



FLUIDS

PHILOSOPHY & PHYSIOLOGY

Philippe Rola

#STOWEEM20



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RESUS LEADERSHIP ACADEMY

thinking critical care

A BLOG FOR THINKING DOCS: BLENDING GOOD EVIDENCE, PHYSIOLOGY, COMMON SENSE, AND APPLYING IT AT THE BEDSIDE!

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

$$\text{CaO}_2 = (\text{SaO}_2 \times \text{Hb} \times 1.34) + .003(\text{PaO}_2)$$

$$\text{CaO}_2 = 20 \text{ ml O}_2 / 100 \text{ ml blood}$$

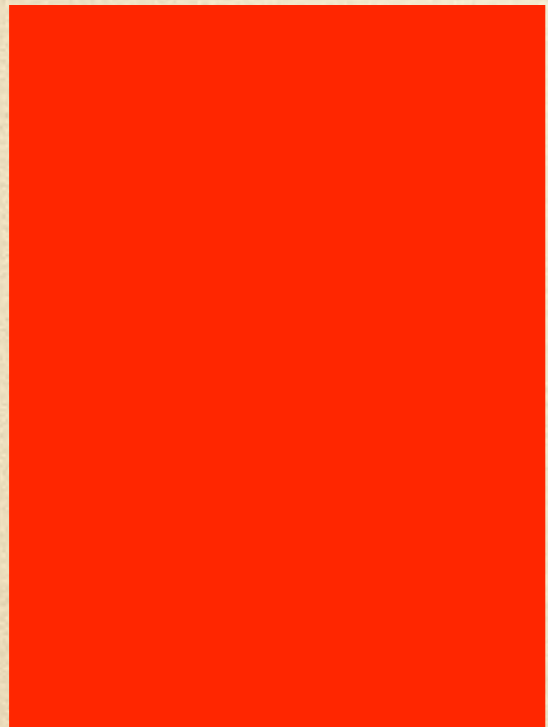
Crystalloid O₂ content?

$$C_{crO_2} = [(SaO_2 \times hb \times 1.34) + .003(PaO_2)] - (SaO_2 \times hb \times 1.34)$$

$$C_{crO_2} = .003(PaO_2)$$

eg $PaO_2 = 80$

$$C_{crO_2} = 0.24 \text{ ml} / 100 \text{ ml} \dots$$



BV 5L

CO 4

CaO₂ 20ml/100ml

DO₂ 800ml/m



BV 6L

CI 4.8

CaO₂ 17ml/100ml

DO₂ 816ml/m



Tissue edema

BV 5.2L

CO 4.1

CaO₂ 19.5ml/100ml

DO₂ 800 ml/m

Oxygen supersaturated fluid using fine micro/nanobubbles

This article was published in the following Dove Press journal:

International Journal of Nanomedicine

23 September 2014

[Number of times this article has been viewed](#)

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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 (OFMNBs) to common infusion solutions in daily medical care. In this study, it was demonstrated that OFMNBs 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 OFMNBs 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

The image features a dark, patinated bronze sculpture of a man in a state of deep thought, known as 'The Thinker' by Auguste Rodin. The man is seated on a rock, leaning forward with his chin resting on his hand, his body tensed with the effort of contemplation. The background is a plain, light gray.

WHY...?

HOW
MUCH...?

FLUID

MAR...
OCEAN BEACH BLVD



POINTS



- Plethoric IVC - except tension pntx & tamponade.
- Respiratory failure with oxygenation issue.
- Intracranial hypertension or risk of.
- Elevated intra-abdominal pressure or risk of.

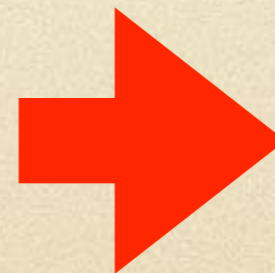




STOP

CEASE & DESIST

- plethoric IVC and splanchnic venous Doppler abnormalities (VEXUS score)
- delirium (cerebral congestion)
- rising oxygenation issues
- renal dysfunction



DIURESIS!
RRT!

“ARDS”



& Friends...

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

clinical integration

- vitals - check for beta bs, ccbs.
- general skin temperature, appearance, diaphoresis.
- respiratory effort.
- POCUS findings.

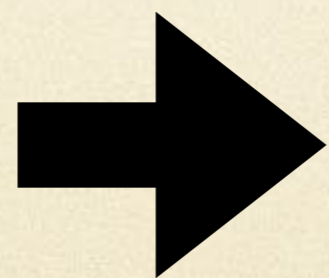
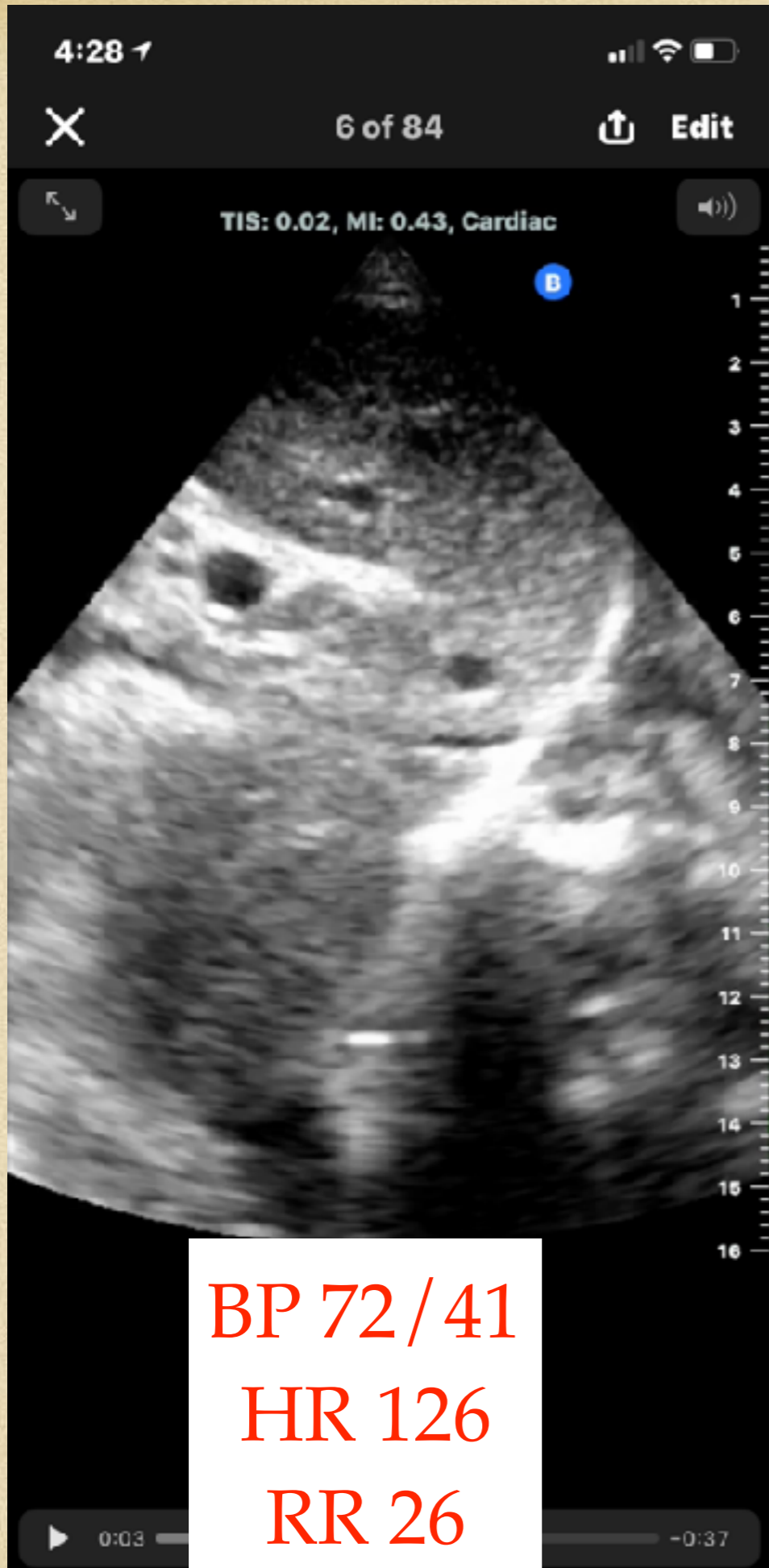
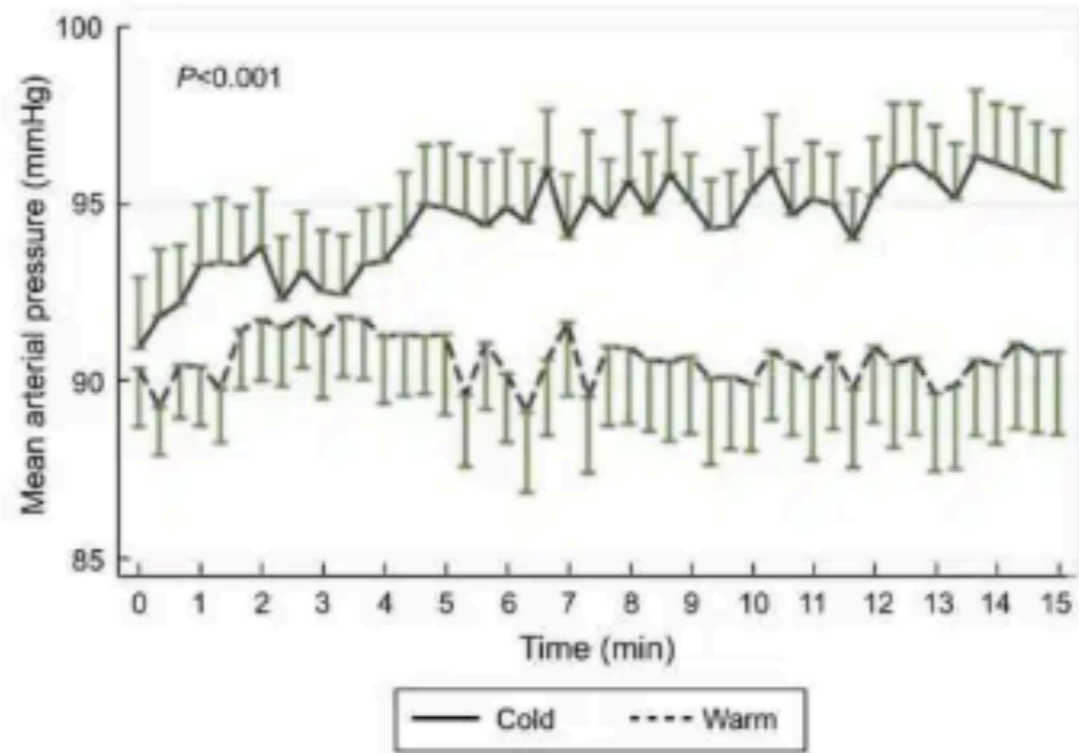
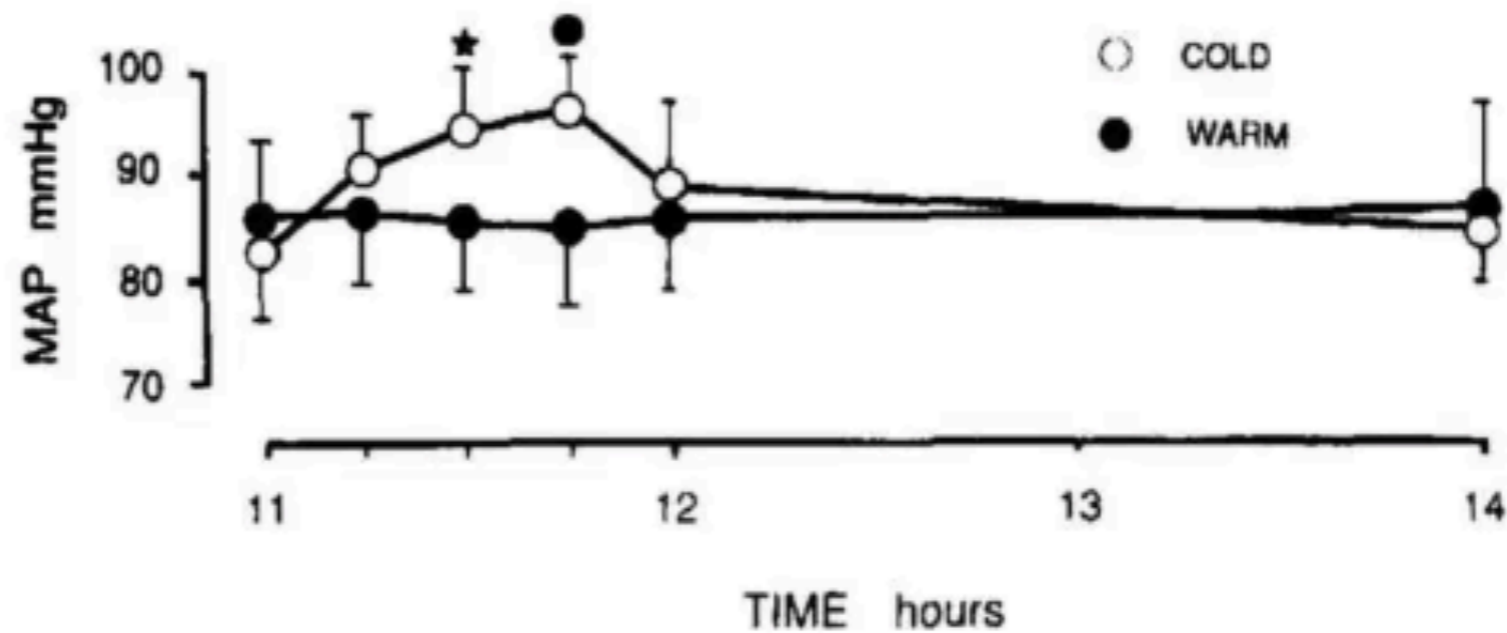


Figure 2. Mean arterial pressure (MAP) during the 15 minutes of fluid bolus administration



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.

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 † ☒

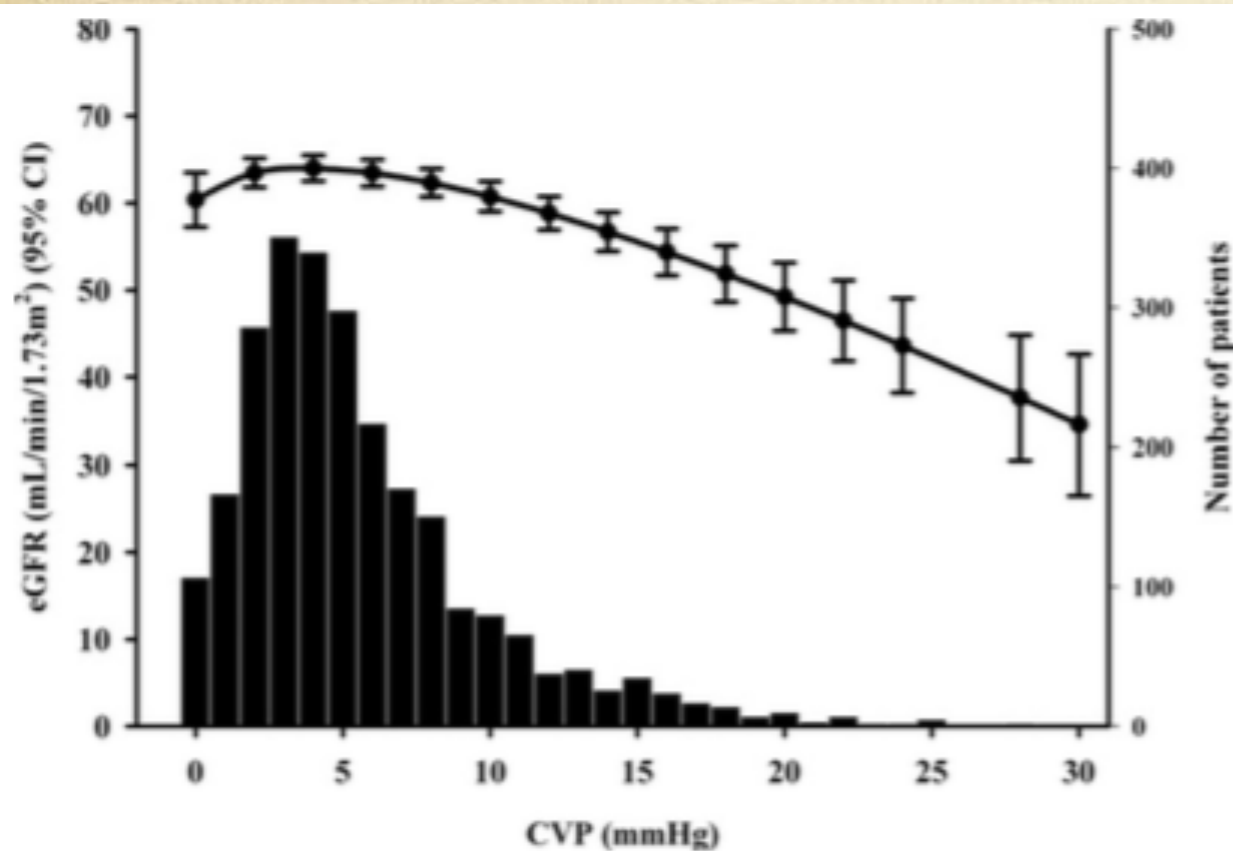


Figure 1 Distribution of CVP and Curvilinear Relationship Between CVP and eGFR in the Study Population

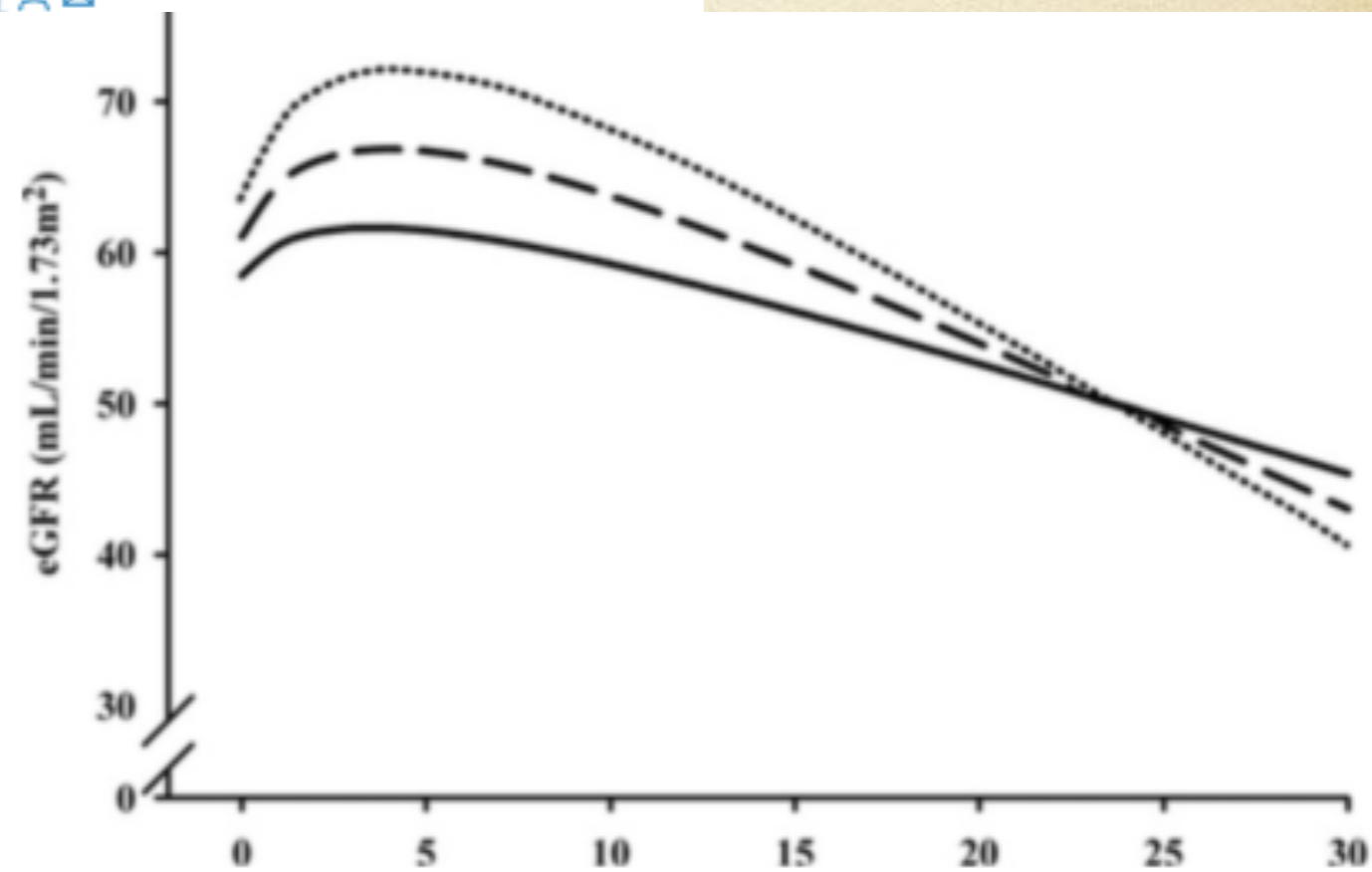


Figure 2 Curvilinear Relationship Between CVP and eGFR According to Different Cardiac Index Values

$p = 0.0217$ 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.

THE INFLUENCE OF VENOUS PRESSURE ON THE ISOLATED MAMMALIAN KIDNEY.

By F. R. WINTON.
Boit Memorial Fellow.

(From the Department of Pharmacology, University College, London.)

1931...

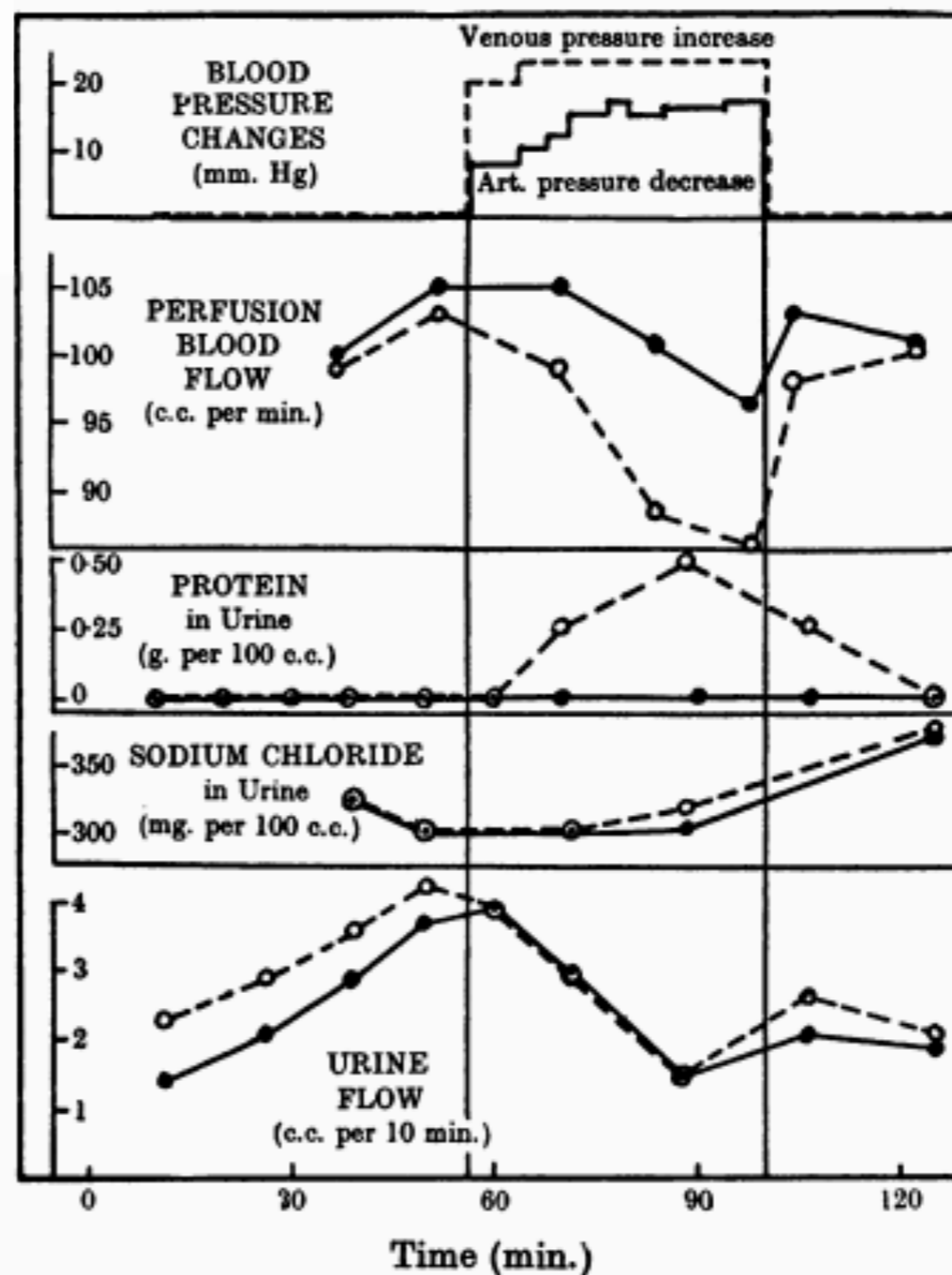


Fig. 2. Heart-lung-double-kidney preparation. The broken lines represent the kidney subjected to venous obstruction, the continuous lines represent the other kidney subjected to a decrease of arterial pressure so chosen as to produce the same reduction in the urine flow.

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

Joseph F. Gnanaraj¹, Stephan von Haehling², Stefan D. Anker^{2,3}, Dominic S. Raj⁴ and Jai Radhakrishnan⁵

¹Internal Medicine, Cardiology, Charlemagne Research, IRCCS, DC, USA and ⁵C

Chen et al. *Ann. Intensive Care* (2018) 8:91
<https://doi.org/10.1186/s13613-018-0439-x>

 Annals of Intensive Care

f
sic
shington,

REVIEW

Open Access

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



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

Xiukai Chen^{1*}, Xiaoting Wang², P



RESEARCH

Open Access

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

Matthieu Legrand^{1,2*}, Claire Dupuis¹, Christelle Simon¹, Etienne Gayat^{1,3}, Joaquim Mateo¹, Anne-Claire Lukaszewicz^{1,2,4} and Didier Payen^{1,2,4}

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!

 @ThinkingCC

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philipperola@gmail.com