FLUIDS

PHILOSOPHY & PHYSIOLOGY

Philippe Rola

#STOWEEM20
COIs

I teach POCUS.

I run an annual conference.

I am an occasional consultant for ultrasound companies.

I wrote a couple of POCUS & RESUS books.
Our key questions today.

- Why do we give fluids?
- How much should we give?
- How do we know when to stop?
Why might we give fluids?

- To restore intracellular water
- To restore intravascular volume
- To restore tissue perfusion
- To expand interstitial space
- To improve oxygenation
$$CaO_2 = (SaO_2 \times Hb \times 1.34) + 0.003(PaO_2)$$

$$CaO_2 = 20 \text{ ml O}_2/100 \text{ ml blood}$$
Crystalloid O2 content?

\[
\text{CcrO2} = [(\text{SaO2} \times \text{hb} \times 1.34) + 0.003(\text{PaO2})] - (\text{SaO2} \times \text{hb} \times 1.34) \\
\text{CcrO2} = 0.003(\text{PaO2}) \\
\text{eg PaO2} = 80
\]

\[
\text{CcrO2} = 0.24 \text{ ml/100 ml}...
\]
Oxygen supersaturated fluid using fine micro/nanobubbles

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Abstract: Microbubbles show peculiar properties, such as shrinking collapse, long lifetime, high gas solubility, negative electric charge, and free radical production. Fluids supersaturated with various gases can be easily generated using microbubbles. Oxygen microbubble fluid can be very useful for oxygen delivery to hypoxic tissues. However, there have been no reports of comparative investigations into adding fluids containing oxygen fine micro/nanobubbles (OFMN Bs) to common infusion solutions in daily medical care. In this study, it was demonstrated that OFMN Bs can generate oxygen-supersaturated fluids, and they may be sufficiently small to infuse safely into blood vessels. It was found that normal saline solution is preferable for generating an oxygen-rich infusion fluid, which is best administered as a 30-minute intravenous infusion. It was also concluded that dextran solution is suitable for drug delivery substances packing oxygen gas over a 1-hour intravenous infusion. In addition, normal saline solution containing OFMN Bs was effective for improving blood oxygenation. Thus, the use of OFMNB-containing fluids is a potentially effective novel method for improving blood oxygenation in cases involving hypoxia, ischemic diseases, infection control, and anticancer chemoradiation therapies.

Keywords: microbubble, fine micro/nanobubble, nanobubble, oxygenation, fluid oxygenation
WHY...?

HOW MUCH...?
• Plethoric IVC - except tension pntx & tamponade.

• Respiratory failure with oxygenation issue.

• Intracranial hypertension or risk of.

• Elevated intra-abdominal pressure or risk of.
- plethoric IVC and splanchnic venous Doppler abnormalities (VEXUS score)
- delirium (cerebral congestion)
- rising oxygenation issues
- renal dysfunction

**CEASE & DESIST**

DIURESIS!

RRT!
“ARDS”

...patient passed away “despite” everything we did...

& Friends...
clinical integration

- vitals - check for beta bs, ccbs.
- general skin temperature, appearance, diaphoresis.
- respiratory effort.
- POCUS findings.
Figure 2. Mean arterial pressure (MAP) during the 15 minutes of fluid bolus administration

Mean (standard error of the mean) MAP during the 15 minutes of fluid bolus administration in subjects receiving a warm (dotted line) and cold (solid line) fluid bolus, respectively. *P* value represents the interaction between time and group on repeated measures analysis of variance.

Two RCTs show that administration of cold fluid increases blood pressure, whereas warm fluid does not.

Top: Wall O et al. 2018 PMID 30482135
Bottom: Tollofsrud S et al 1993 PMID 8279253
FLUIDS and AKI...
GO GO GO!!!
Hypovolemic
Euvolemic
Hypervolemic
The Common Approach

- Try Fluids.
- Look for fluid responsiveness and eliminate it.
- If the patient isn’t fluid responsive, try albumin.

If that doesn’t do the trick... dialysis?
Increased Central Venous Pressure Is Associated With Impaired Renal Function and Mortality in a Broad Spectrum of Patients With Cardiovascular Disease

Kevin Damman MD *, Vincent M. van Deursen *, Gerjan Navis MD, PhD †, Adriaan A. Voors MD, PhD *, Dirk J. van Veldhuisen MD, PhD, FACC *, Hans L. Hillege MD, PhD * ‡, §

Figure 1  Distribution of CVP and Curvilinear Relationship Between CVP and eGFR in the Study Population

Figure 2  Curvilinear Relationship Between CVP and eGFR According to Different Cardiac Index Values

p = 0.0217 for interaction between cardiac index and CVP on the relationship with eGFR. **Solid line** = cardiac index < 2.5 l/min/m²; **dashed line** = cardiac index 2.5 to 3.2 l/min/m²; **dotted line** = cardiac index > 3.2 l/min/m². Abbreviations as in Figure 1.
Fig. 2. Heart-lung-double-kidney preparation. The broken lines represent the kidney subjected to venous obstruction, the continuous lines represent the other kidney subjected to a decrease of arterial pressure so chosen as to produce the same reduction in the urine flow.

The curves illustrate (1) that the venous pressure change exceeds the equivalent change in the arterial pressure, (2) that the venous pressure reduces the blood flow more than does the equivalent decrease in arterial pressure, (3) that a reversible production of protein in the urine is associated with venous obstruction in certain of these experiments (the amounts of protein shown are only approximate), and (4) that the chloride concentration is the same in the urines secreted under the two different conditions of pressure.
The relevance of congestion in the cardio-renal syndrome

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Renal failure in critically ill patients, beware of applying (central venous) pressure on the kidney

Xiukai Chen¹, Xiaoting Wang², P

Legrand et al. Critical Care 2013, 17:R278
http://ccforum.com/content/17/6/R278

Association between systemic hemodynamics and septic acute kidney injury in critically ill patients: a retrospective observational study

Matthieu Legrand¹,², Claire Dupuis¹, Christelle Simon¹, Etienne Gayat¹,³, Joaquim Mateo¹, Anne-Claire Lukaszewicz¹,²,⁴ and Didier Payen¹,²,⁴

Conclusions: We observed no association between most systemic hemodynamic parameters and AKI in septic patients. Association between elevated CVP and AKI suggests a role of venous congestion in the development of AKI. The paradigm that targeting high CVP may reduce occurrence of AKI should probably be revised. Furthermore, DAP should be considered as a potential important hemodynamic target for the kidney.
• Hypovolemic
  • Euvolemic
    • Hypervolemic
I do give fluids.
sometimes even a lot.
sometimes a little.
sometimes not at all.
and sometimes take off.
bottom line:

FLUIDS are PHARMACOLOGIC AGENTS

...lets treat them as such.

Thank you!