

# Gestion du remplissage vasculaire dans le SDRA

Laurent Brochard



Avril 2012

# Remplissage vasculaire et SDRA

- Risque pulmonaire spécifique lié au remplissage
- Risque circulatoire spécifique lié à la ventilation mécanique
- Autres effets du remplissage
- Rôle des index prédictifs de la réponse au remplissage
- Effet sur la durée de ventilation

The Lancet · Saturday 12 August 1967

**ACUTE RESPIRATORY DISTRESS  
IN ADULTS**

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THOMAS L. PETTY  
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ASSISTANT PROFESSOR OF MEDICINE

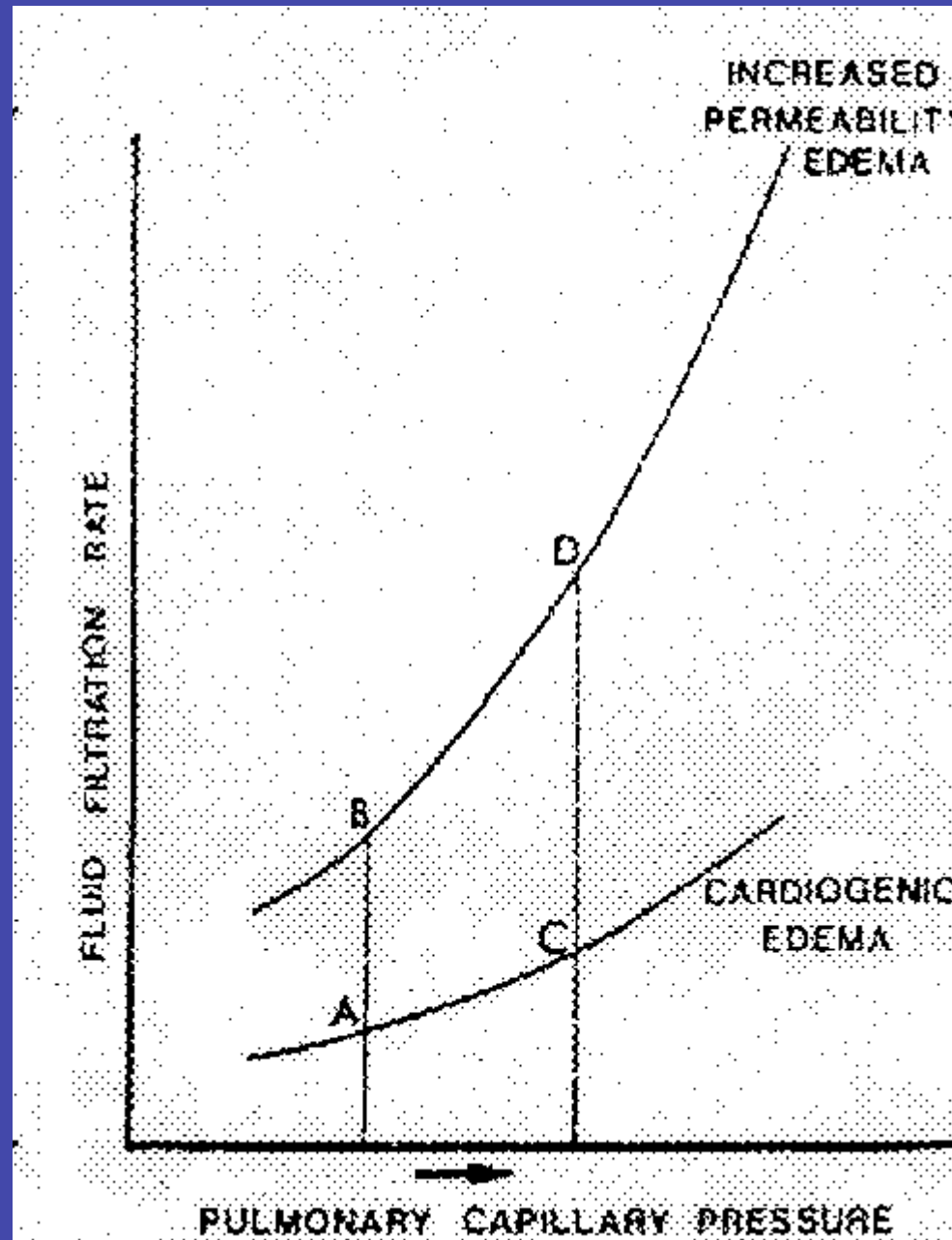
BERNARD E. LEVINE  
M.D. Michigan

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FELLOW IN PULMONARY DISEASE\*

*Summary* The respiratory-distress syndrome in 12 patients was manifested by acute onset of tachypnoea, hypoxaemia, and loss of compliance after a variety of stimuli; the syndrome did not respond to usual and ordinary methods of respiratory therapy. The clinical and pathological features closely resembled those seen in infants with respiratory distress and to conditions in congestive atelectasis and postperfusion lung. The theoretical relationship of this syndrome to alveolar surface active agent is postulated. Positive end-expiratory pressure was most helpful in combating atelectasis and hypoxaemia. Corticosteroids appeared to have value in the treatment of patients with fat-embolism and possibly viral pneumonia.

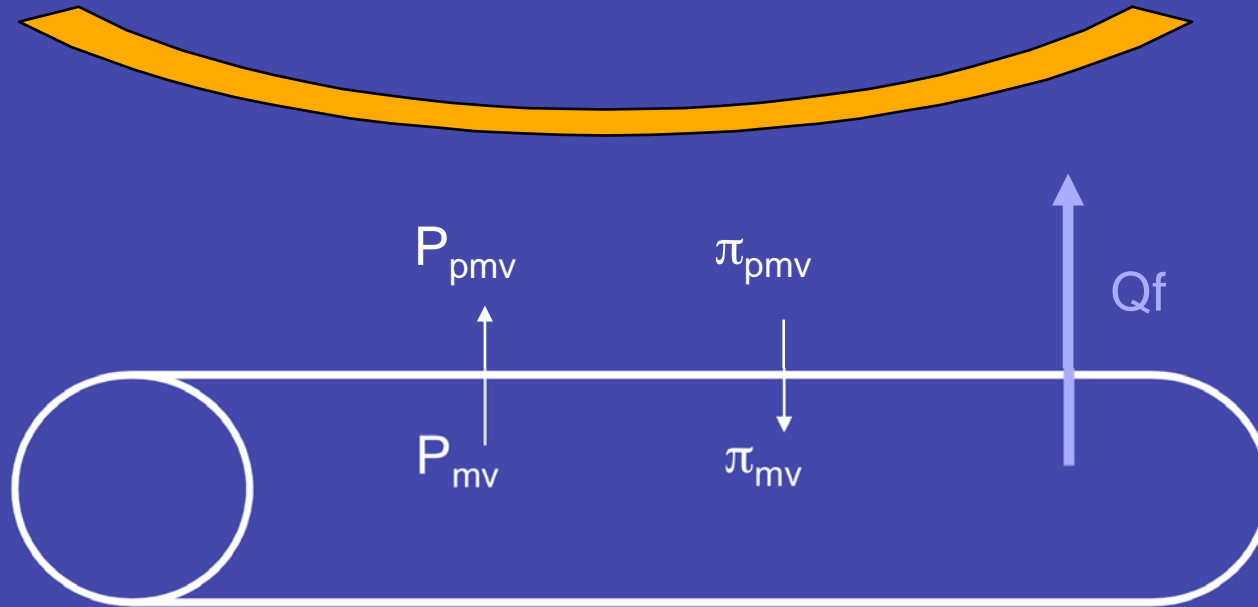
TABLE 1—ACUTE RESPIRATORY DISTRESS

| Case | Age (yr.) | Sex | Illness   | Onset of acute respiratory distress (hr. after illness) | Possible contributory factors |          |                  |
|------|-----------|-----|---|---|-------------------------------|----------|------------------|
|      |           |     |   |   | Hypotension                   | Acidosis | Fluid overload   |
| 1    | 29        | M   | Multiple trauma; lung contusion                   | 8   | ++                            | ++       | +++<br>7500 ml.  |
| 2    | 19        | F   | Multiple trauma; lung laceration and contusion    | 1   | +++                           | ++       | +++<br>3000 ml.  |
| 3    | 19        | F   | Multiple trauma and fractures; fat-embolism       | 72  | +                             | ..       | ..               |
| 4    | 25        | M   | Shotgun wound to abdomen                          | 96  | +++                           | +        | +++<br>9000 ml.  |
| 5    | 11        | M   | Blunt chest injury; lung contusion                | 1   | ..                            | ++       | ..               |
| 6    | 43        | F   | Acute pancreatitis                                | 48  | +++                           | +++      | +++<br>5000 ml.  |
| 7    | 23        | F   | ? viral pneumonia                                 | 48  | ..                            | ..       | ..               |
| 8    | 39        | F   | Drug ingestion; ? viral pneumonia                 | 24  | ..                            | ..       | ++               |
| 9    | 19        | F   | Guillain-Barre; ? viral pneumonitis               | 96  | ..                            | ..       | ++               |
| 10   | 18        | M   | Multiple trauma; crushed chest; severe concussion | 1   | ..                            | ..       | ..               |
| 11   | 48        | F   | Drug ingestion; ? aspiration; ? viral pneumonia   | 48  | ..                            | ..       | +++<br>10328 ml. |
| 12   | 34        | M   | Gunshot wound left chest                          | 96  | ..                            | ..       | ..               |



Staub NC Chest 1978

A



$$Q_f = K_f [(P_{mv} - P_{pmv}) - \sigma(\pi_{mv} - \pi_{pmv})]$$

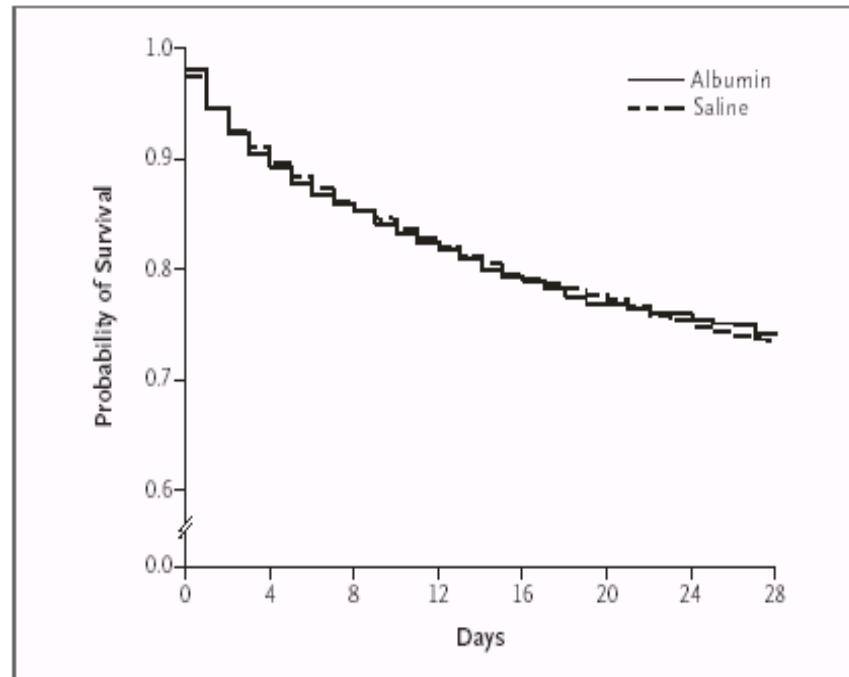
# Fluid loading & oncotic pressure

$$Q_f = K_f [(P_{mv} - P_{pmv}) - \sigma (\pi_{mv} - \pi_{pmv})]$$

ORIGINAL ARTICLE

## A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit

The SAFE Study Investigators\*



**Figure 1.** Kaplan–Meier Estimates of the Probability of Survival.

P=0.96 for the comparison between patients assigned to receive albumin and those assigned to receive saline.

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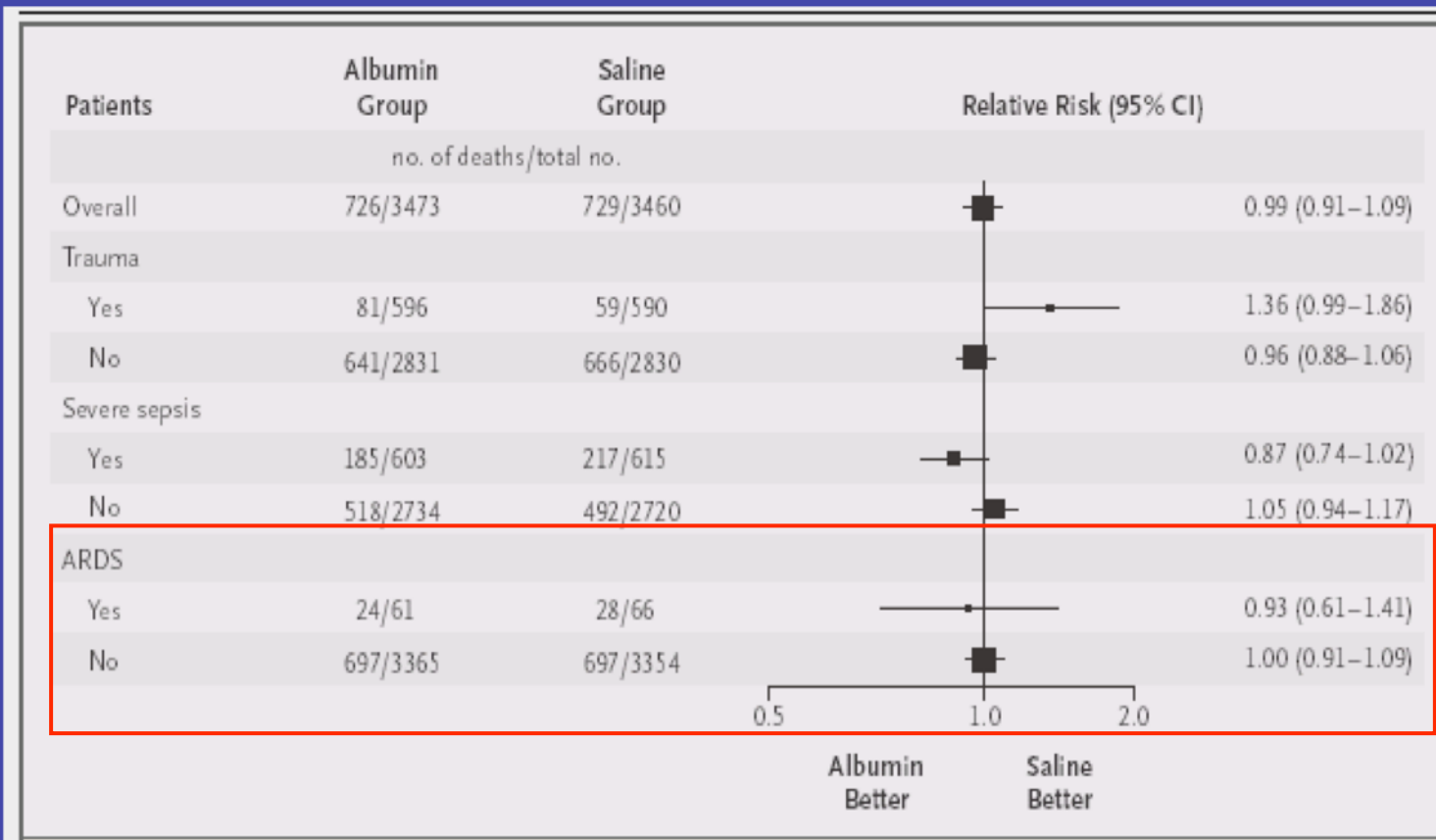
Table 3. Primary and Secondary Outcomes.\*

| Outcome                                      | Albumin Group   | Saline Group    | Relative Risk (95% CI) | Absolute Difference (95% CI) | P Value |
|--|-----------------|-----------------|------------------------|------------------------------|---------|
| Status at 28 days — no./total no. (%)        |                 |                 |                        |                              |         |
| Dead   | 726/3473 (20.9) | 729/3460 (21.1) | 0.99 (0.91 to 1.09)    |                              | 0.87    |
| Alive in ICU                                 | 111/3473 (3.2)  | 87/3460 (2.5)   | 1.27 (0.96 to 1.68)    |                              | 0.09    |
| Alive in hospital†                           | 793/3473 (22.8) | 848/3460 (24.5) | 0.93 (0.86 to 1.01)    |                              | 0.10    |
| Length of stay in ICU — days                 | 6.5±6.6         | 6.2±6.2         |                        | 0.24 (−0.06 to 0.54)         | 0.44    |
| Length of stay in hospital — days†           | 15.3±9.6        | 15.6±9.6        |                        | 0.24 (−0.70 to 0.21)         | 0.30    |
| Duration of mechanical ventilation — days    | 4.5±6.1         | 4.3±5.7         |                        | 0.19 (−0.08 to 0.47)         | 0.74    |
| Duration of renal-replacement therapy — days | 0.48±2.28       | 0.39±2.0        |                        | 0.09 (−0.0 to 0.19)          | 0.41    |

ORIGINAL ARTICLE

## A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit

The SAFE Study Investigators\*



# CRYCO

- Prospective cohort study
- Consecutive adult patients admitted in 115 ICUs (30 countries) during a 4 week-period and needing fluid resuscitation for shock in the intensive care unit

# 736 patients with shock

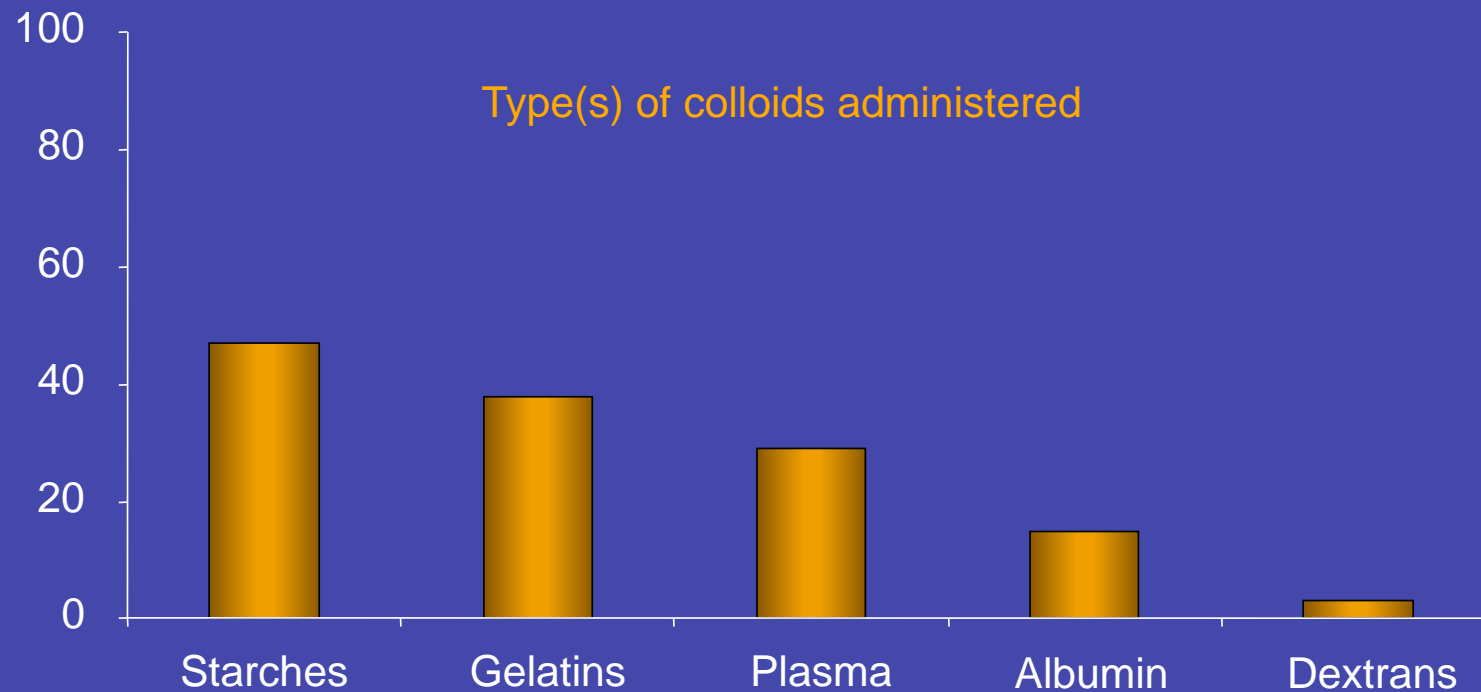


611 receiving colloids



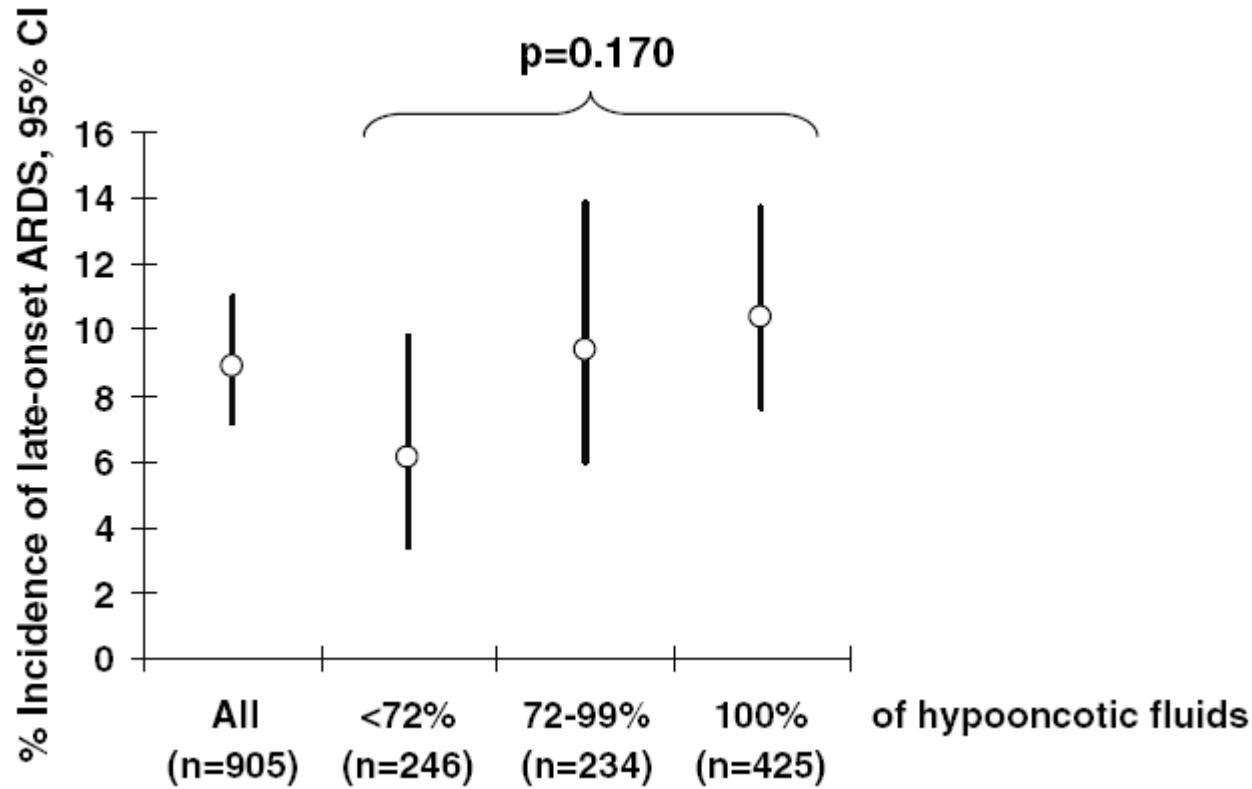
125 receiving crystalloids

% of patients

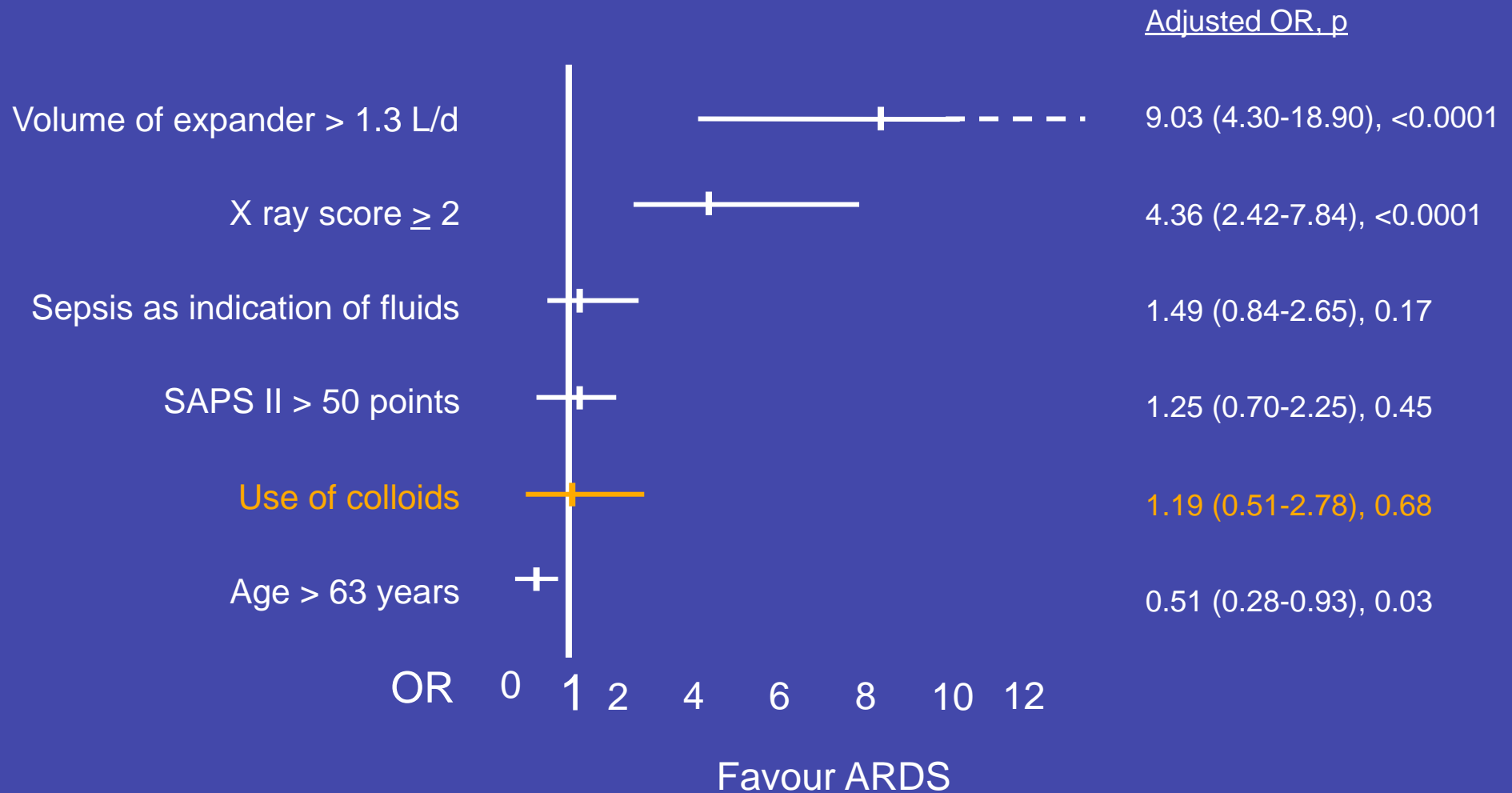


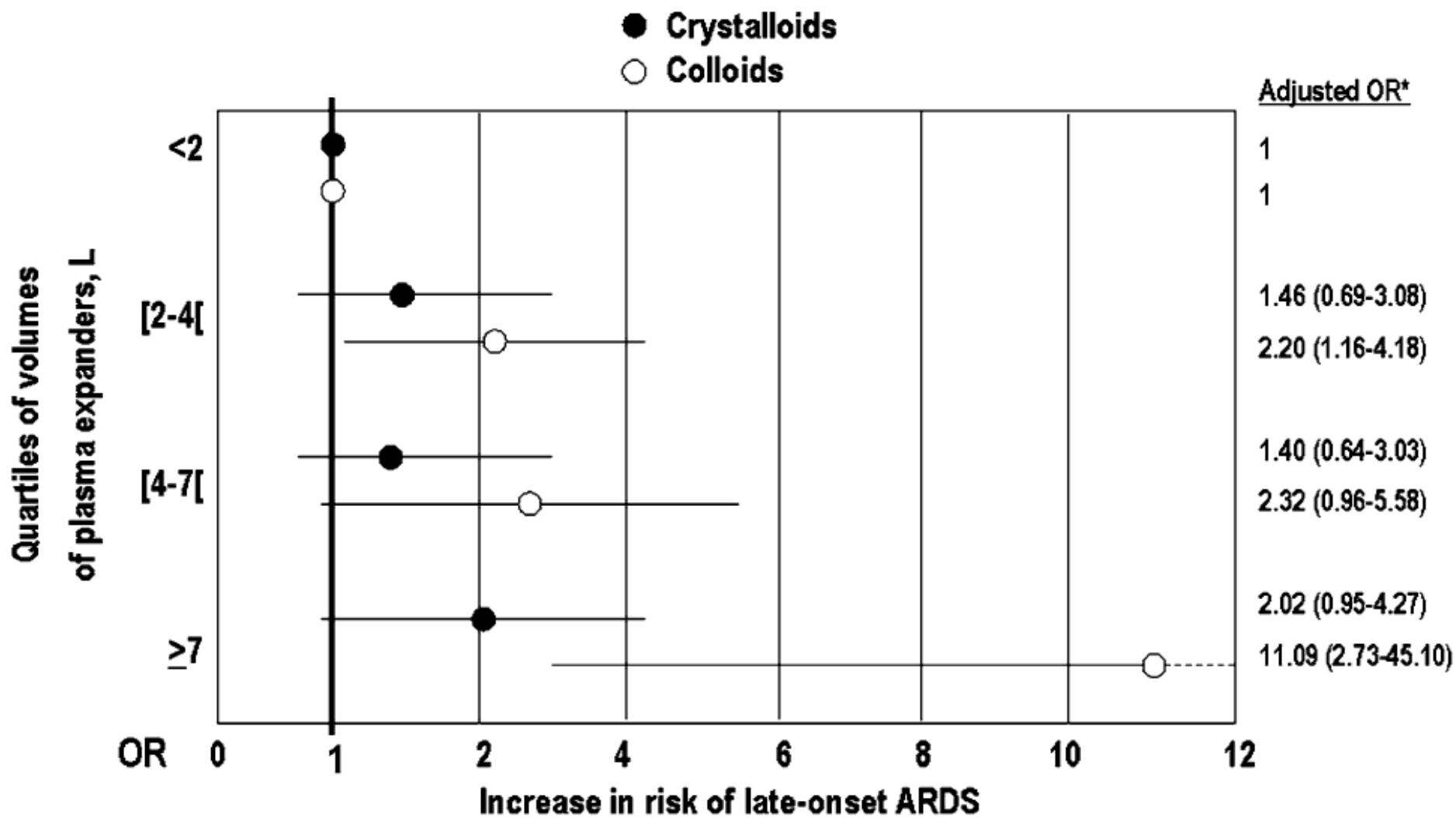
Frédérique Schortgen  
Emmanuelle Girou  
Nicolas Deye  
Laurent Brochard  
For the CRYCO Study Group

## Do hyponcotic fluids for shock increase the risk of late-onset acute respiratory distress syndrome?



# Risk factors for late ARDS: multivariate analysis





# Remplissage vasculaire et SDRA

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# Mechanical Ventilation in the Chest

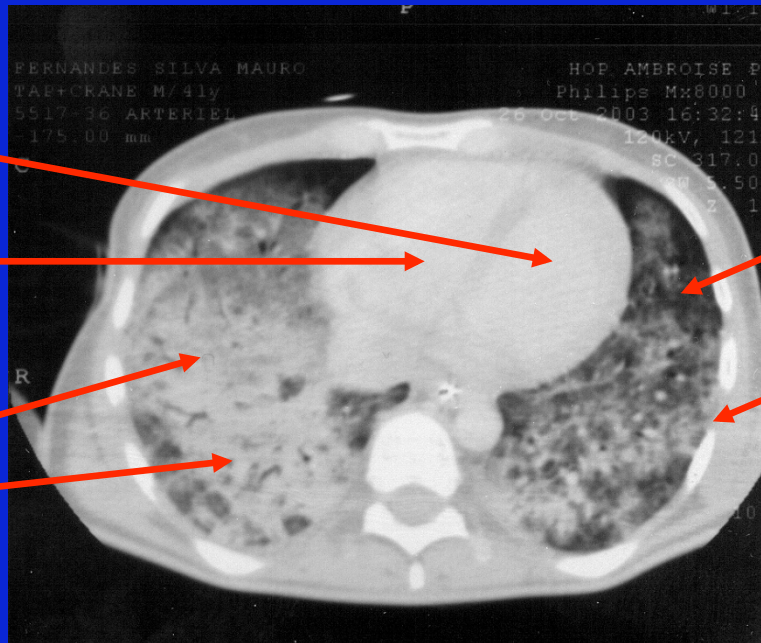
Left Heart

Right Heart

Abnormal Lungs  
Capillaries

Healthy lungs

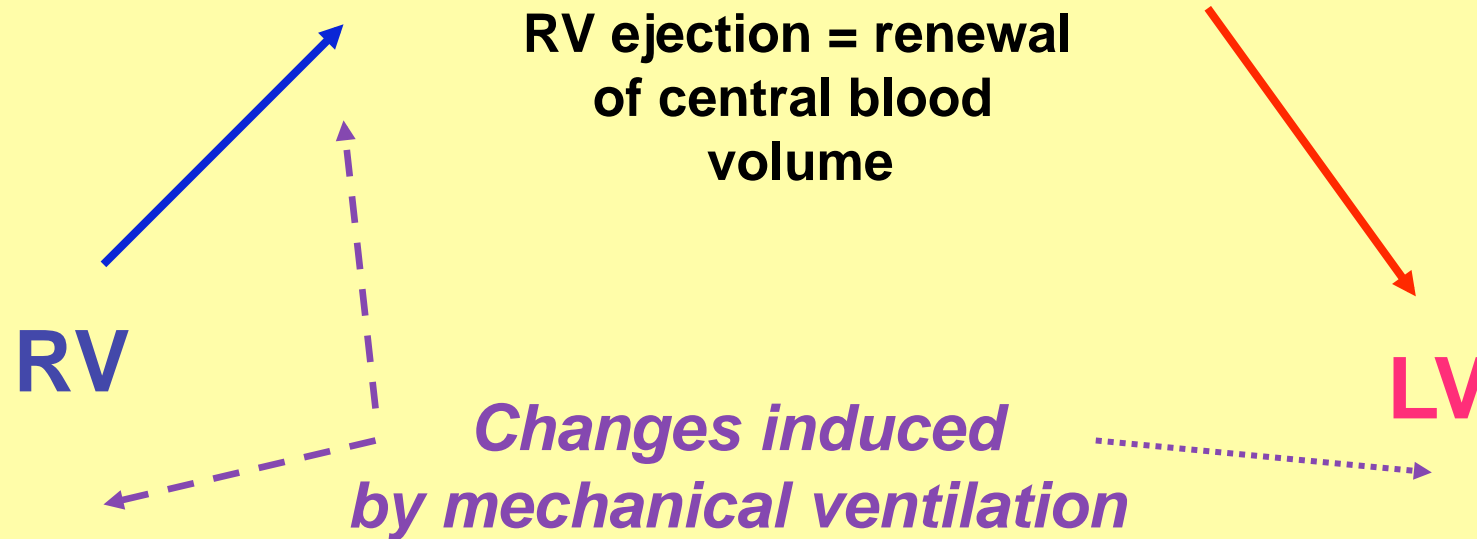
Chest wall



## Central blood volume

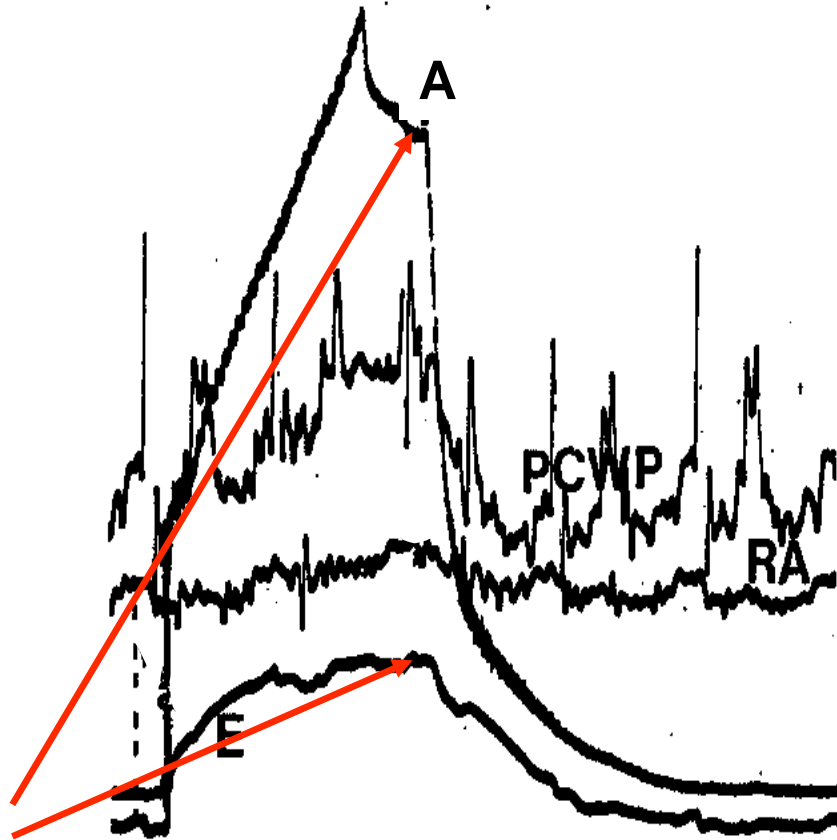
Pulmonary arteries: 80 ml  
Pulmonary capillaries: 120 ml  
Pulmonary veins: 300ml

(500 ml)



INSP.

EXP.



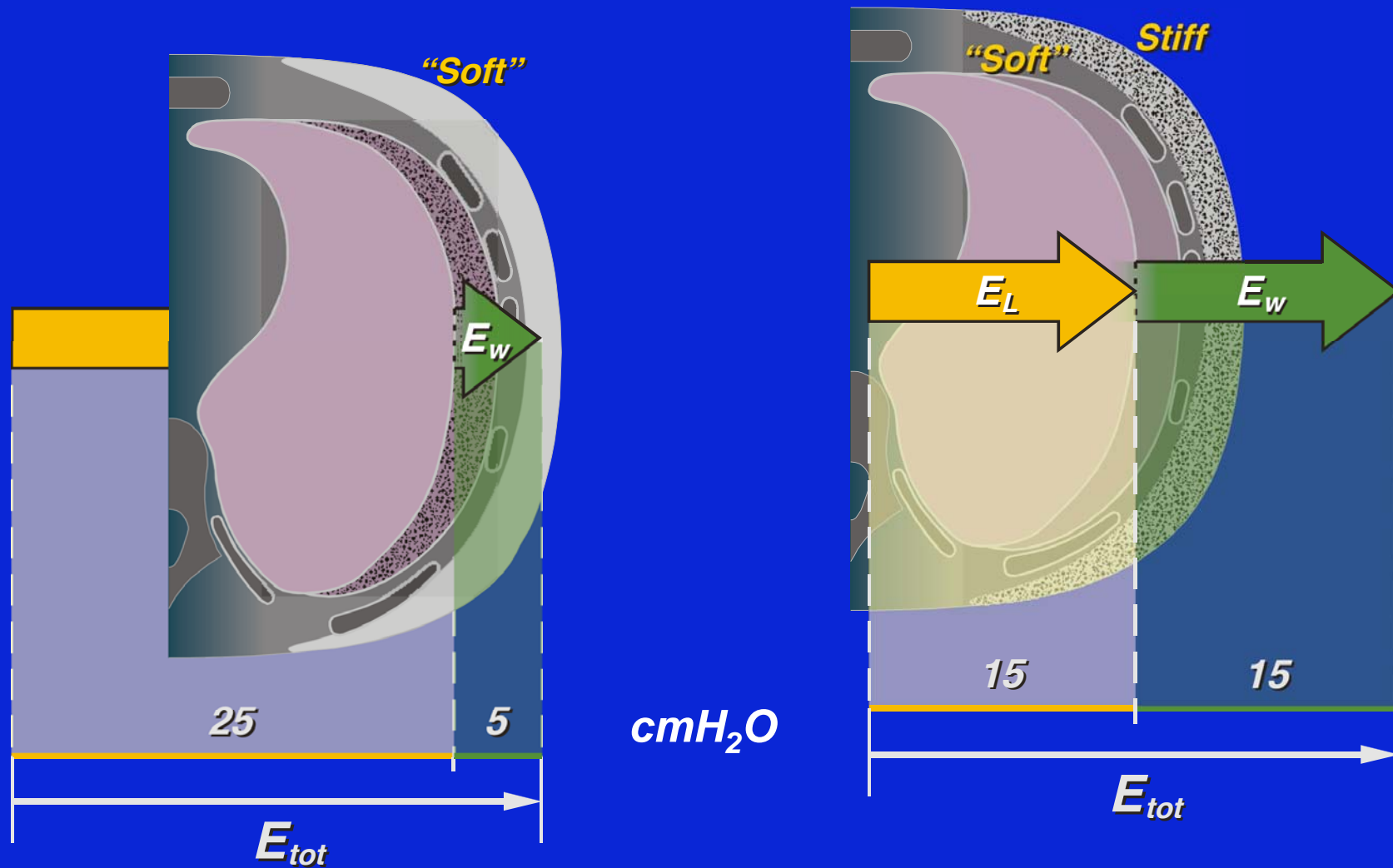
## ***Pressure changes induced by Mechanical Ventilation***

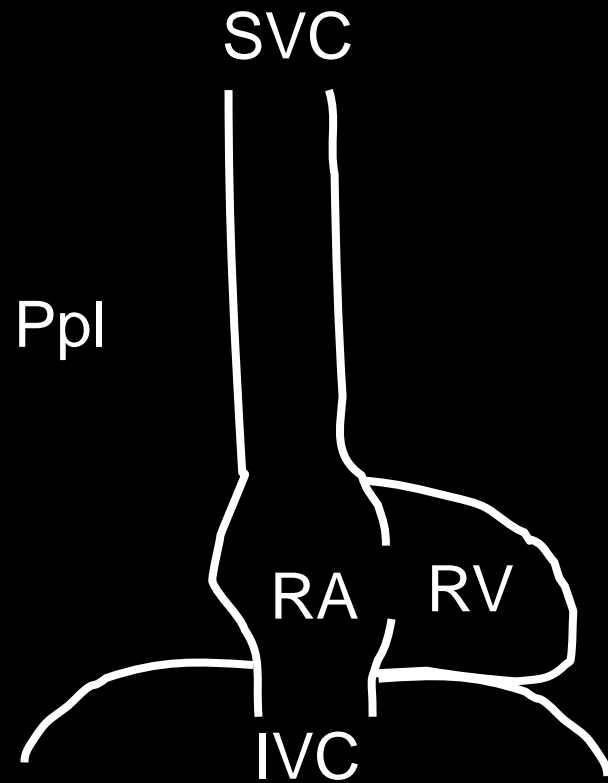
***Marked increase in alveolar pressure (A)***

***Modest increase in esophageal (E) (pleural) pressure***

***ZONE III :  $P_{PV} > P_{ALV}$***

# Chest wall elastance





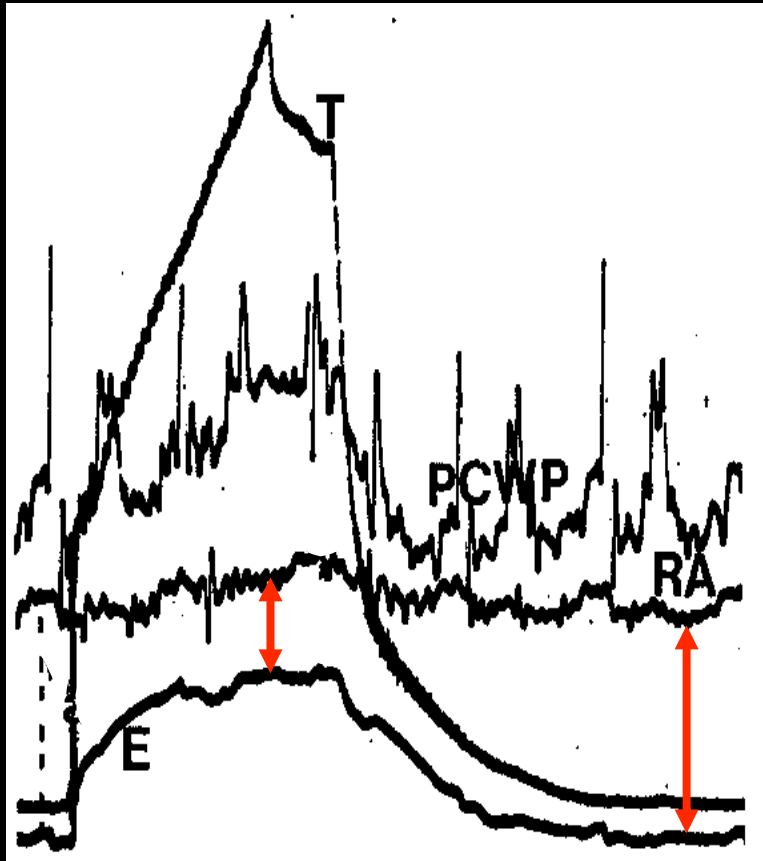
SVC is a vessel  
susceptible  
to collapse

$$P_{\text{dist}} > P_{\text{crit}}$$

$$P_{\text{dist}} = RA - P_{\text{pl}}$$

INSP.

EXP.



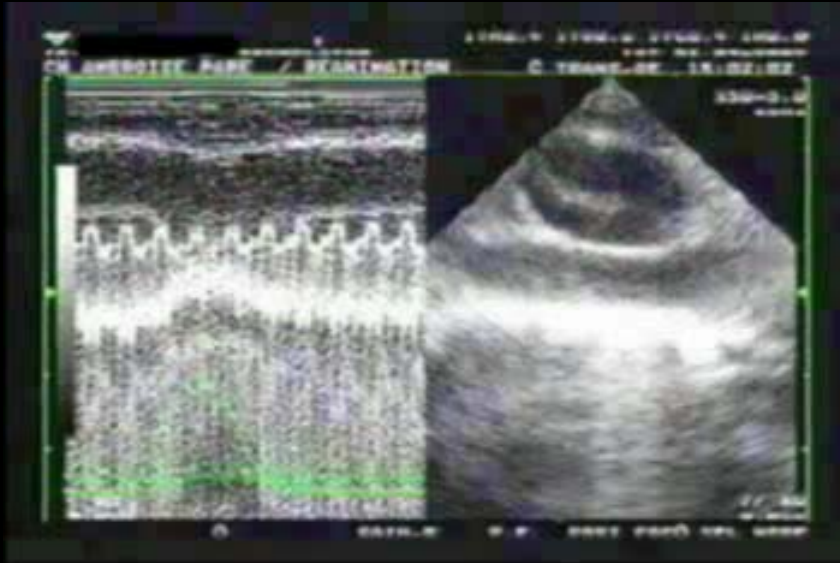
*Distending pressure = RA - Ppl*

**SVC Collapse**

**ZONE II :  $P_{ALV} > P_{PV}$**

**ZONE III :  $P_{PV} > P_{ALV}$**

# HYPOVOLEMIA

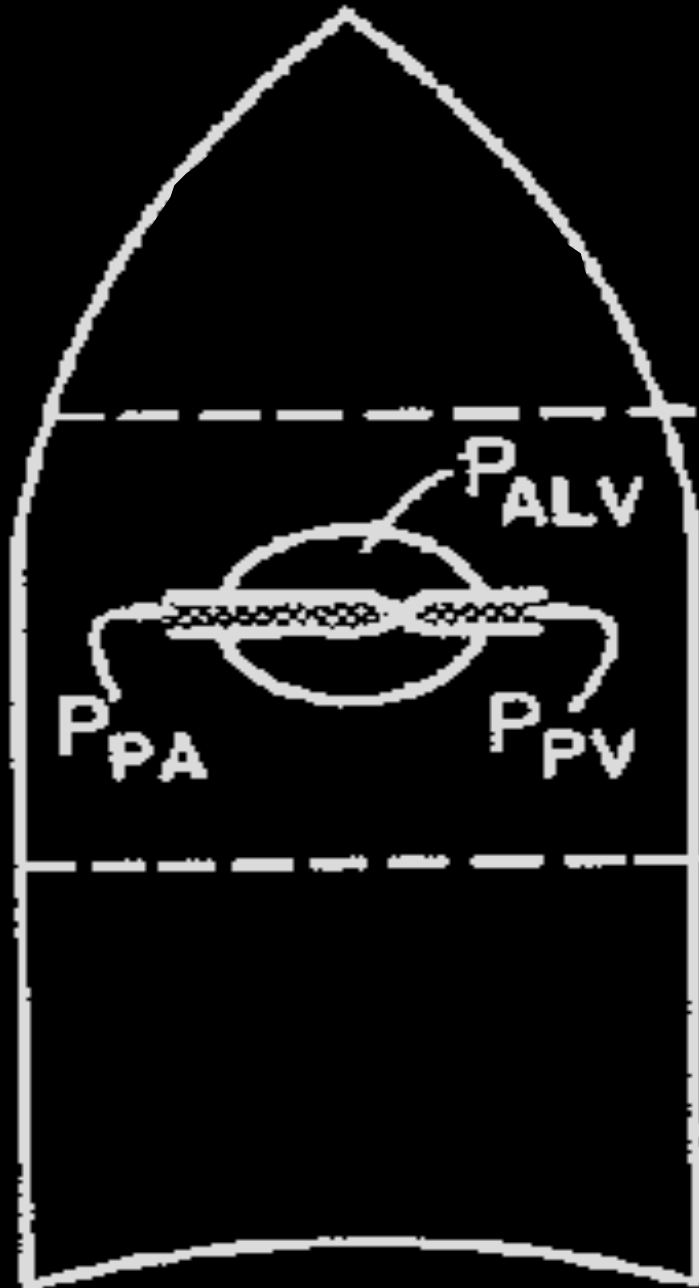


Basal



Expansion

Intra-alveolar pulmonary capillaries are susceptible to collapse

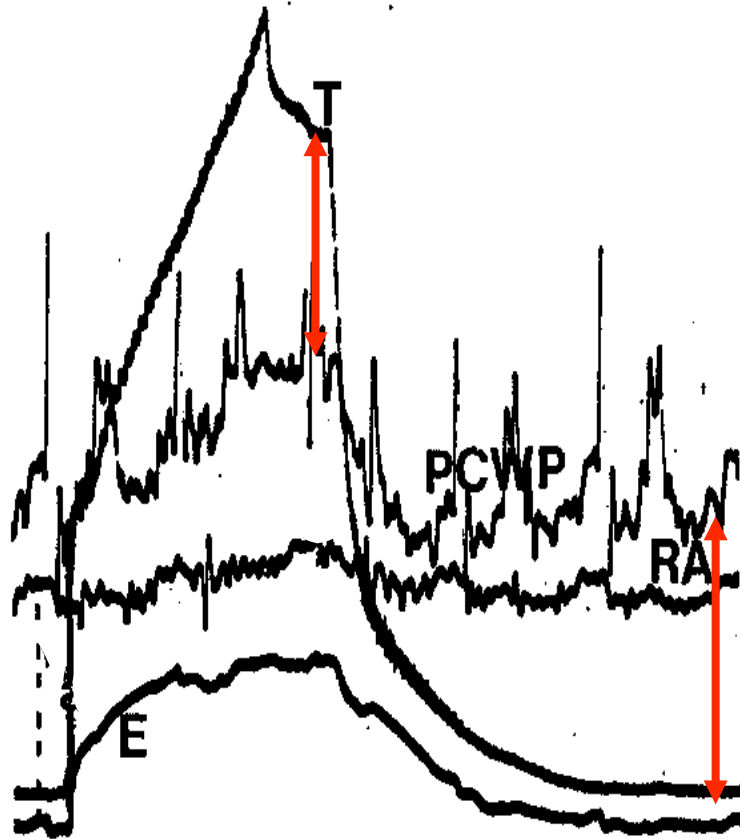


$$P_{dist} > P_{crit}$$

$$P_{dist} = P_{VP} - P_{ALV}$$

INSP.

EXP.

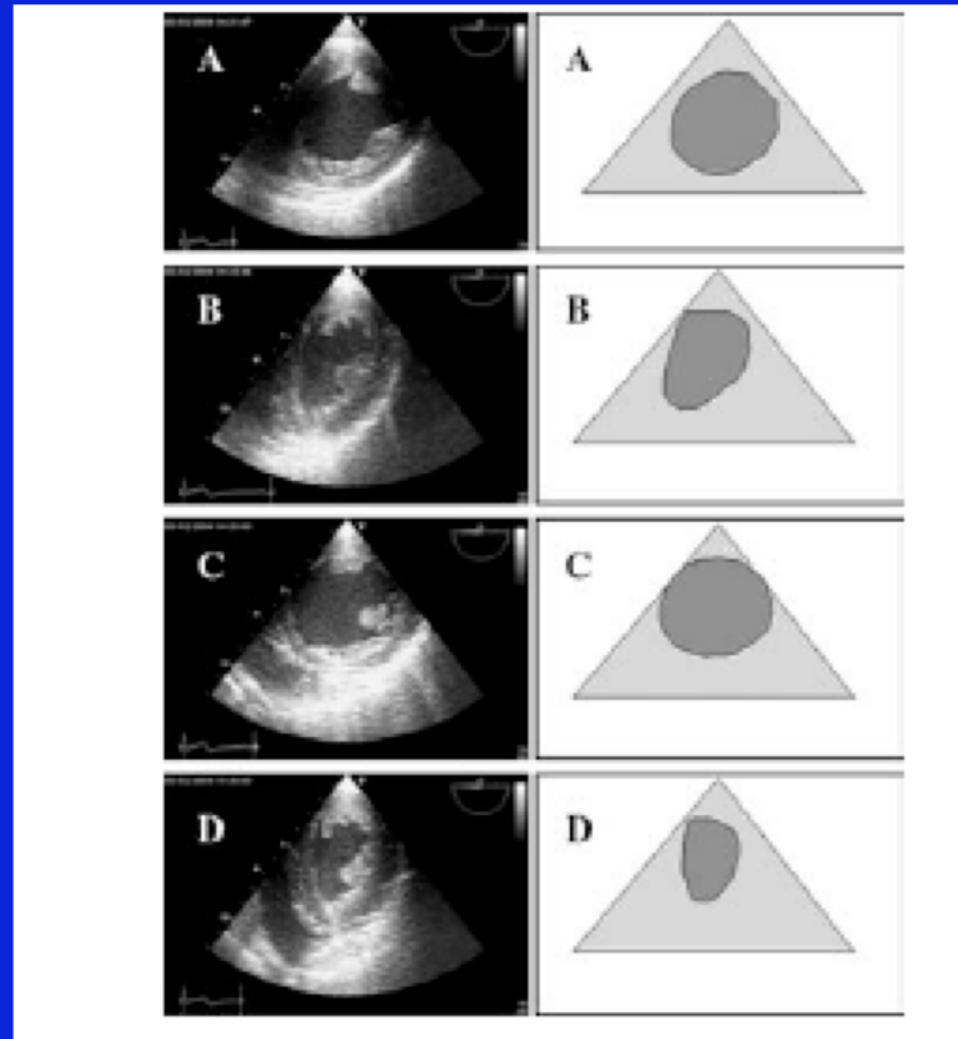


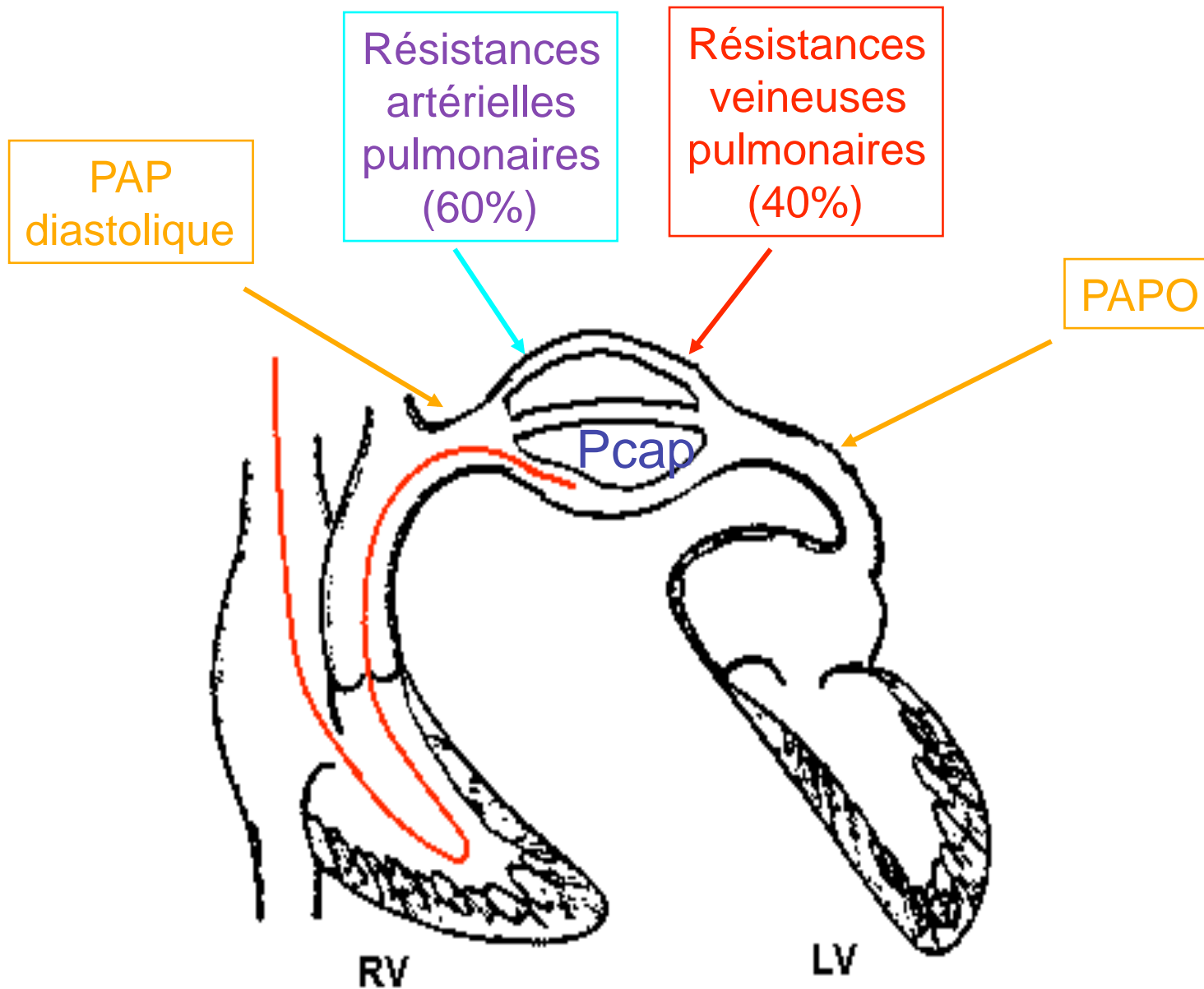
### ***Collapse of capillaries***

*Distending pressure ( $P_{cwp} - P_{Alv}$ ),  
Becomes negative and  $< P_{crit}$*

$$\text{ZONE II : } P_{ALV} > P_{PV}$$

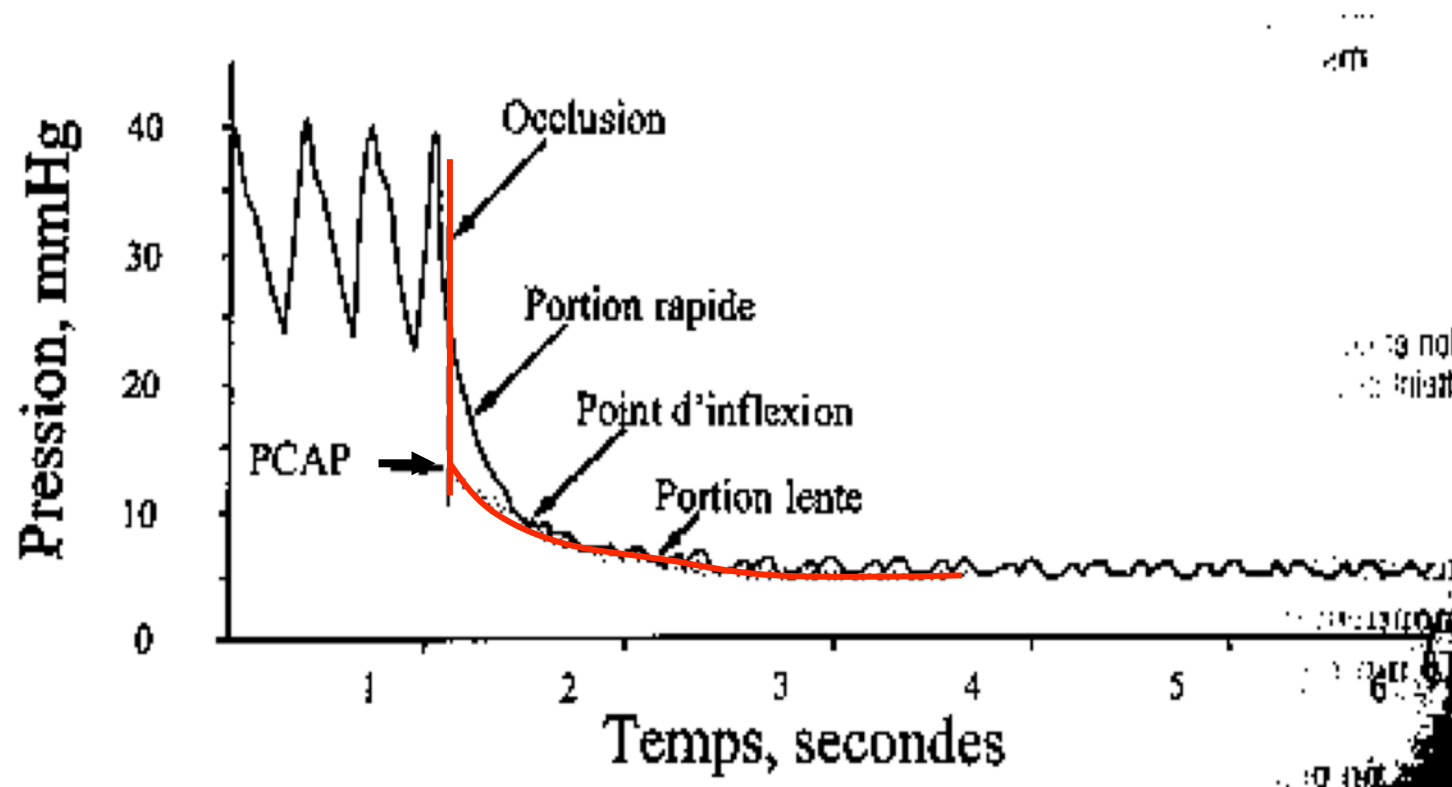
**Lung recruitment maneuver depresses central hemodynamics in patients following cardiac surgery**





La  $P_{cap}$  est toujours supérieure à la PAPO

# Estimation de la pression capillaire pulmonaire



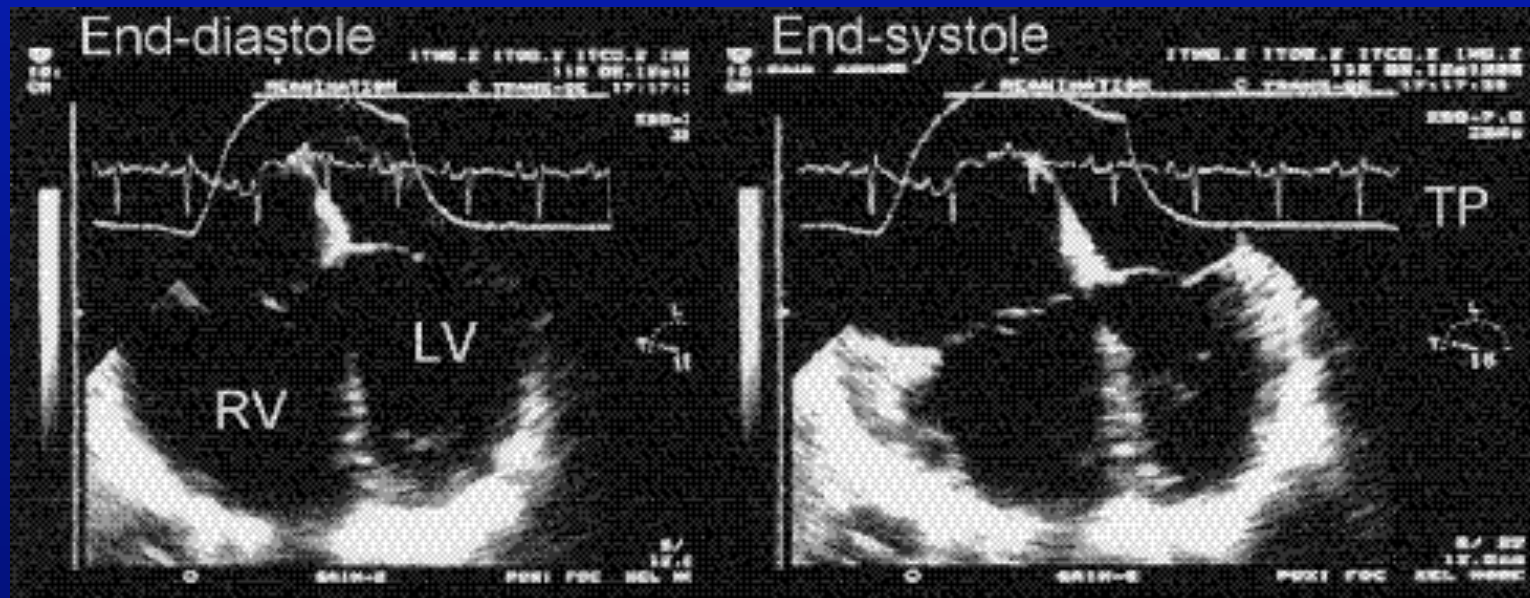
# Acute cor pulmonale in acute respiratory distress syndrome submitted to protective ventilation: Incidence, clinical implications, and prognosis

Antoine Vieillard-Baron, MD; Jean-Marie Schmitt, MD; Roch Augarde, MD; J. L. Fellahi, MD; Sebastien Prin, MD; Bernard Page, MD; Alain Beauchet, MD; François Jardin, MD

CCM 2001; 29: 1551

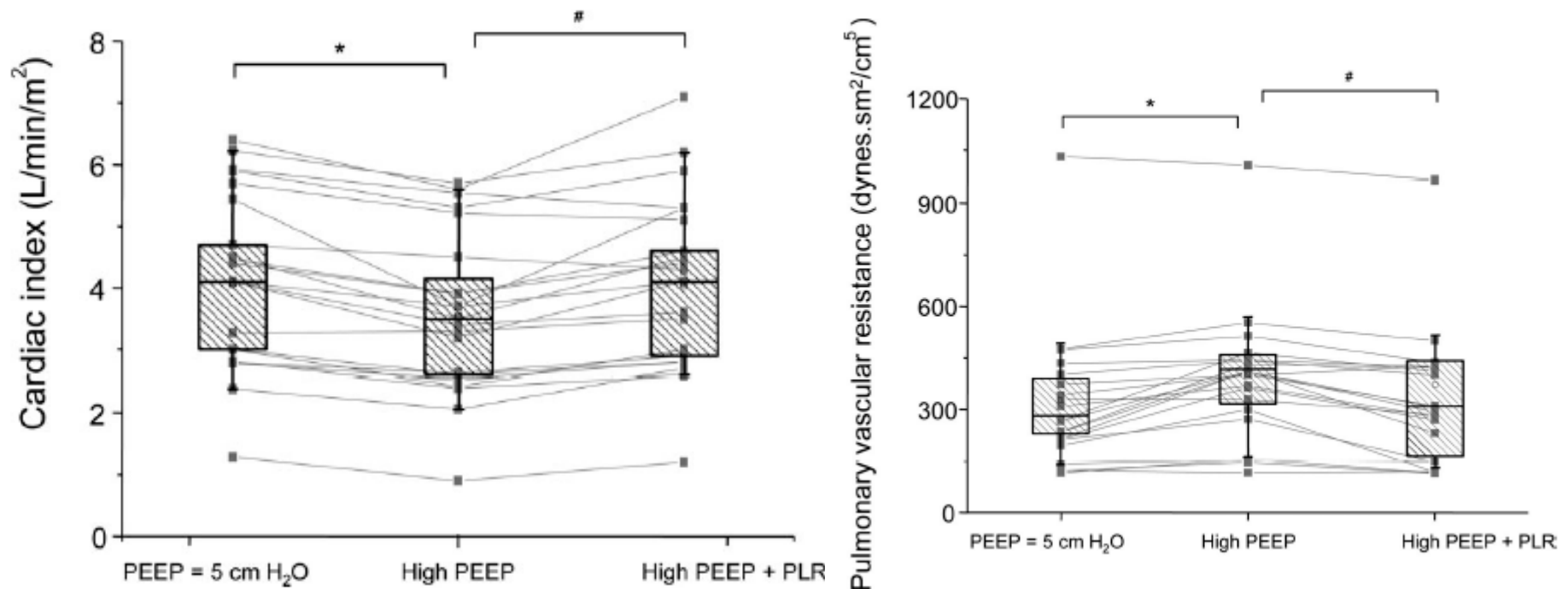
**1985 : 61% ACP**

**2000 : 25% ACP**



# Hemodynamic impact of a positive end-expiratory pressure setting in acute respiratory distress syndrome: Importance of the volume status\*

Emilie Fougères, MD; Jean-Louis Teboul, MD, PhD; Christian Richard, MD; David Osman, MD; Denis Chmela, MD, PhD; Xavier Monnet, MD, PhD



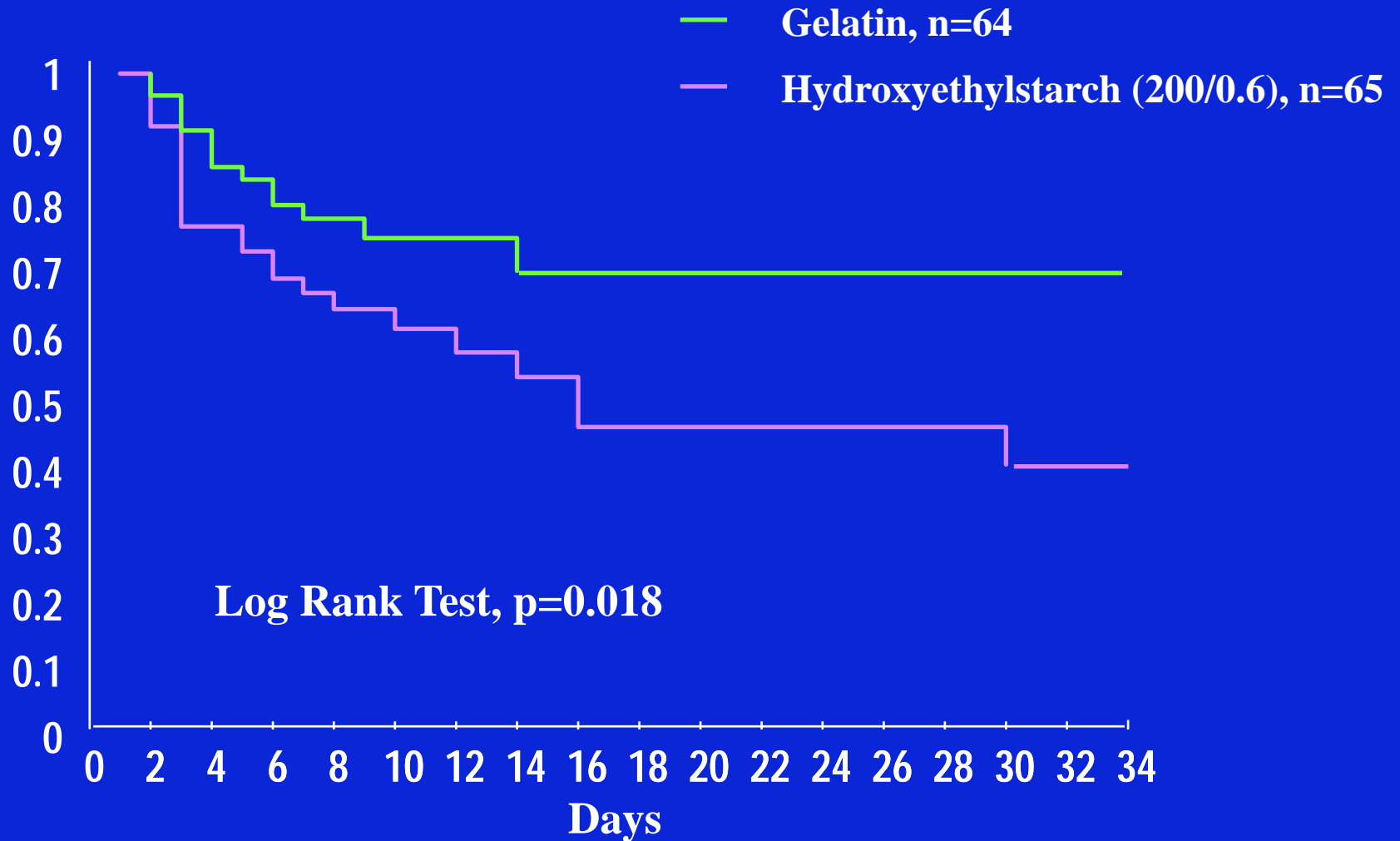
# Remplissage vasculaire et SDRA

- Risque pulmonaire spécifique lié au remplissage
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- **Autres effets du remplissage**
- **Rôle des index prédictifs de la réponse au remplissage**
- **Effet sur la durée de ventilation**

# Effects of hydroxyethylstarch and gelatin on renal function in severe sepsis: a multicentre randomised study

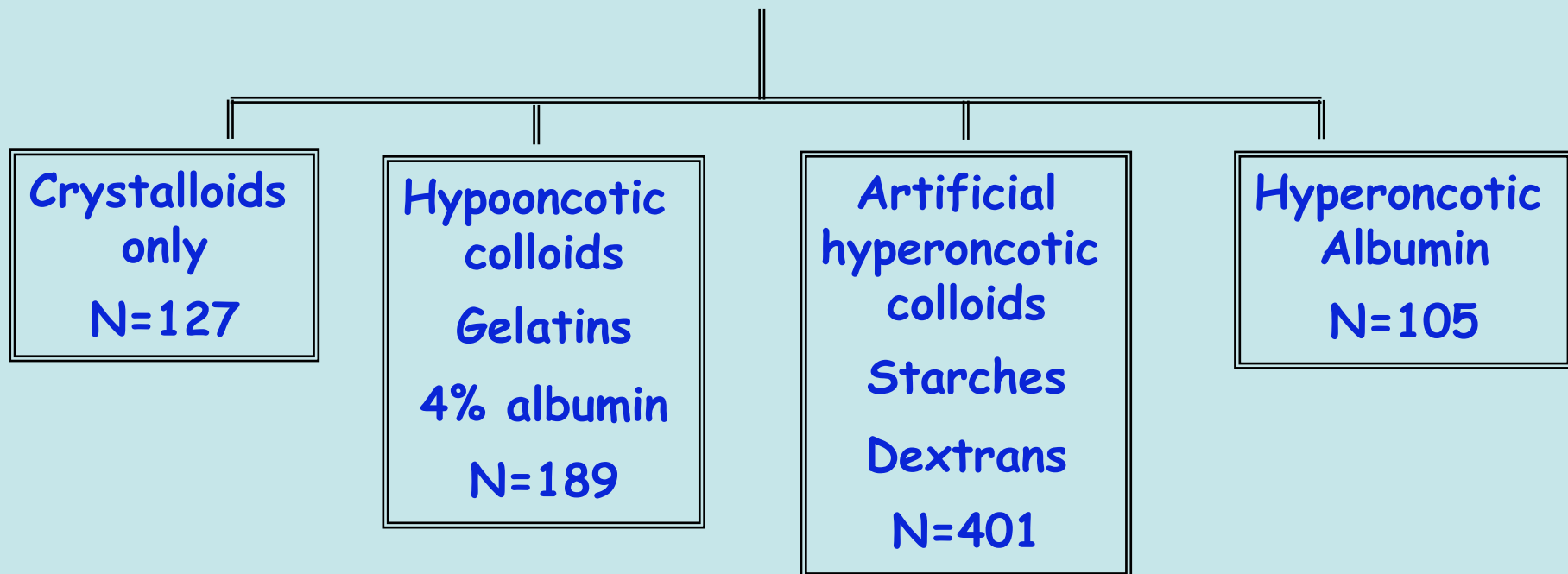
Frédérique Schortgen, Jean-Claude Lacherade, Fabrice Bruneel, Isabelle Cattaneo, François Hemery, François Lemaire, Laurent Brochard

Proportion of patients without ARF



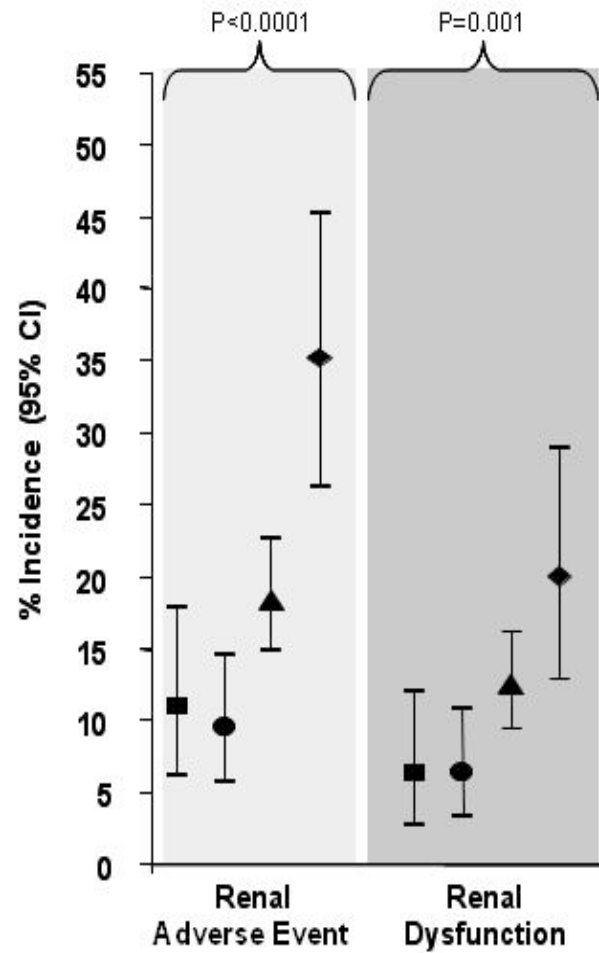
Frédérique Schortgen  
Emmanuelle Girou  
Nicolas Deye  
Laurent Brochard  
for the CRYCO Study Group

## The risk associated with hyperoncotic colloids in patients with shock



# CRYCO Study

- Crystalloids only
- Hypooncotic colloids
- ▲ Artificial hyperoncotic colloids
- ◆ Hyperoncotic albumin



## Colloids versus crystalloids for fluid resuscitation in critically ill patients (Review)

**THE COCHRANE  
COLLABORATION®**

Perel P, Roberts I

This is a reprint of a Cochrane review, prepared and maintained by The Cochrane Collaboration and published in *The Cochrane Library* 2008, Issue 3 <http://www.thecochranelibrary.com>

### **Authors' conclusions**

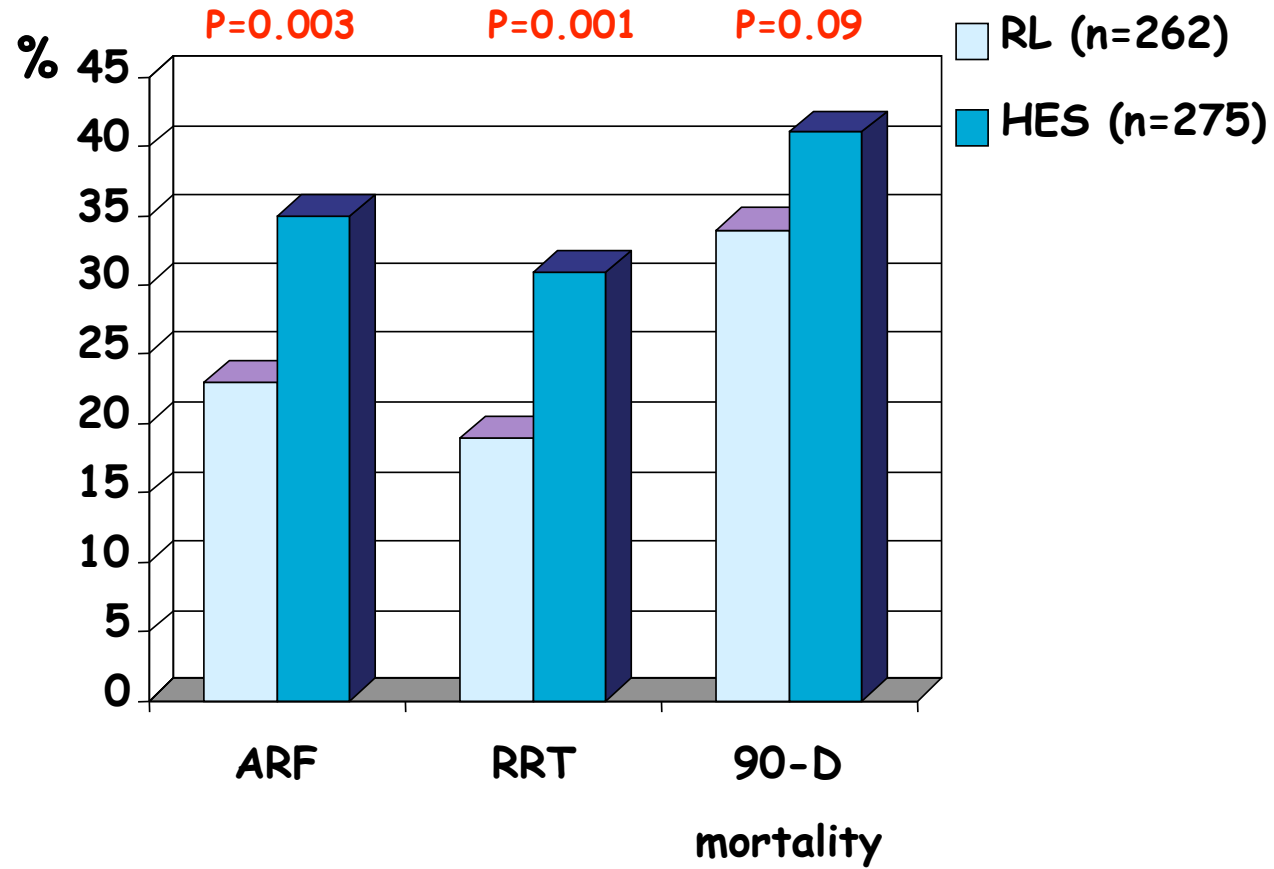
There is no evidence from RCTs that resuscitation with colloids reduces the risk of death, compared to resuscitation with crystalloids, in patients with trauma, burns or following surgery. As colloids are not associated with an improvement in survival, and as they are

it is hard to see how their continued use in these patients can be justified outside the context of RCTs.

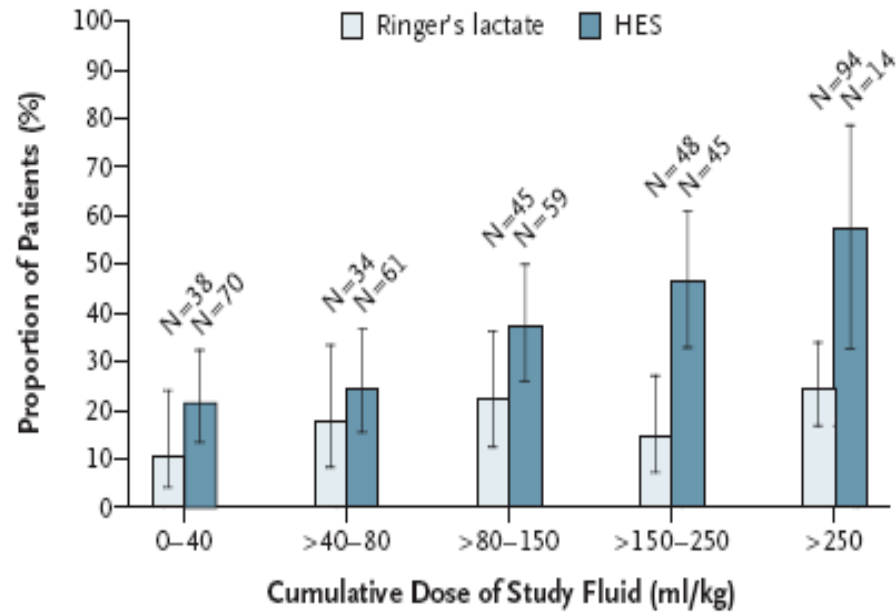
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ORIGINAL ARTICLE

### Intensive Insulin Therapy and Pentastarch Resuscitation in Severe Sepsis



### A Renal-Replacement Therapy



HES:

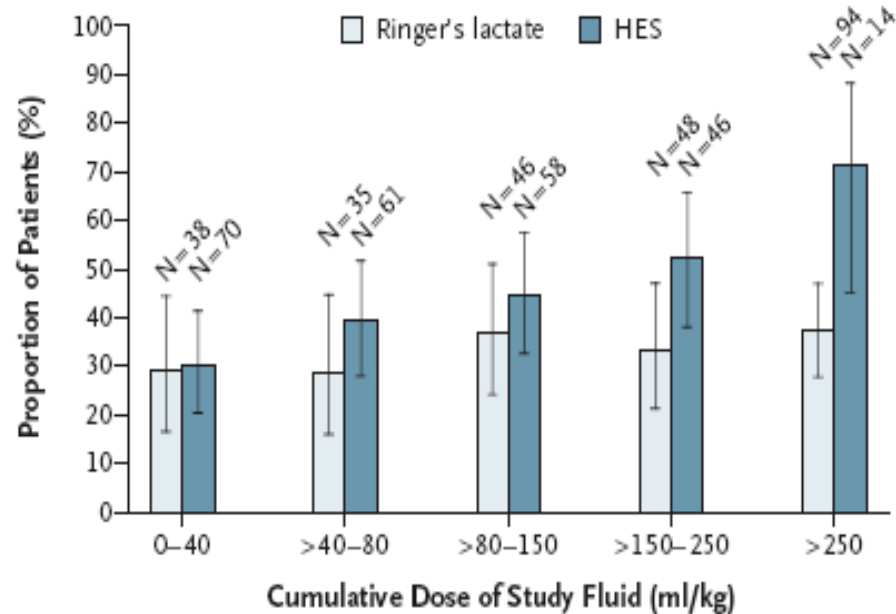
More RRT

More hemostasis abnormalities

More transfusions

More ventilation days

### B Death at 90 Days



# Renal effects of synthetic colloids and crystalloids in patients with severe sepsis: A prospective sequential comparison

Ole Bayer, MD; Konrad Reinhart, MD; Yasser Sakr, MD, PhD; Bjoern Kabisch, PhD; Matthias Kohl, PhD; Niels C. Riedemann, MD; Michael Bauer, MD; Utz Settmacher, MD; Khosro Hekmat, MD; Christiane S. Hartog, MD

Crit Care Med 2011 Vol. 39, No. 6

|                             | <b>Phase I</b>        | <b>Phase II</b>   | <b>Phase III</b>   |
|-----------------------------|-----------------------|-------------------|--------------------|
|                             | <b>6% HES 130/0.4</b> | <b>4% Gelatin</b> | <b>Crystalloid</b> |
| <b>Year</b>                 | 2005                  | 2006              | 2008/09            |
| <b>No of sepsis treated</b> | 118                   | 87                | 141                |
| <b>No of AKI (%)</b>        | 83 (70)               | 59 (68)           | <b>66 (47)</b>     |
| <b>Adjusted OR 95%CI</b>    | 4.52 (2.27–8.99)      | 3.65 (1.81–7.35)  | Ref                |

## 6S trial

*Anders Perner (Copenhagen, Denmark)*

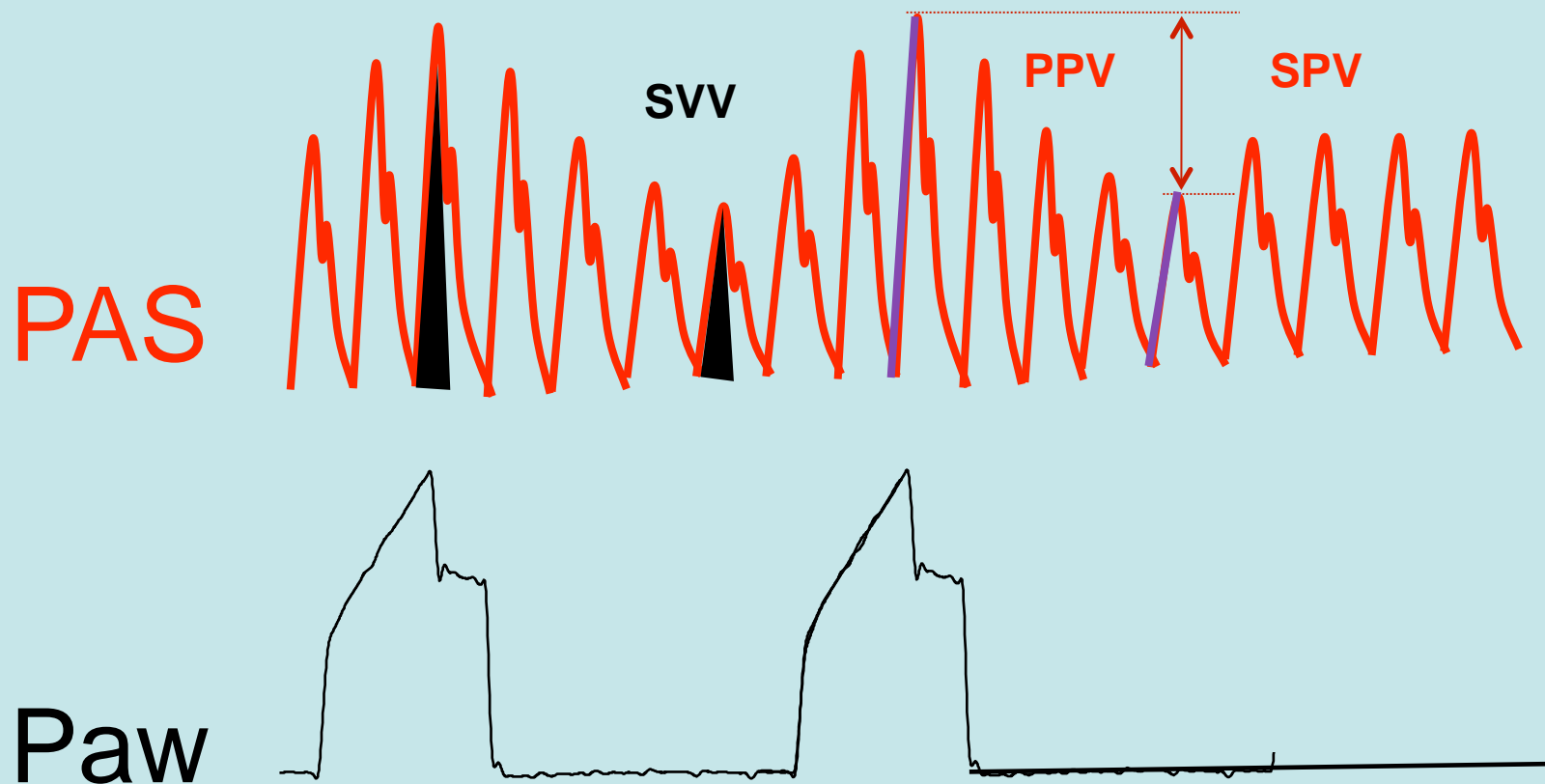
- 800 pts with septic shock
- HES acetate vs Ringer acetate
- Need for RRT 22% vs. 16%,  $P < 0.05$
- Mortality 51% vs. 43%,  $P < 0.05$

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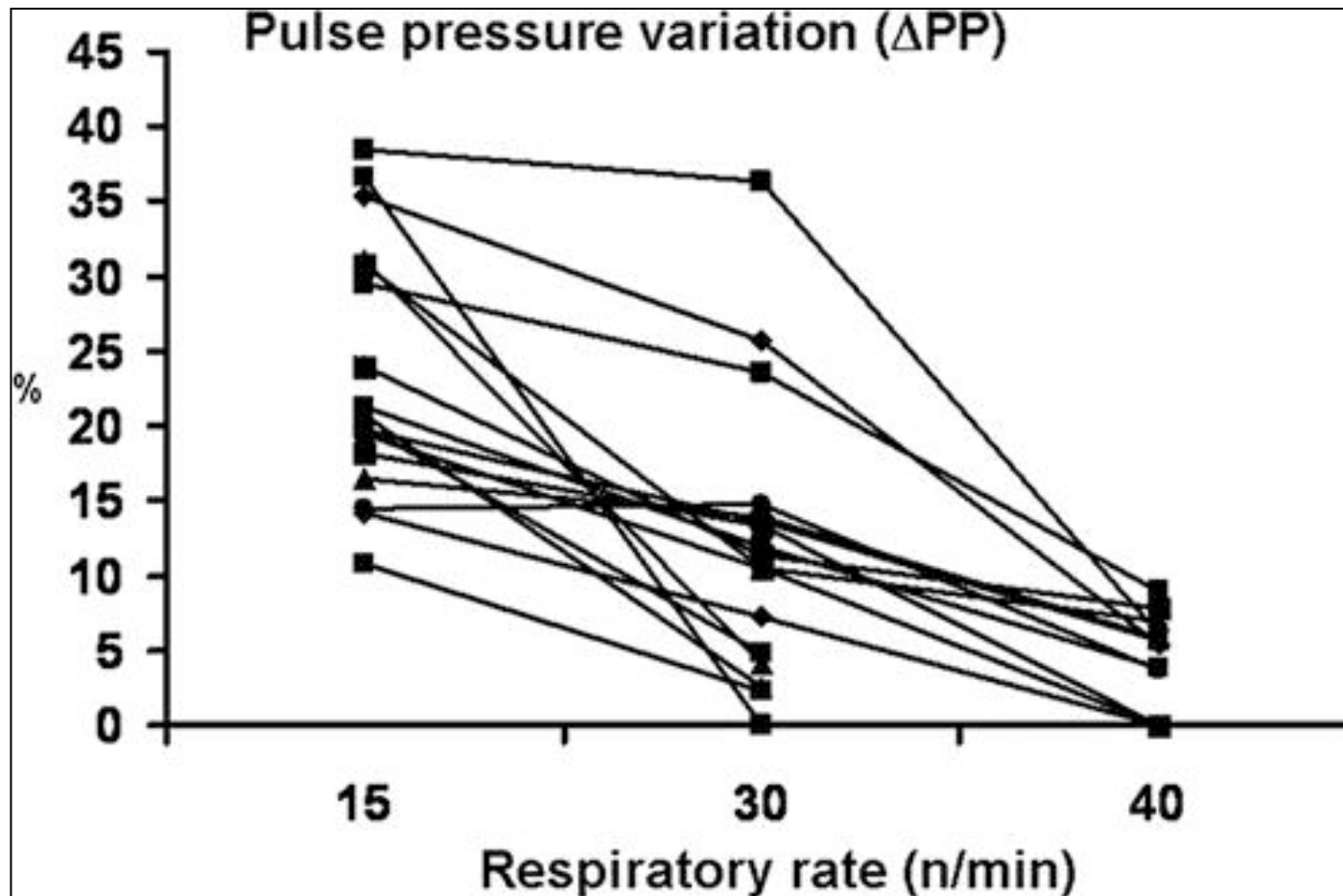
# SEDATED PATIENTS, VENTILATED BY POSITIVE PRESSURE AND WITH REGULAR CARDIAC RHYTHM

## Dynamic Indices



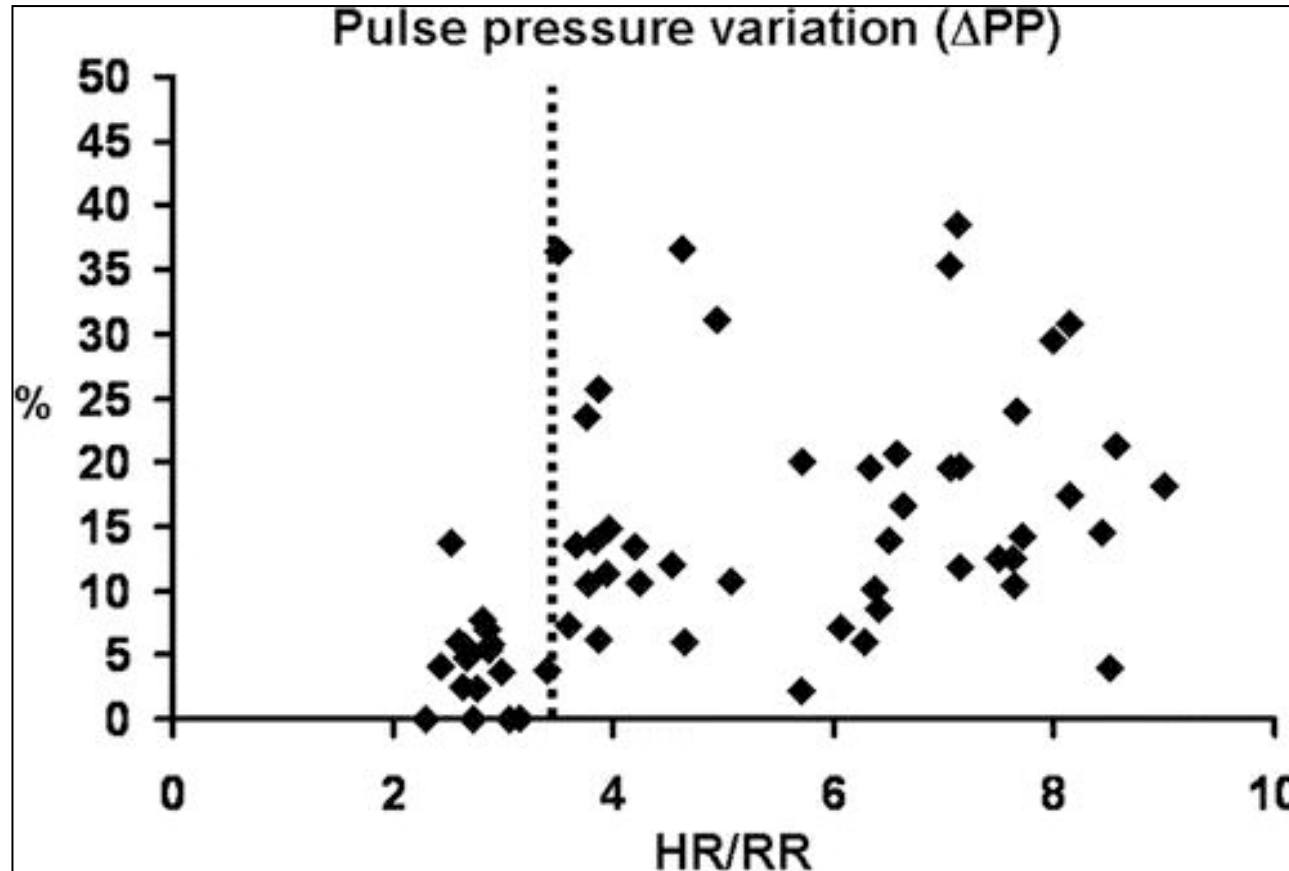
## Influence of Respiratory Rate on Stroke Volume Variation in Mechanically Ventilated Patients.

De Backer, Daniel; Taccone, Fabio; Holsten, Roland; Ibrahim, Fayssal; Vincent, Jean-Louis  
Anesthesiology. 110(5):1092-1097, May 2009



**Influence of Respiratory Rate on Stroke Volume Variation in Mechanically Ventilated Patients.**

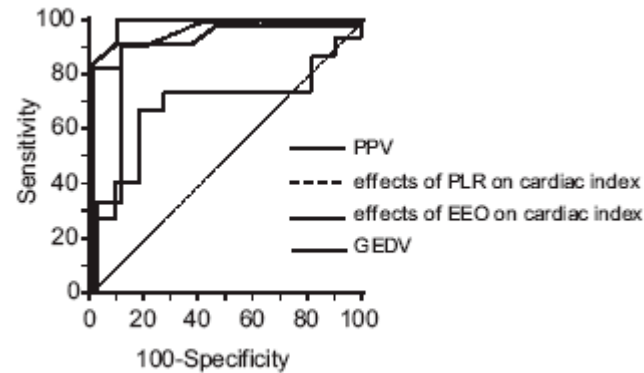
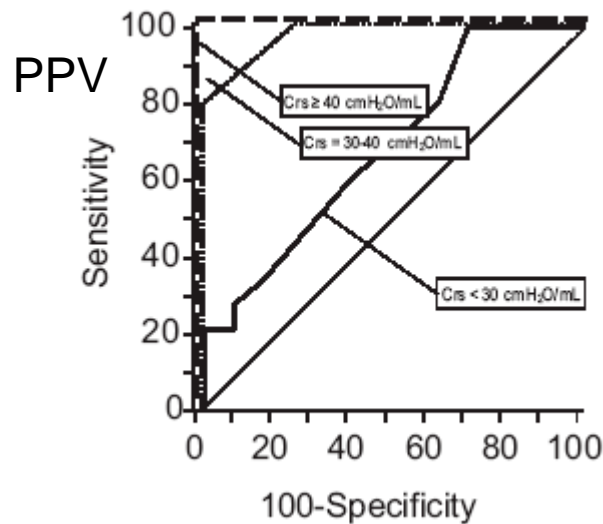
De Backer, Daniel; Taccone, Fabio; Holsten, Roland; Ibrahim, Fayssal; Vincent, Jean-Louis  
Anesthesiology. 110(5):1092-1097, May 2009



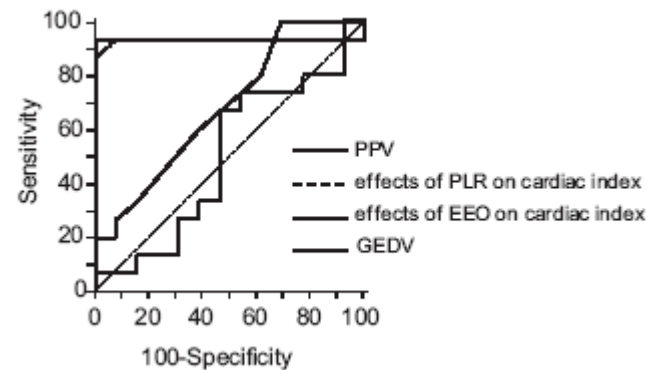
[DELTA]PP became negligible when HR/RR ratio was less than or equal to 3.6.

# Passive leg-raising and end-expiratory occlusion tests perform better than pulse pressure variation in patients with low respiratory system compliance\*

Xavier Monnet, MD, PhD; Alexandre Bleibtreu, MD; Alexis Ferré, MD; Martin Dres, MD; Rim Gharbi, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD



$C > 30 \text{ ml/cmH}_2\text{O}$



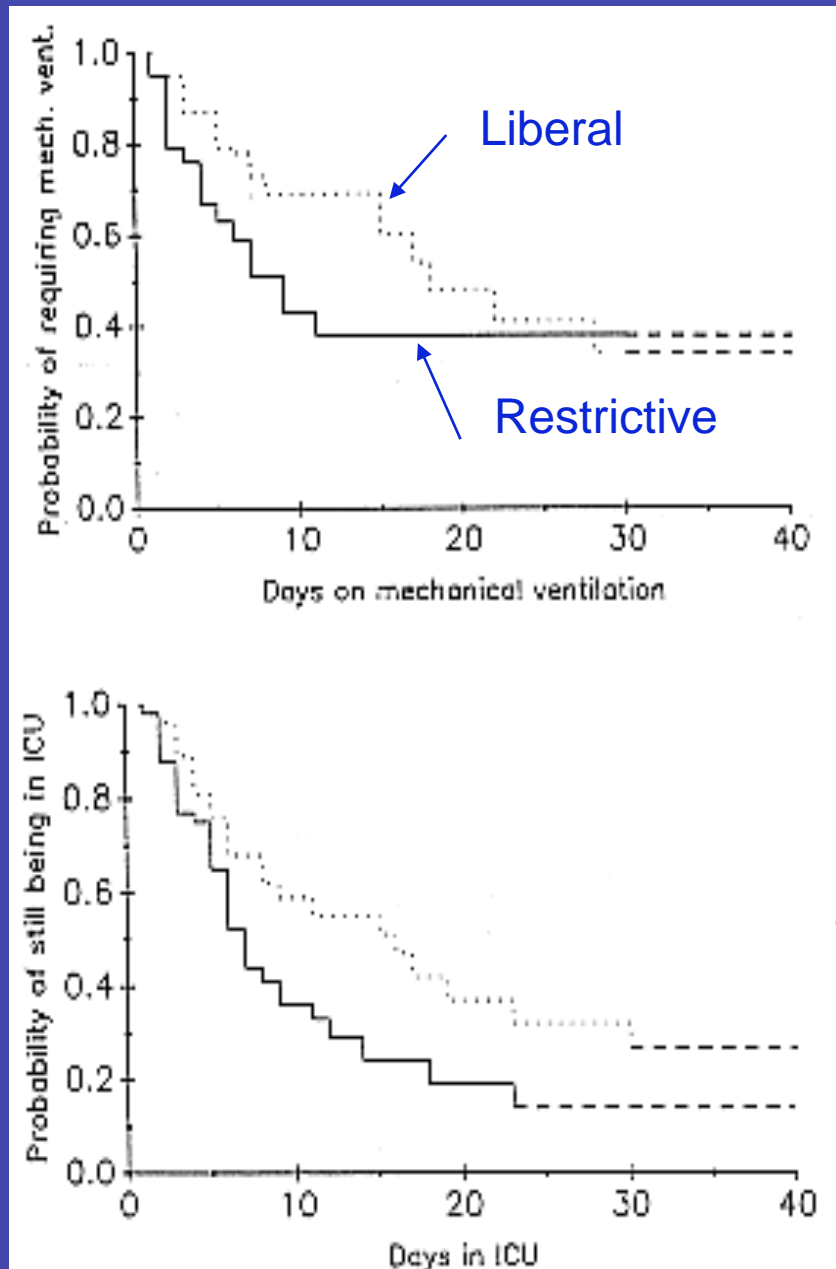
$C < 30 \text{ ml/cmH}_2\text{O}$

# Remplissage vasculaire et SDRA

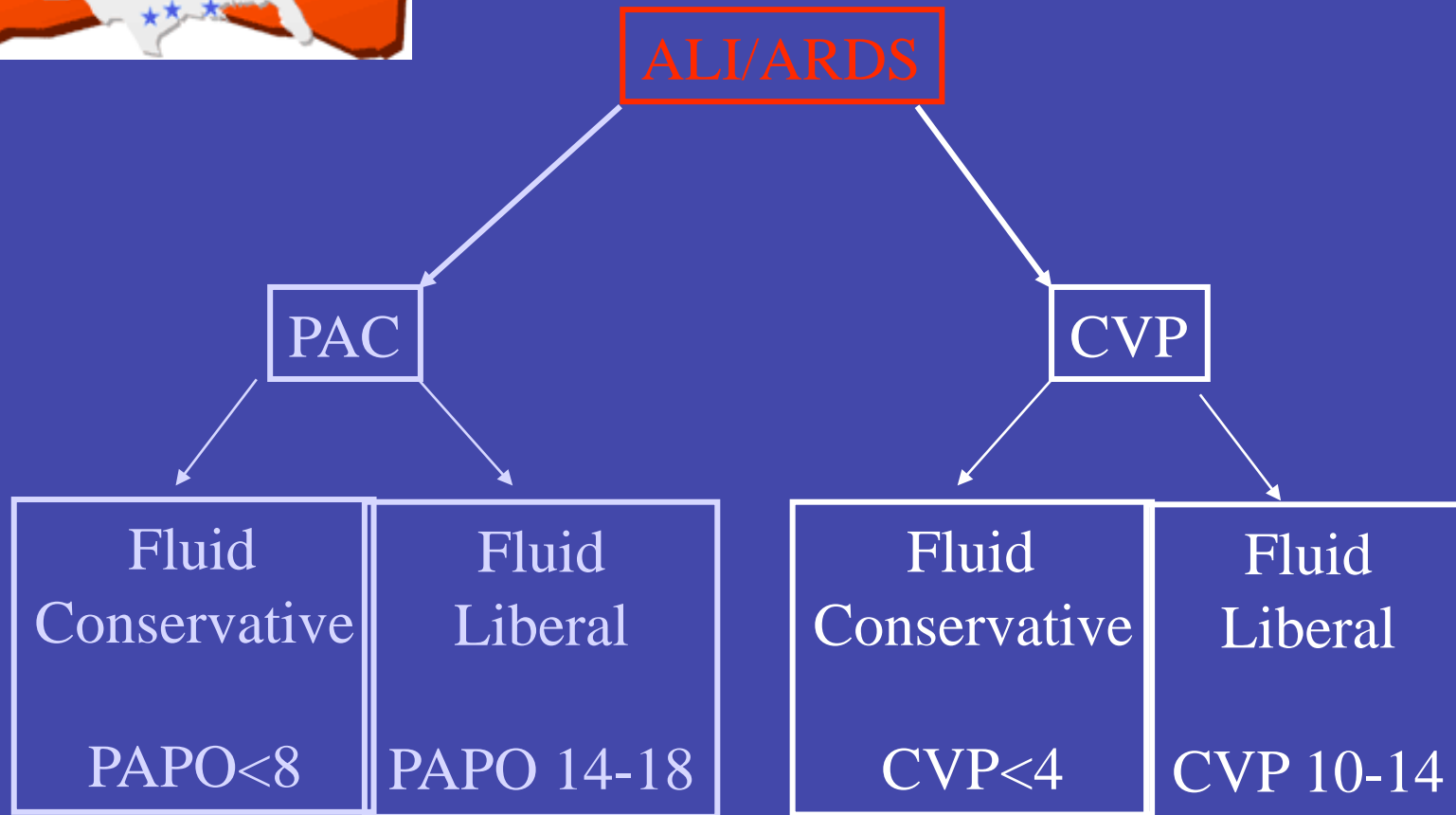
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## Improved outcome based on fluid management in critically ill patients requiring pulmonary artery catheterization

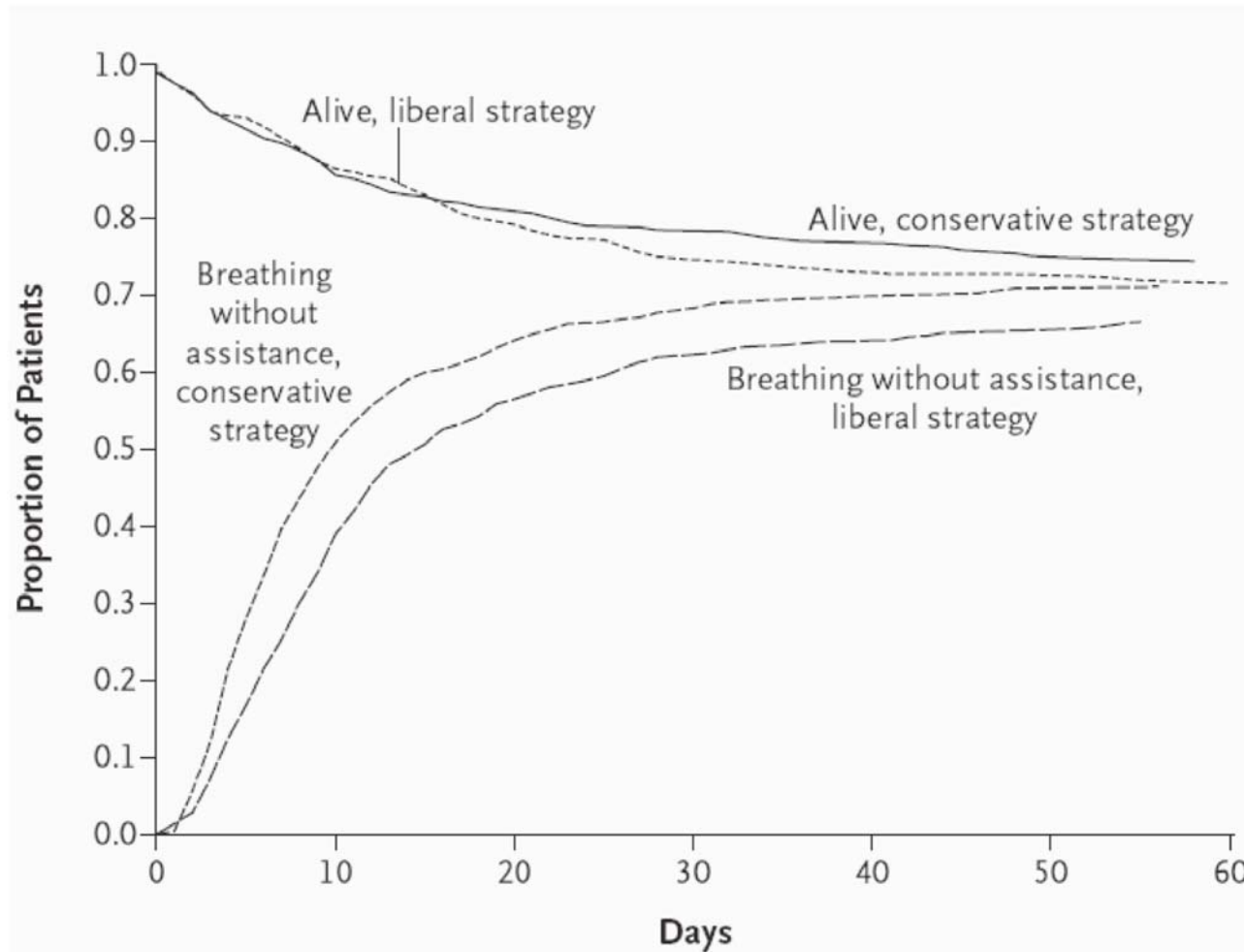
Mitchell et al. ARRD 1992



# FACTT Study



# BALANCE HYDRIQUE OEDEME LESIONNEL



# Stratégie de remplissage dans le SDRA

- Remplissage nécessaire et suffisant pour le choc
- Puis limiter le remplissage au strict nécessaire: indexes de réponse, lever de jambe passif
- Comprendre les interactions avec la ventilation
- Pas d'indication aux colloïdes
- Bilan négatif plus rapidement (effet sédation)= durée de ventilation raccourcie

