Fluid therapy for ICU patients

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Today's aims

- Daily fluid considerations
  - Fluid balance
  - Debates on fluid type
- Challenging ICU patients
  - Hypoproteinemia
  - Excessive GI losses
  - Vasopressor dependent
  - CHF with azotemia

Daily fluid balance

- Perfusion parameters
- Interstitial hydration
- POCUS

- Fluid volume in= out
- Weight (5% changes)
- PCV/TP

Cardiovascular

Trending up?

Hydration parameters

Skin tenting

- BCS
- Age

Eyes

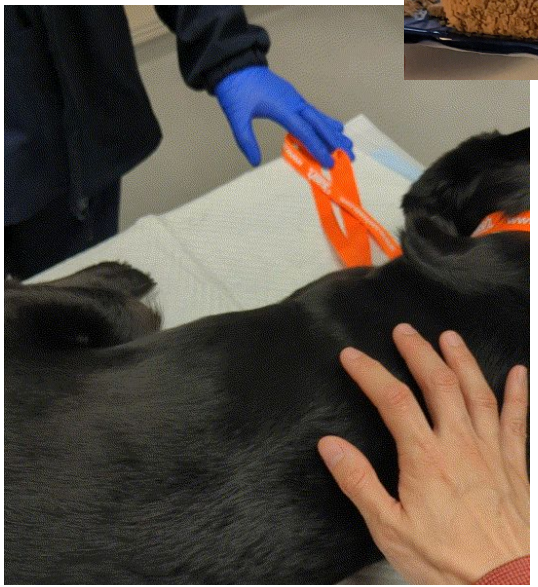
- Tear film
- Sunken eyes

Gum tackiness

- Panting
- Uremia
- Nausea

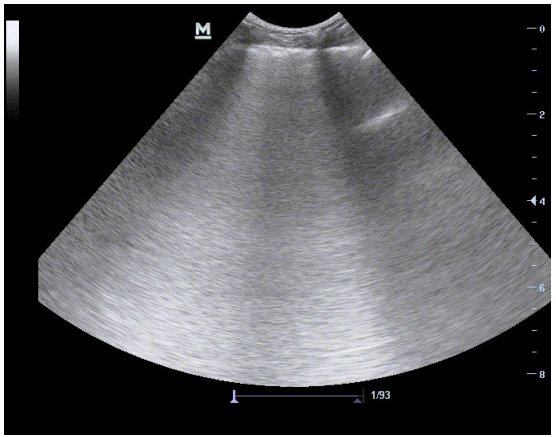
Daily fluid balance

- Over-estimate dehydration
- Underestimate overhydration
- Best to trend with time

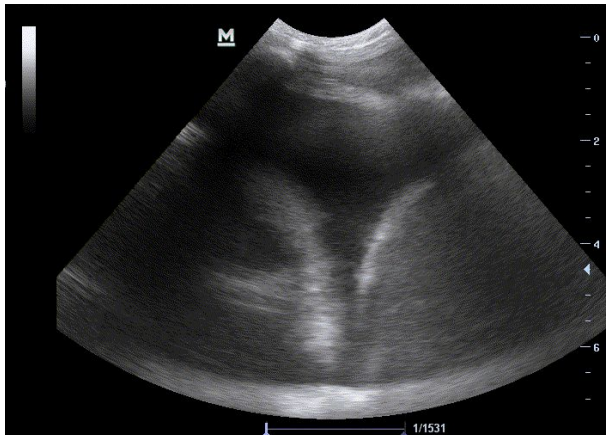


Daily POCUS

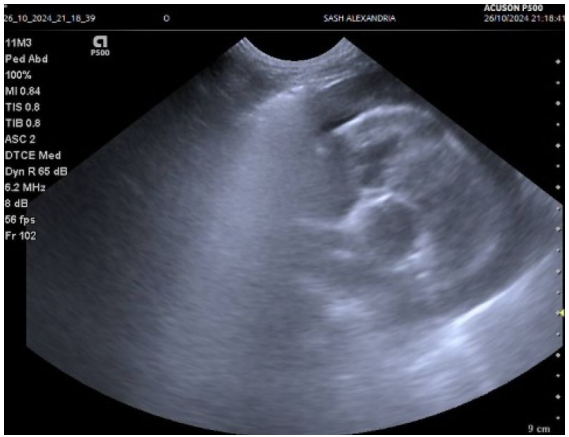
Signs of fluid overload



B lines



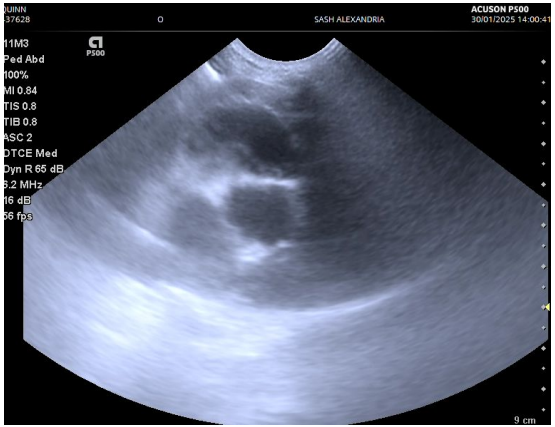
Pleural effusion



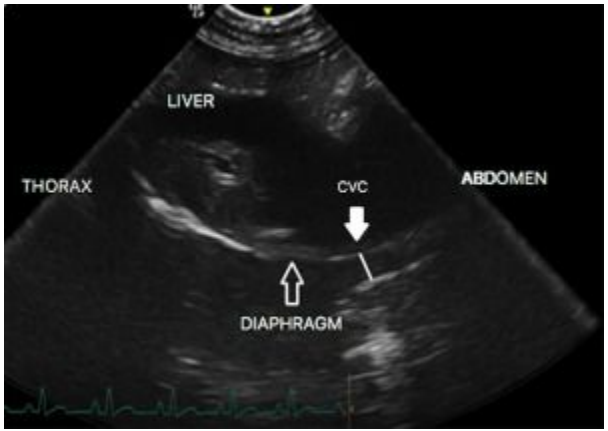
Pericardial effusion

Daily POCUS

Signs of fluid overload



↑ LA:Ao

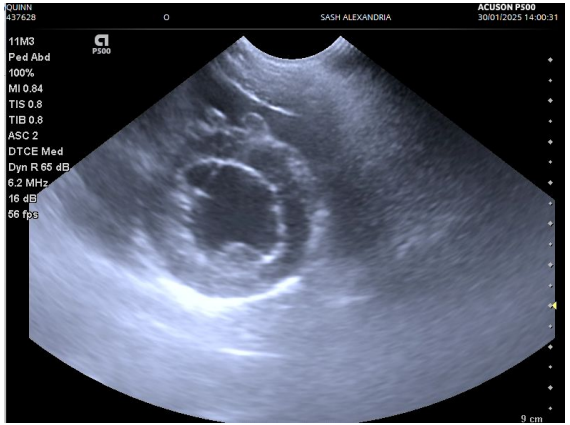


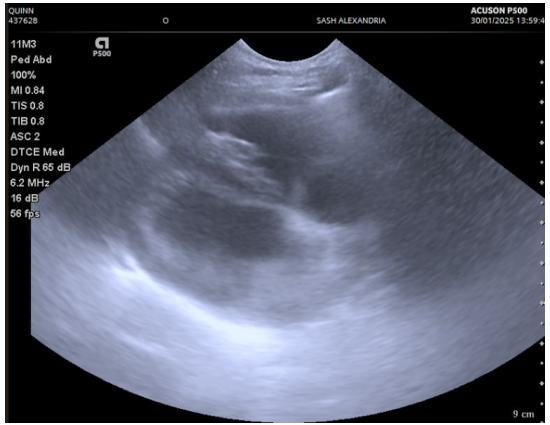
Non-collapsible vena cava

doi: 10.1111/jvim.15136

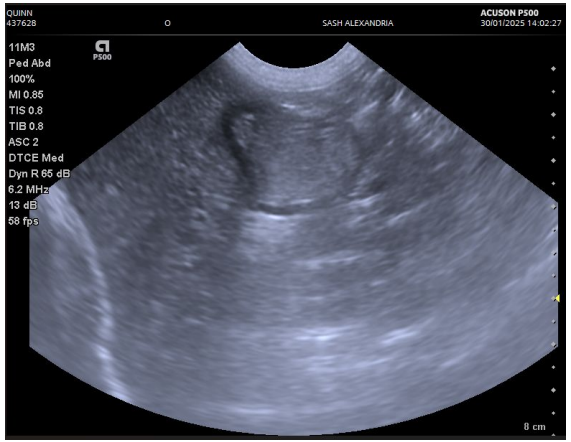
Daily POCUS

Signs of being underloaded





Inadequate LV filling



GIT losses

Big picture assessment

- Perfusion parameters
- Interstitial hydration
- POCUS

- Fluid volume in= out
- Weight (5% changes)
- PCV/TP

Break

Fluid overload is bad

Longer stay

Mortality

Retrospective evaluation of fluid overload and relationship to outcome in critically ill dogs

Amanda A Cavanagh [1], Lauren A Sullivan [1], Bernard D Hansen [2]

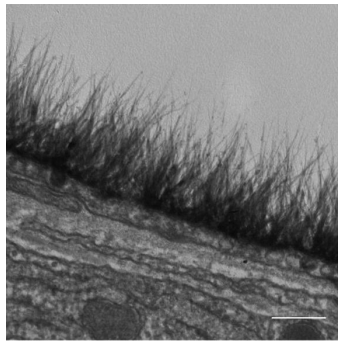
- **1% ↑ fluid overload**
- **Odds of death ↑ by 8%**

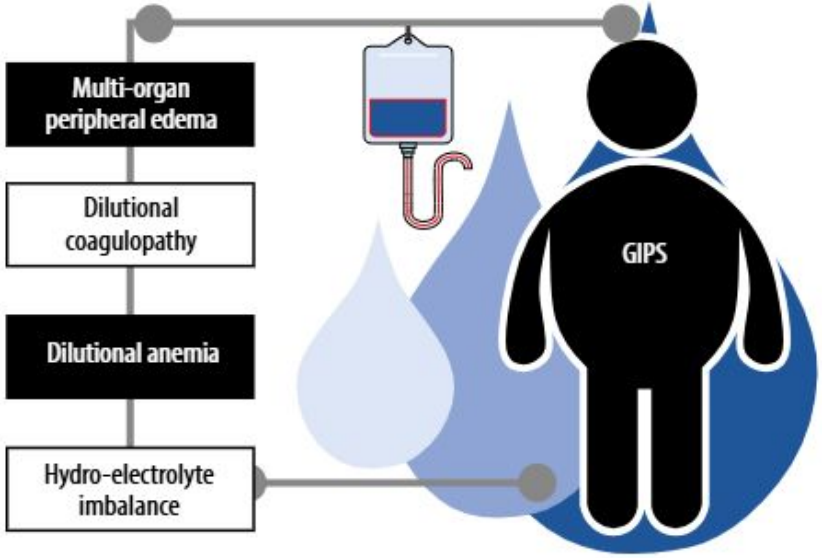
doi: 10.1111/vec.12477
doi: 10.5603/AIT.2014.0060
doi: 10.1097/CCM.0b013e3181feeb15

Fluid overload is bad

- **Multiple organs**
- **Poor GFR**
  - 7.5ml/hr for 5h ↓ perfusion within 5h
- **Intra-abdominal hypertension**

Glycocalyx degradation

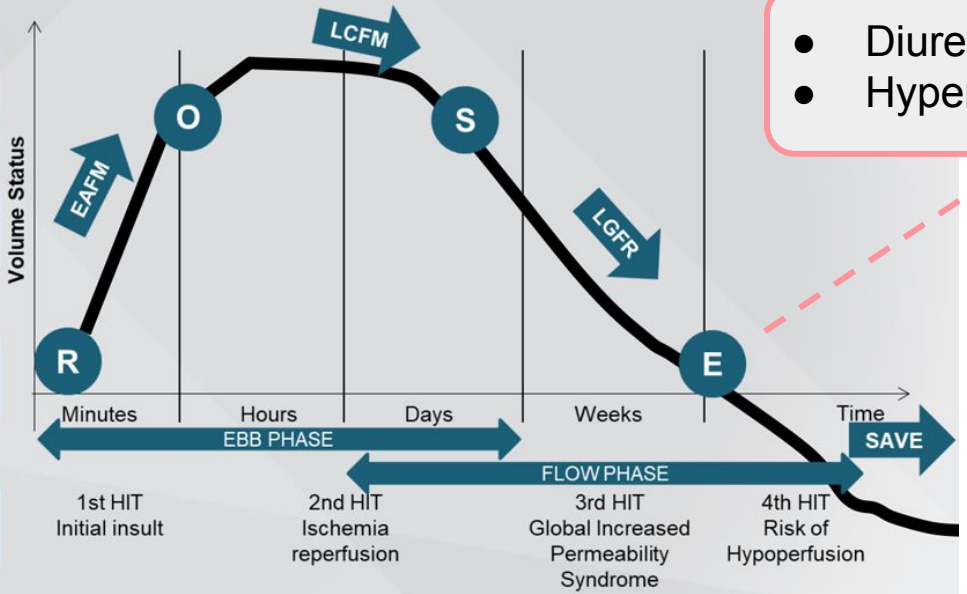




doi: 10.1111/vec.13125
doi: 10.2460/ajvr.75.4.344
doi: 10.5114/ait.2021.105252
SACCM chapter 9: The Endothelial Surface Layer

De-Escalation: The R.O.S.E. Model

- **R** Resuscitation
- **O** Optimisation
- **S** Stabilisation
- **E** Evacuation



- Diuretics
- Hyperoncotic album

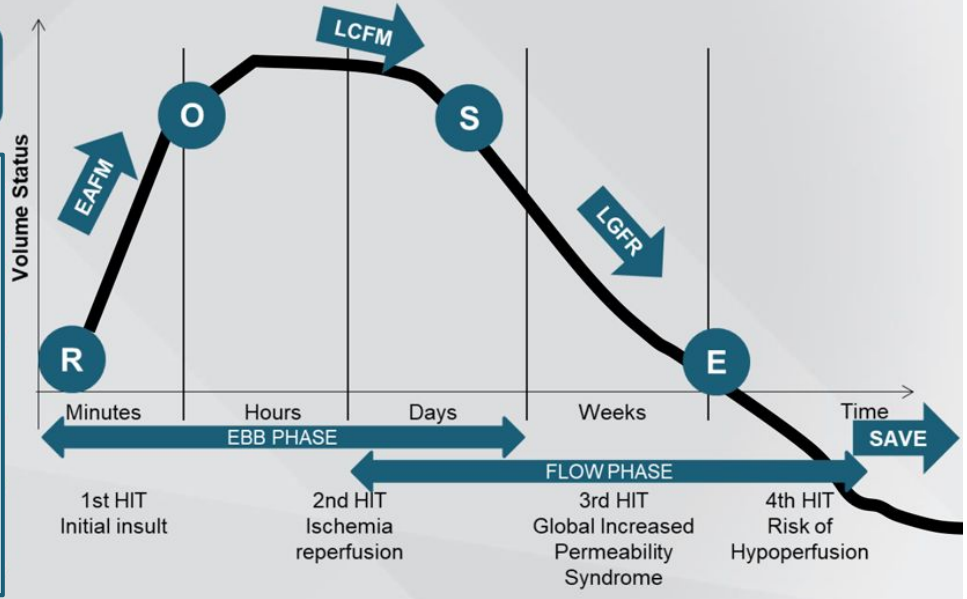
From: The International fluid academy

doi: 10.1016/j.jcrc.2018.07.020
doi:10.1007/s00134-022-06761-7
doi: 10.1097/CCM.0000000000003276

De-Escalation: The R.O.S.E. Model

R Resuscitation

- Resus to effect
- Restrictive resus



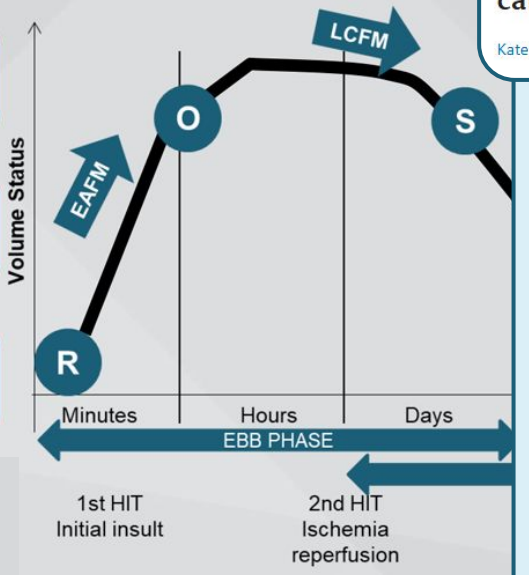
From: The International fluid academy

De-Escalation: The R.O.S.E. Model

Just enough maintenance fluids

O Optimisation

S Stabilisation



An online survey of small animal veterinarians regarding current fluid therapy practices in dogs and cats

Kate Hopper, Alejandro Garcia Rojas, Linda Barter

- 44% 60 ml/kg/day
- 30% 2-4 ml/kg/hr
- Minority indexed to body weight

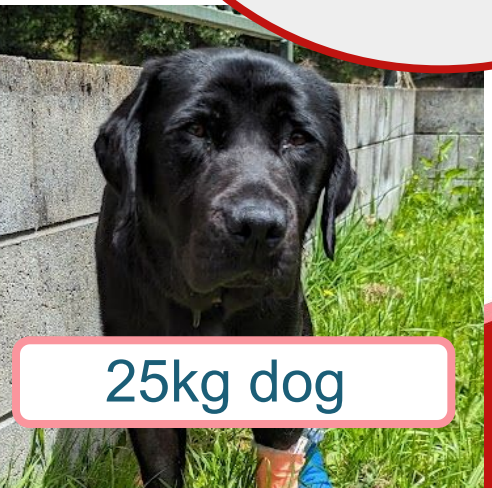
From: The International fluid academy

doi: 10.2460/javma.252.5.553

60ml/kg/day
=
62.5 ml/hr

2-4 ml/kg/h
=
50-100 ml/hr

70 X BW^0.75
=
32.5ml/hr

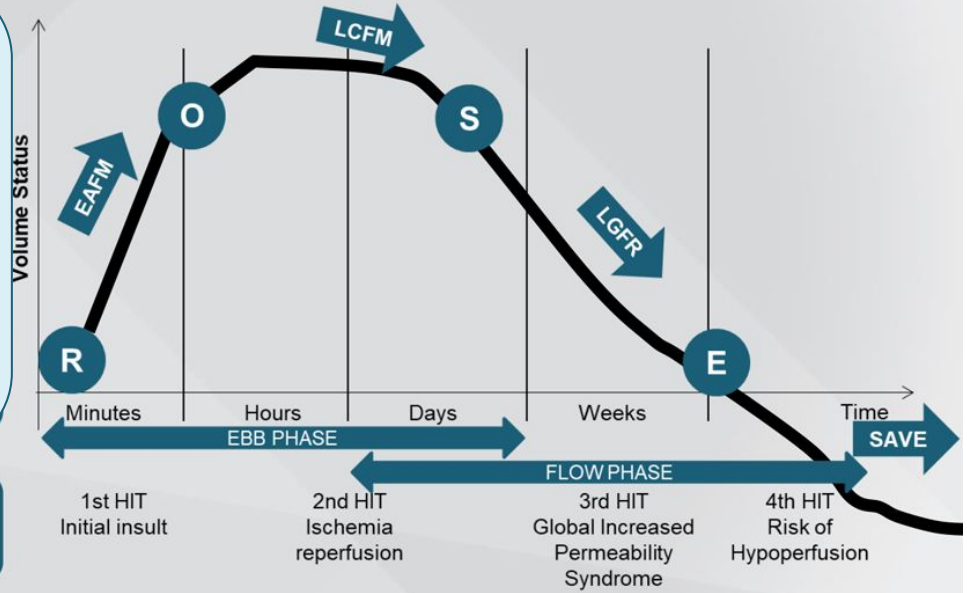


25kg dog

Fluid overload

De-Escalation: The R.O.S.E. Model

Achieving negative fluid balance improves mortality



E Evacuation

doi: 10.1007/s00134-022-06761-7
doi: 10.1097/CCM.0000000000003276

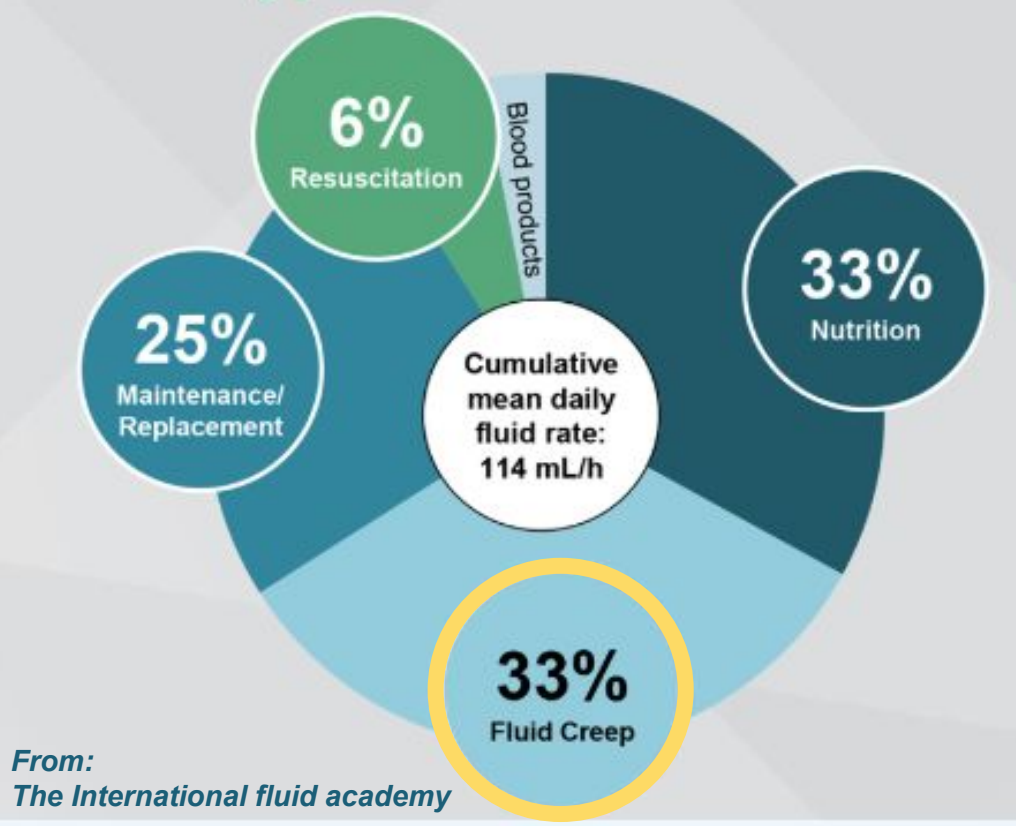
Fluid overload

- Stop or decrease fluid therapy
- Frusemide

- Up to 20mg total over 3 days
- 5-40 mg total + CRI

- 0.2- 0.5mg/kg, up to 1 mg/kg
- Single dose or q 6-8h

Fluid creep

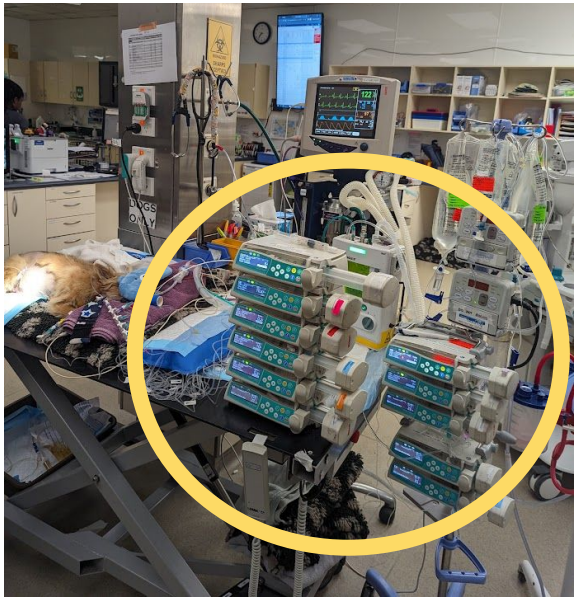


From:
The International fluid academy

- Diluents, flushes
- Contributes to large sodium and chloride load

doi: 10.1007/s00134-018-5147-3
doi: 10.1097/CCM.0000000000003276

Fluid creep



Easy to exceed daily maintenance requirements

- Less diluted drugs
- Use sterile water or NaCl 0.45%?

Break

Debates about fluid type in the ICU

Balanced crystalloids

Fluid image

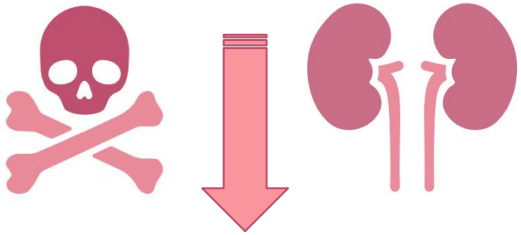
VS

NaCl 0.9%

Fluid image

The NEW ENGLAND JOURNAL of MEDICINE

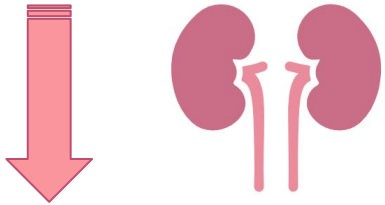
Balanced Crystalloids versus Saline in Critically Ill Adults

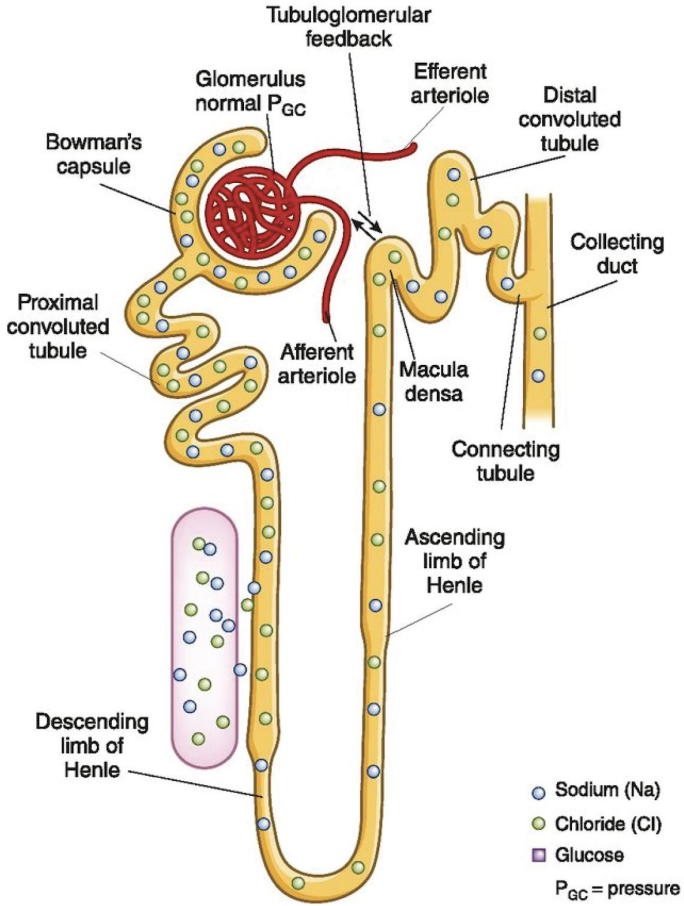


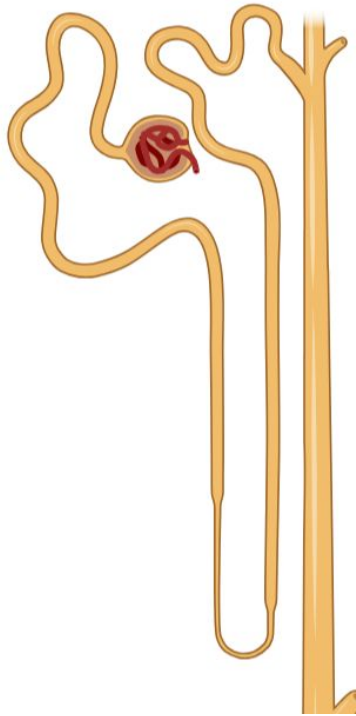
2018

The NEW ENGLAND JOURNAL of MEDICINE

Balanced Crystalloids versus Saline in Noncritically Ill Adults

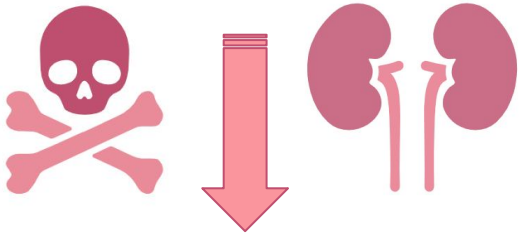






The NEW ENGLAND JOURNAL of MEDICINE

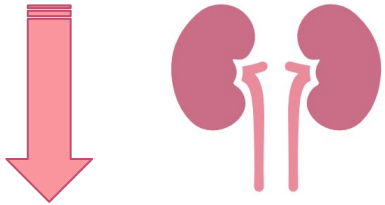
Balanced Crystalloids versus Saline in Critically Ill Adults



2018

The NEW ENGLAND JOURNAL of MEDICINE

Balanced Crystalloids versus Saline in Noncritically Ill Adults



2021

JAMA

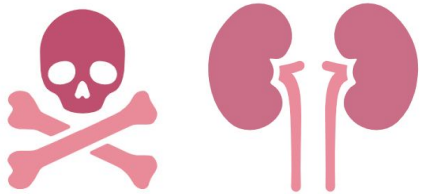
Effect of Intravenous Fluid Treatment With a Balanced Solution vs 0.9% Saline Solution on Mortality in Critically Ill Patients

The BaSICS Randomized Clinical Trial

2022

The NEW ENGLAND JOURNAL of MEDICINE

Balanced Multielectrolyte Solution versus Saline in Critically Ill Adults



No difference

doi: 10.1056/NEJMoa1711584
doi: 10.1056/NEJMoa1711586
doi:10.1001/jama.2021.11684
doi: 10.1056/NEJMoa2114464

What to do?

Balanced crystalloids preferred

NaCl 0.9%

- *Limited stocks*
- *Metabolic alkalosis*

Isotonic crystalloids

Fluid image

VS

Hypotonic NaCl 0.45%

Fluid image

Isotonics

High Na load + fluid overload

NaCl 0.45%

- + 2.5% dextrose (iso-osmolar)
- Risk of hyponatremia due to non-osmotic ADH release
  - RAAS activation in states of hypovolemia
  - SIADH
  - Children + adults

What to do w NaCl 0.45%?

Use

- Maintenance fluids only
- HyperNa tx
- Can't tolerate Na load
  - CHF or renal dz
- Minimize fluid overload

Avoid

- In hypoNa
- Patients at risk of hypoNa
  - SIADH
  - Repeated RAAS activation

Break

The hypoproteinemic patient

Hypoalbuminemia

GIT losses

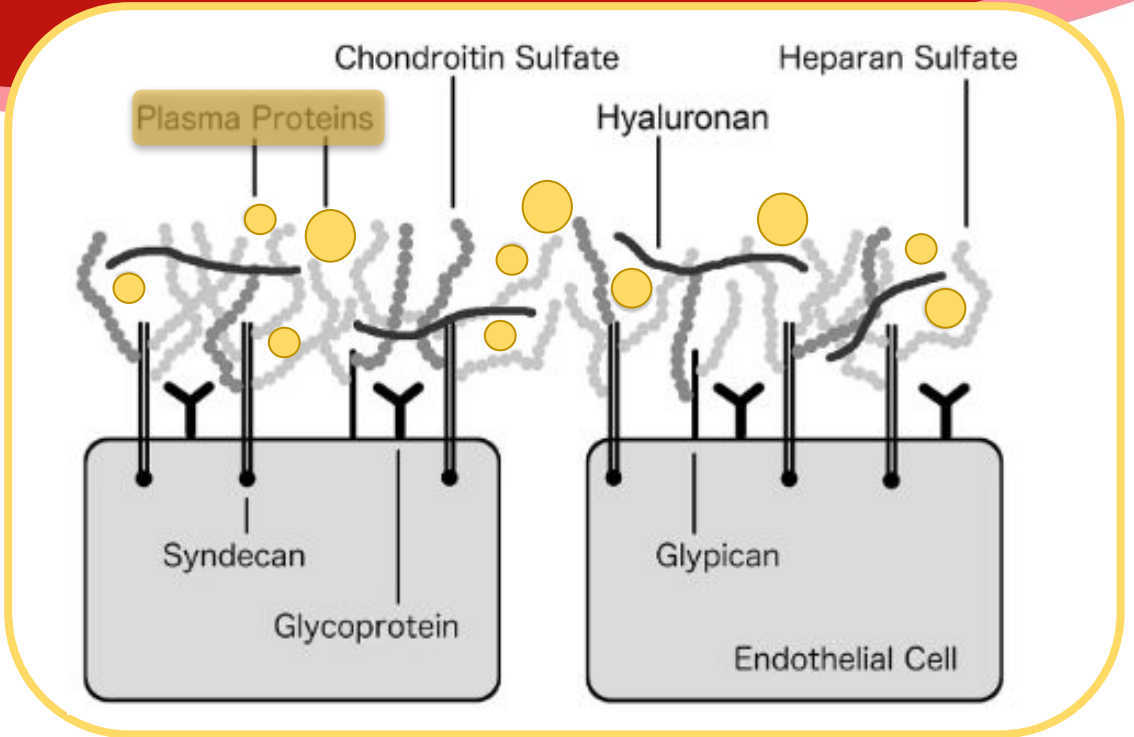
AHDS
Parvovirus
PLE

Hemorrhage

Inflammatory processes

Dilutional effect from fluids

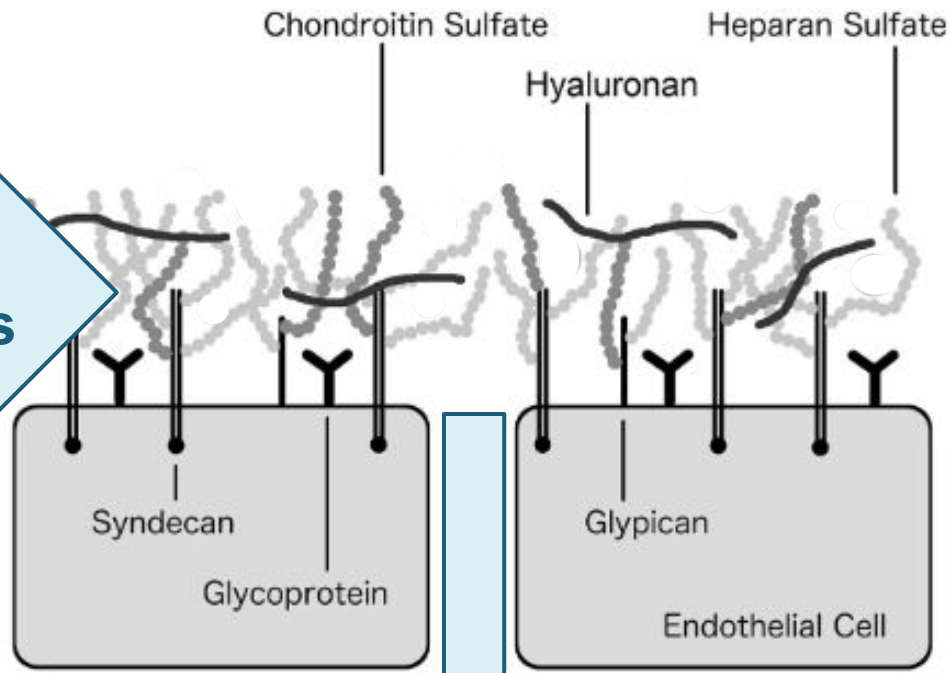
Hypoalbuminemia



doi: 10.1186/s13054-019-2369-x

Hypoalbuminemia

Isotonic crystalloids



doi: 10.1186/s13054-019-2369-x

Colloid support: when?

Start receiving colloids

TP ~4.0g/dL

Albumin 15-20 g/dL

Reasons

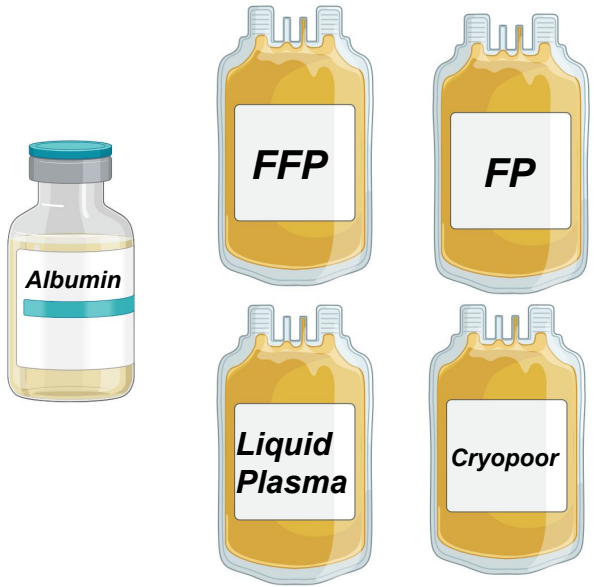
- **Refractory hypotension**
- **Refractory hypovolemia**
- **Interstitial edema**

doi: 10.1016/j.vaa.2024.07.005
doi: 10.1111/vec.12834
doi: 10.1111/vec.13286

Colloid support: what?

Synthetic colloids

Natural colloids



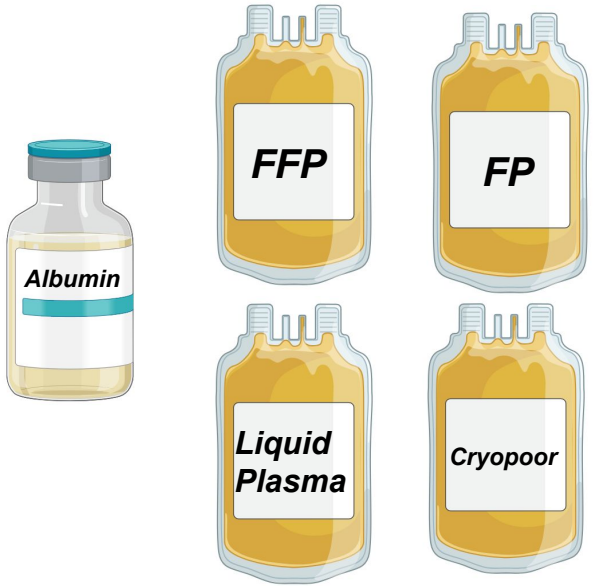
Colloid support: what?

Synthetic colloids

Aim

- *Not specific alb level*
- *CVS stability*
- *↓ crystalloid use*

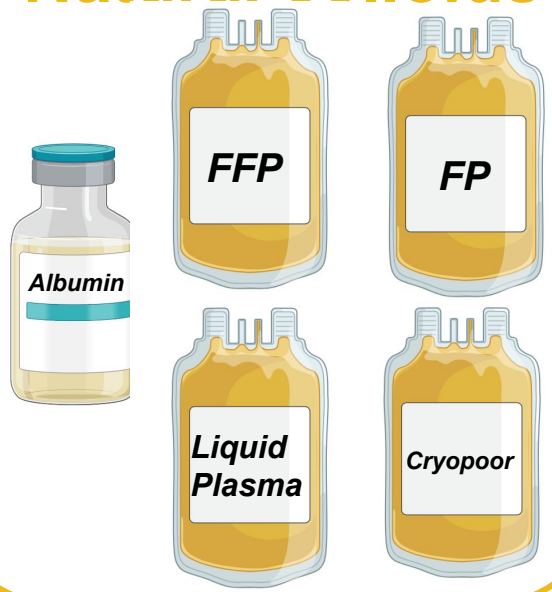
Natural colloids



Colloid support: how?

- 2 ml/kg/hr
- Median 0.72 g/kg

Natural colloids

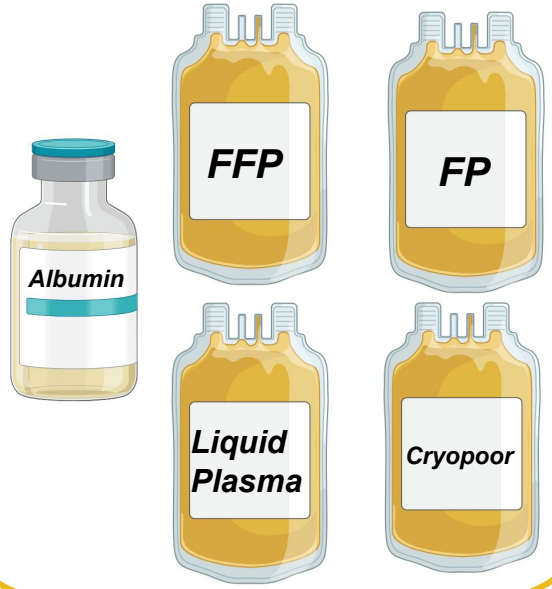


- 4-8 ml/kg bolus 20mins, 1-2 ml/kg/h CRI
- 10-20 ml/kg over 2-4h
- Maintenance fluid
- 50% crystalloid + 50% colloid

doi: 10.1111/vec.12834
doi: 10.1111/vec.12834

Colloid support: how?

Natural colloids



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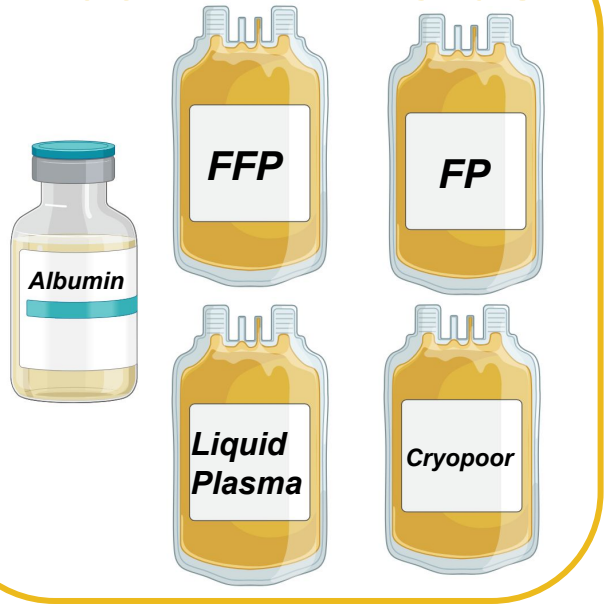
Colloid support: how?

Natural colloids



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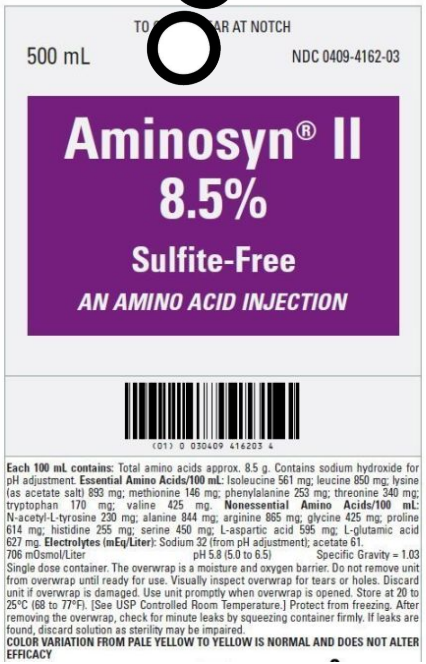


The future?

scientific reports

OPEN

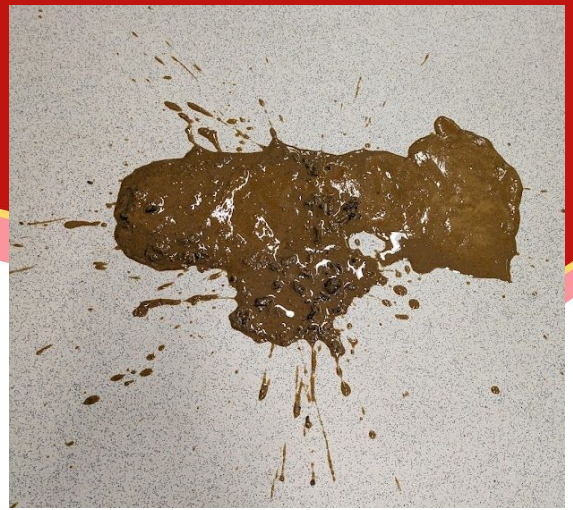
Polyoxazoline-conjugated porcine serum albumin as an artificial plasma expander for dogs

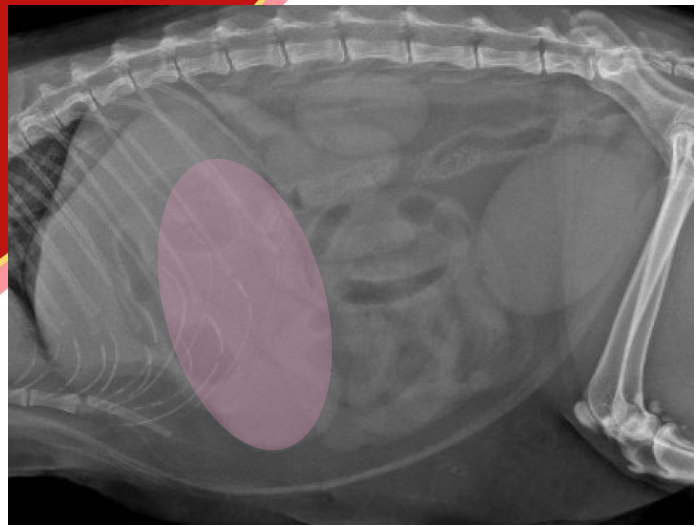
Wataru Okamoto[1], Tomone Usui[1], Mai Hasegawa[1], Tatsuhiro Kobayashi[1], Junya Fujisawa[1], Kazuaki Taguchi[2], Kazuaki Matsumoto[2], Mitsutomo Kohno[3], Masayuki Iwazaki[4], Shotaro Shimano[5], Itsuma Nagao[5], Hiroto Toyoda[5], Naoki Matsumura[5], Hirotaka Tomiyasu[5], Ryota Tochinai[6] & Teruyuki Komatsu[1]✉

doi: 10.1038/s41598-023-35999-4

Break

Excessive fluid losses





When to stop pushing?

Recurrent hypovolemia from losses

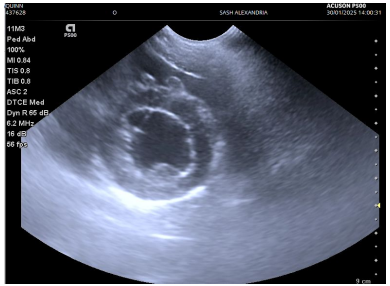
Normal plasma protein

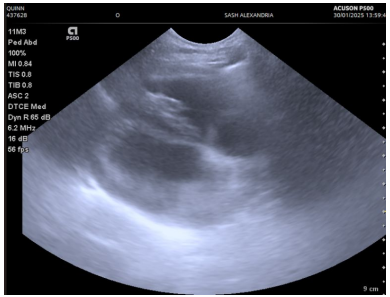
- Isotonic boluses

Low plasma protein

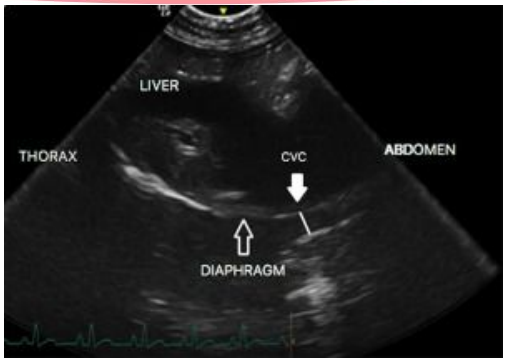
- Consider colloids

Fluid responsiveness

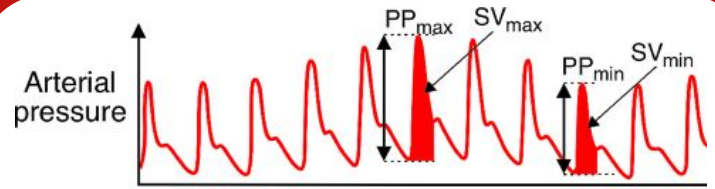




LV filling



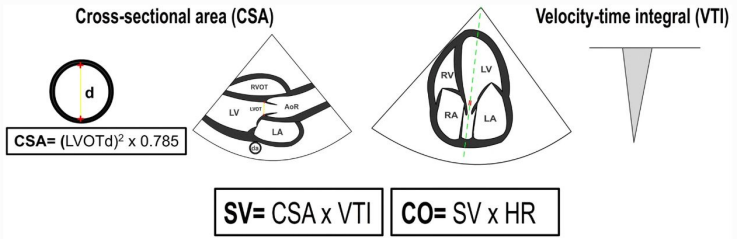
Vena cava collapsibility



$$PPV\ (\%) = \frac{PP_{max} - PP_{min}}{\frac{PP_{max} + PP_{min}}{2}} \cdot 100\ (\%)$$

> 11-16%

Pulse pressure variation



Velocity time integral

Vasopressor dependent

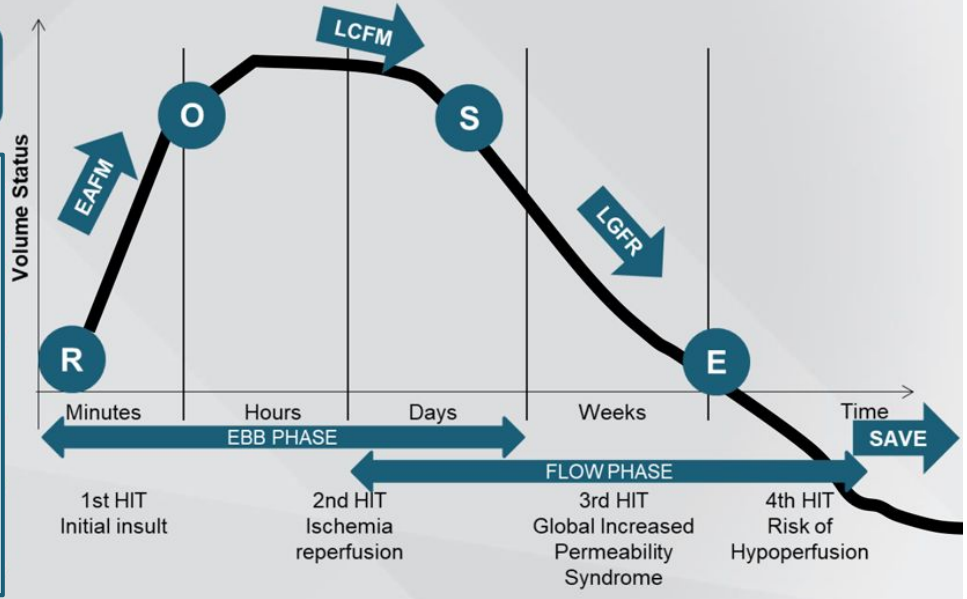
Persistent despite fluids

- Hypotension
- ↑ lactate
- Altered perfusion parameters
- Not fluid responsive on POCUS

De-Escalation: The R.O.S.E. Model

R Resuscitation

- Resus to effect
- Restrictive resus



From: The International fluid academy

Early pressors

- 2019 CENSER trial
- ↑ shock control at 6h

Restrictive fluids

- CLASSIC + CLOVERS
- No improvement in mortality

Pressor push

- Phenylephrine + epinephrine
- Critical hypotension + peri-sx
- Effective + safe
- More studies needed

Early vasopressin + hydrocortisone

- Earlier shock reversal
- Less time on NE

doi: 10.1164/rccm.201806-1034OC
doi: 10.1016/j.ajem.2022.08.055
doi: 10.1056/NEJMoa2212663
doi: 10.1056/NEJMoa2202707
doi: 10.1016/j.ajem.2021.05.007

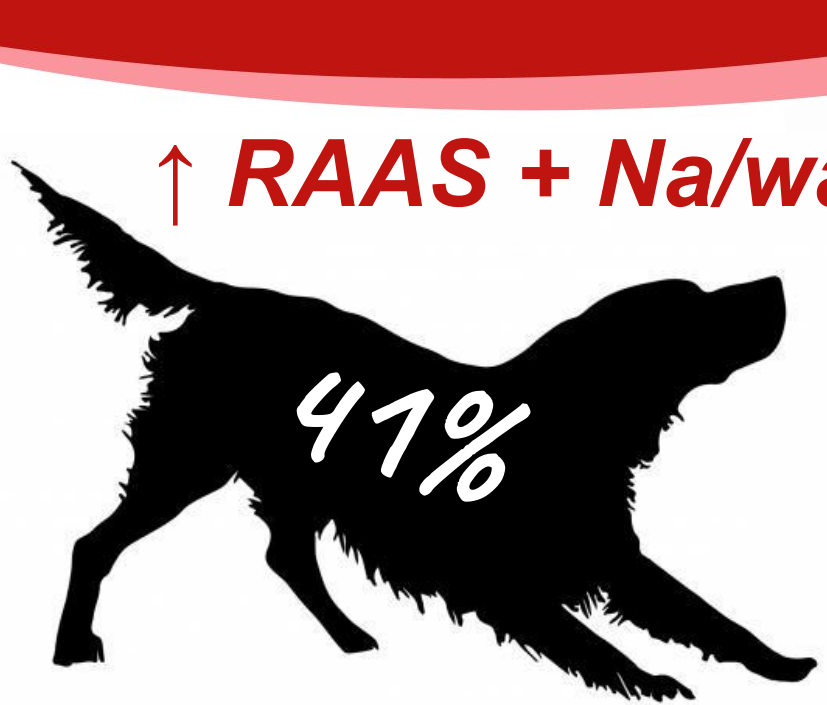
CHF with azotemia

CHF with azotemia

doi:10.1111/jvim.17254
doi: 10.1111/jvim.16571

CHF with azotemia

↑ RAAS + Na/water retention



doi:10.1111/jvim.17254
doi: 10.1111/jvim.16571

CHF with azotemia

NG tube water

0.5-1 x M

NaCl 0.45% or LRS

0.5-1 x M
1-2 ml/kg/hr

3% replacement

Over 24-48h

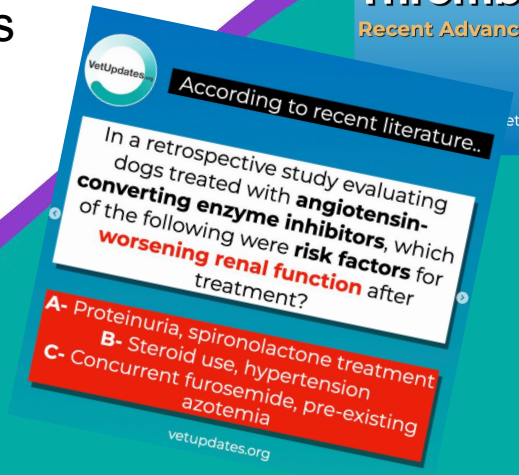
Highlights

- Daily fluid balance (70 xBW^0.75)
- Beware of fluid creep
- Balanced crystalloids
- Hypoproteinemia + plasma products
- Don’t overdo fluids when vasopressors needed

VetUpdates

STAY IN THE LOOP

- Monthly lit newsletters
- Guidelines/Reviews
- Lit quizzes
- And more!



Questions?