonia mortality in older adults: A systematic review and meta-analysis. Clin Nutr ESPEN. 2022