

FLUIDS





Fluid Accumulation Syndrome

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Disclosures

Nil

FAS

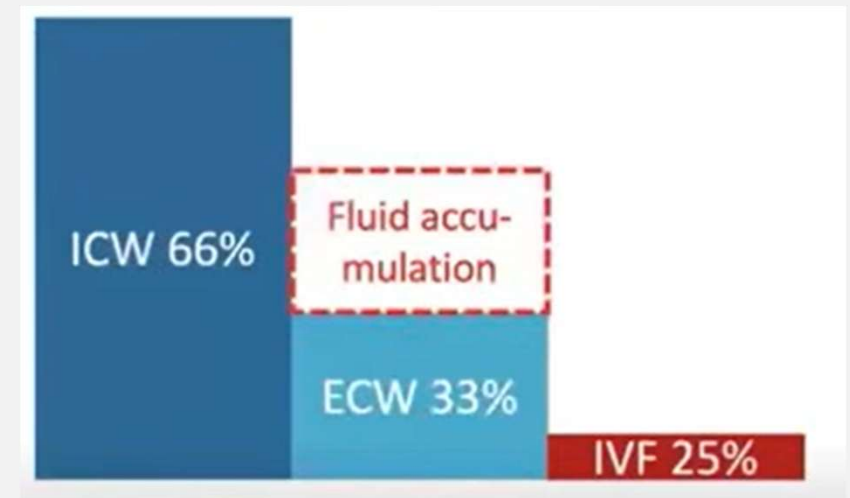
- Fluid accumulation of any degree expressed as a percentage from baseline body weight associated with new organ dysfunction
- FA calc: $\text{Cumulative fluid balance} / \text{Baseline body weight} \times 100$
- SOFA score >3

Fluid accumulation in critically ill children: a systematic review and meta-analysis

- Fluid accumulation(FA) affects 1/3 of children in PICU (Radish Alobaidi et al, 2018)
- FA is associated with increased mortality - 6% increase in odds of mortality per 1% increase of FA%
- Increase in AKI , length of stay in ICU and duration of mechanical ventilation
- Overall associated with poor clinical outcomes

THE TRANSITION

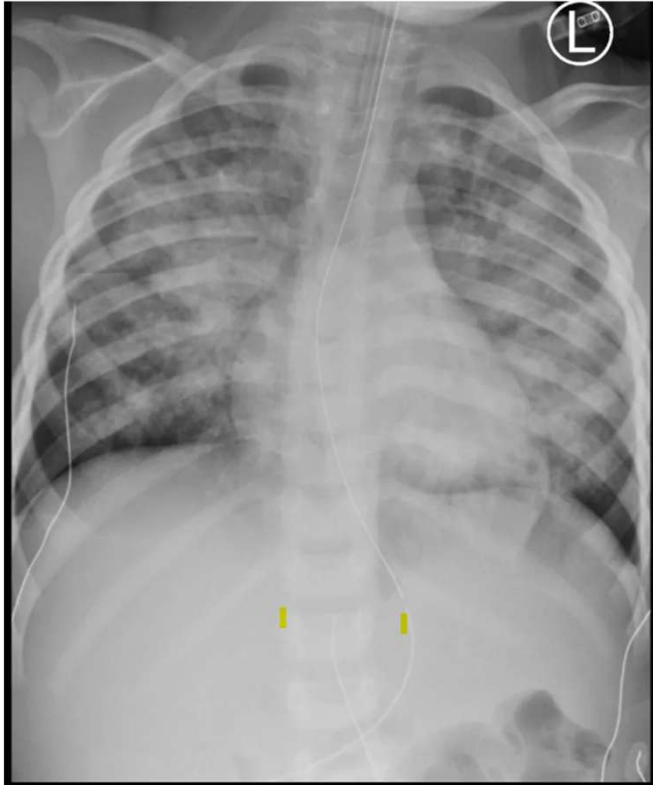
- Shift from fluid overload
- May misleadingly refer intravascular hypervolemia
- Misguided therapeutic decisions
- ECW



RECOGNITION

- **No gold standard**
- Clinical : Pitting oedema
- Daily body weight
- Cumulative fluid balance
- Bioelectrical impedance analysis
- New organ dysfunction





- **US:** Lung ,Echo, VExUS score
- **CXR:** Kelly B-lines/Pleural effusions/Interstitial oedema/alveolar oedema
- **Advanced cardiac monitoring**
Transpulmonary thermodilution PiCCO
-EVLW, Pulm Vascular Permeability Index

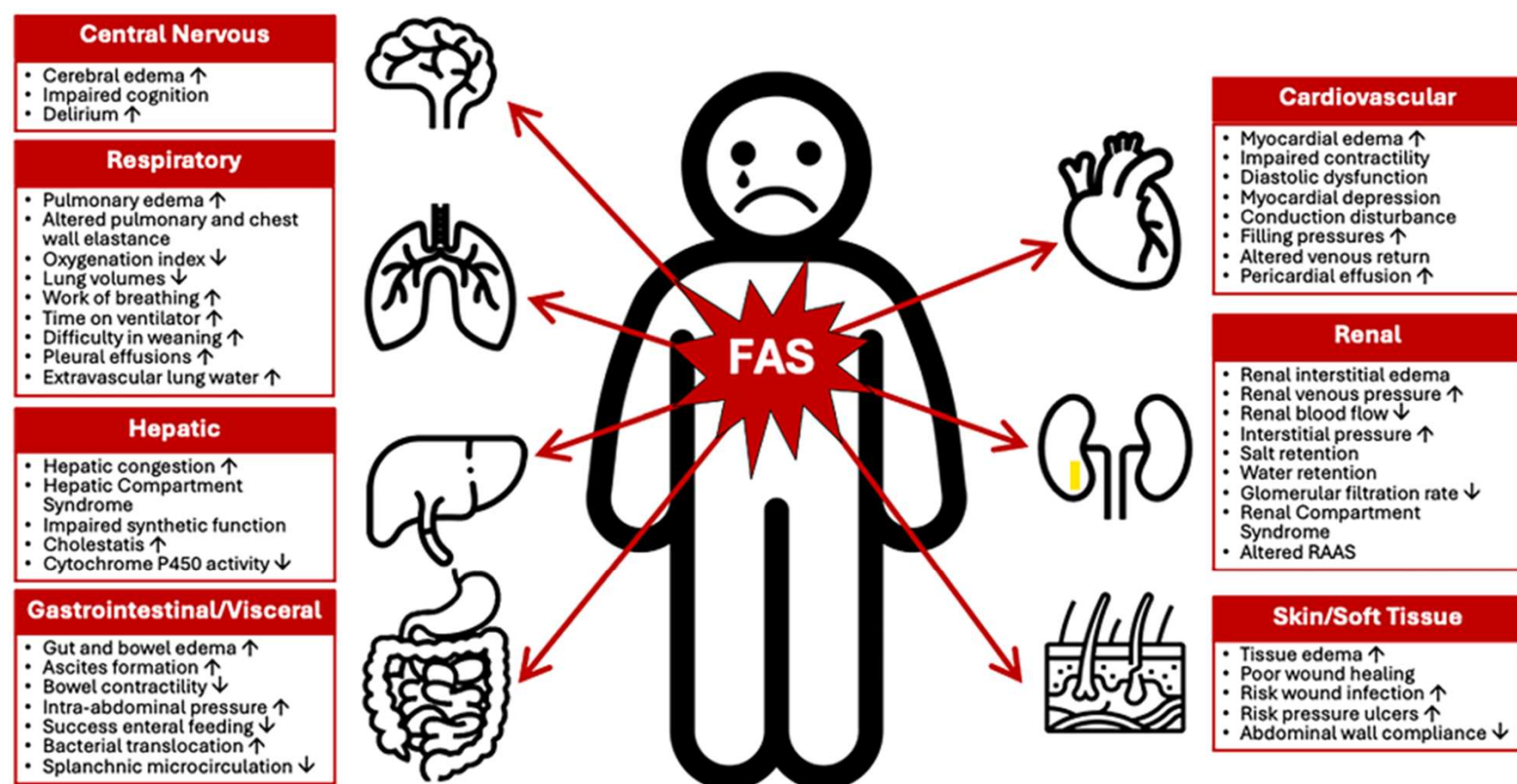
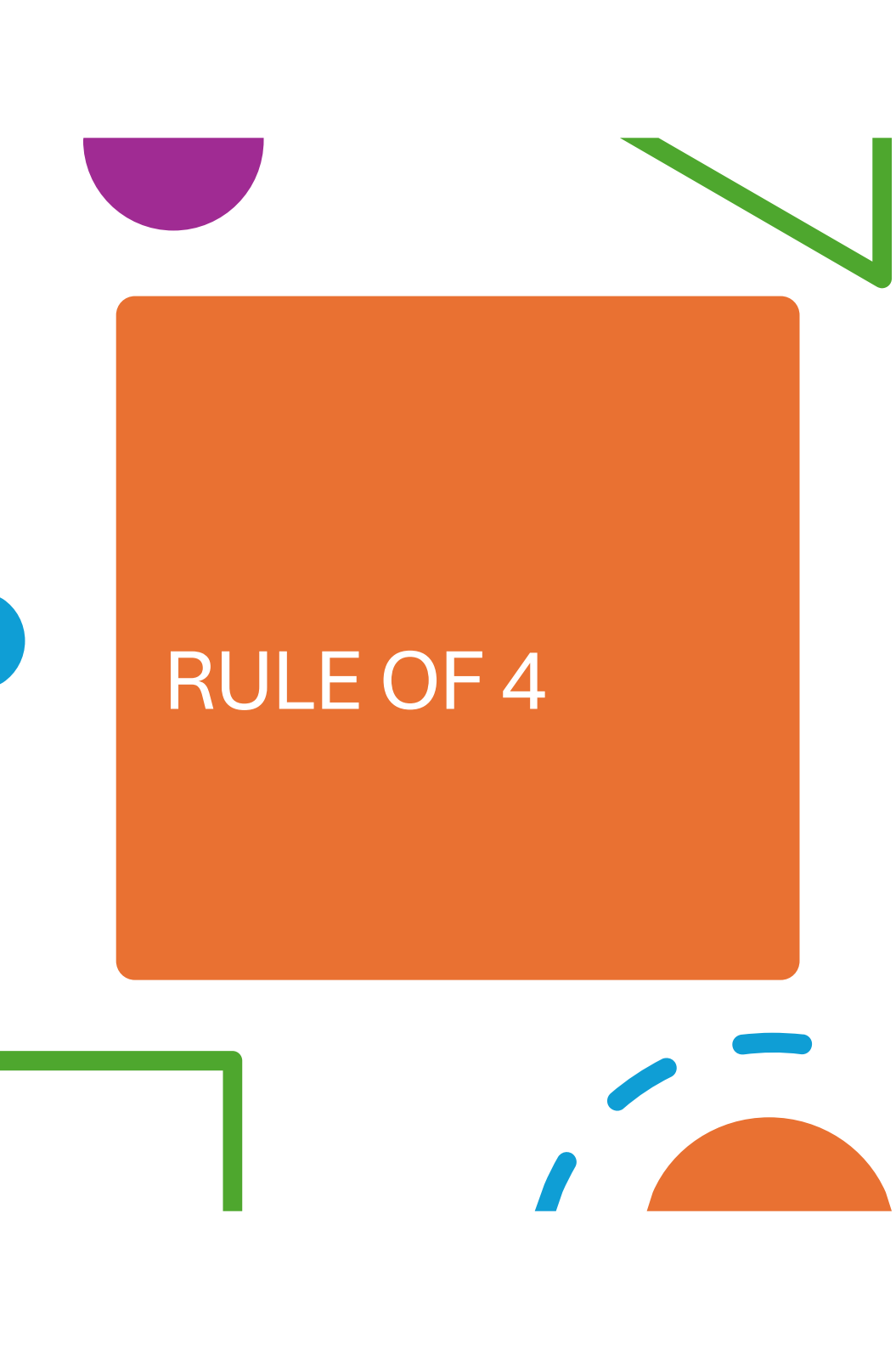


Fig. 1 Potential adverse consequences of fluid accumulation. Adapted with permission from Malbrain et al. according to the Open Access

PREVENTION





RULE OF 4

4D's

4 Indications

4 Phases

4 Questions

4D's

Fluid stewardship = Antibiotic Stewardship

- **Drug** – type of fluid
- **Dose** – volume required
- **Duration** – how long
- **De-escalation** – when to stop/reduce

4D	7D	10D
1. Drug	1. Definition	1. Definition
2, Dose	2. Diagnosis	2. Diagnosis
3. Duration	3. Drug	3. Distribution
4. De-escalation	4. Dose	4. Drug
	5. Duration	5. Dose
	6. De-escalation	6. Duration
	7. Documentation/Discharge	7. De-escalation
		8.Documentation
		9. Diligence
		10. Discussion

Drug

- Fluid choice

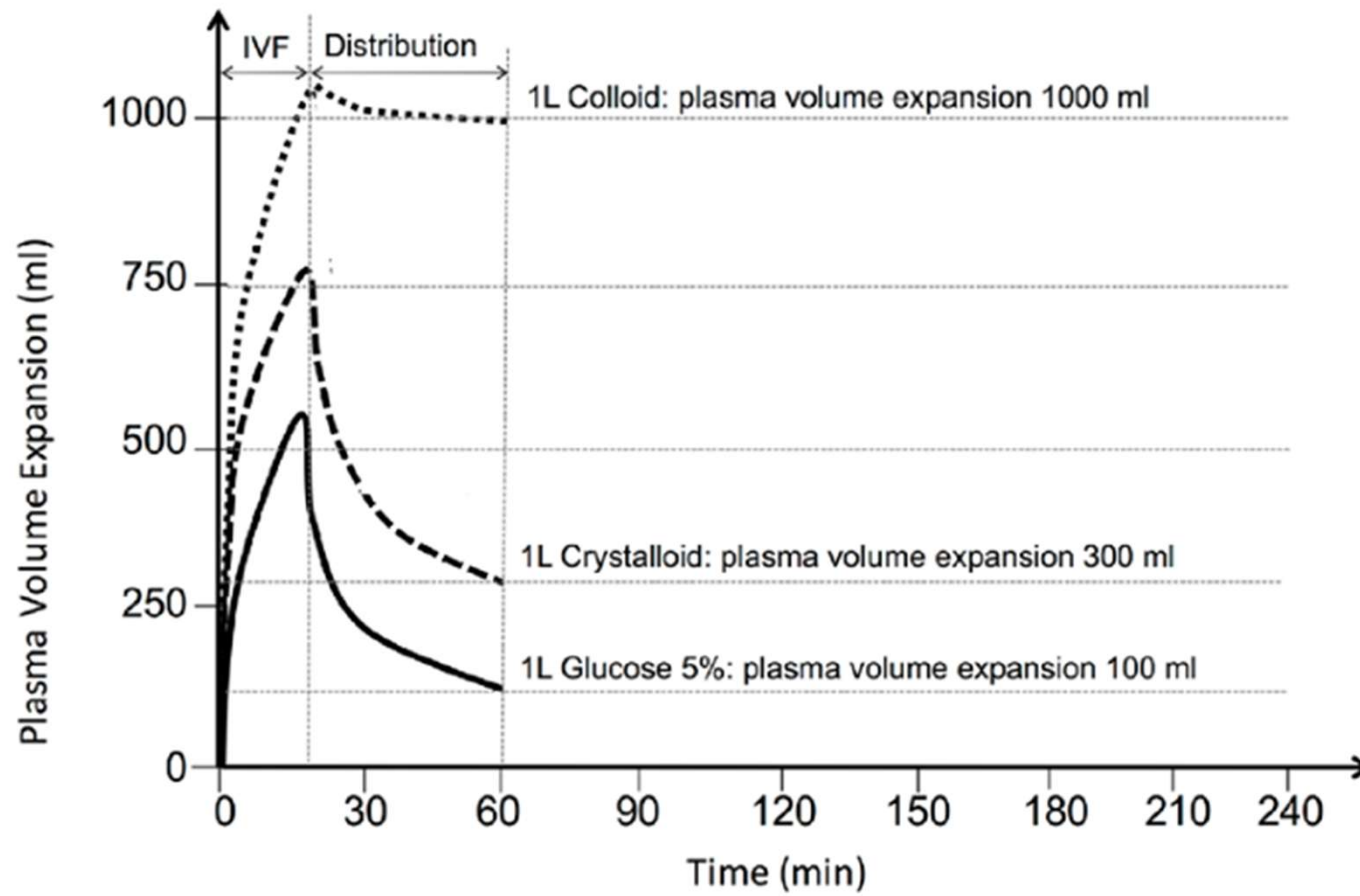
Balanced crystalloids solutions

Plasmalytes/Ringers' Lactate

- (Ab)Normal Saline : negative effects
 - * SID
 - * NAGMA
 - * AKI
 - * Mortality



Pk/Pd



Definition

- Fluid responsiveness (FR)
 - * FR $\neq$ Fluid administration
 - * FR $\neq$ Fluid tolerance
- Fluid creep
- De-escalation
- De-resuscitation



FLUID RESPONSIVENESS

- Dynamic makers
- Static makers

Mimic fluid challenge

* **Passive leg raise test**

* Mini fluid bolus challenge

Dependant on heart-lung interaction

PPV/SVV/IVC collapsibility index/EEOT/TV challenge

Sigh maneuver

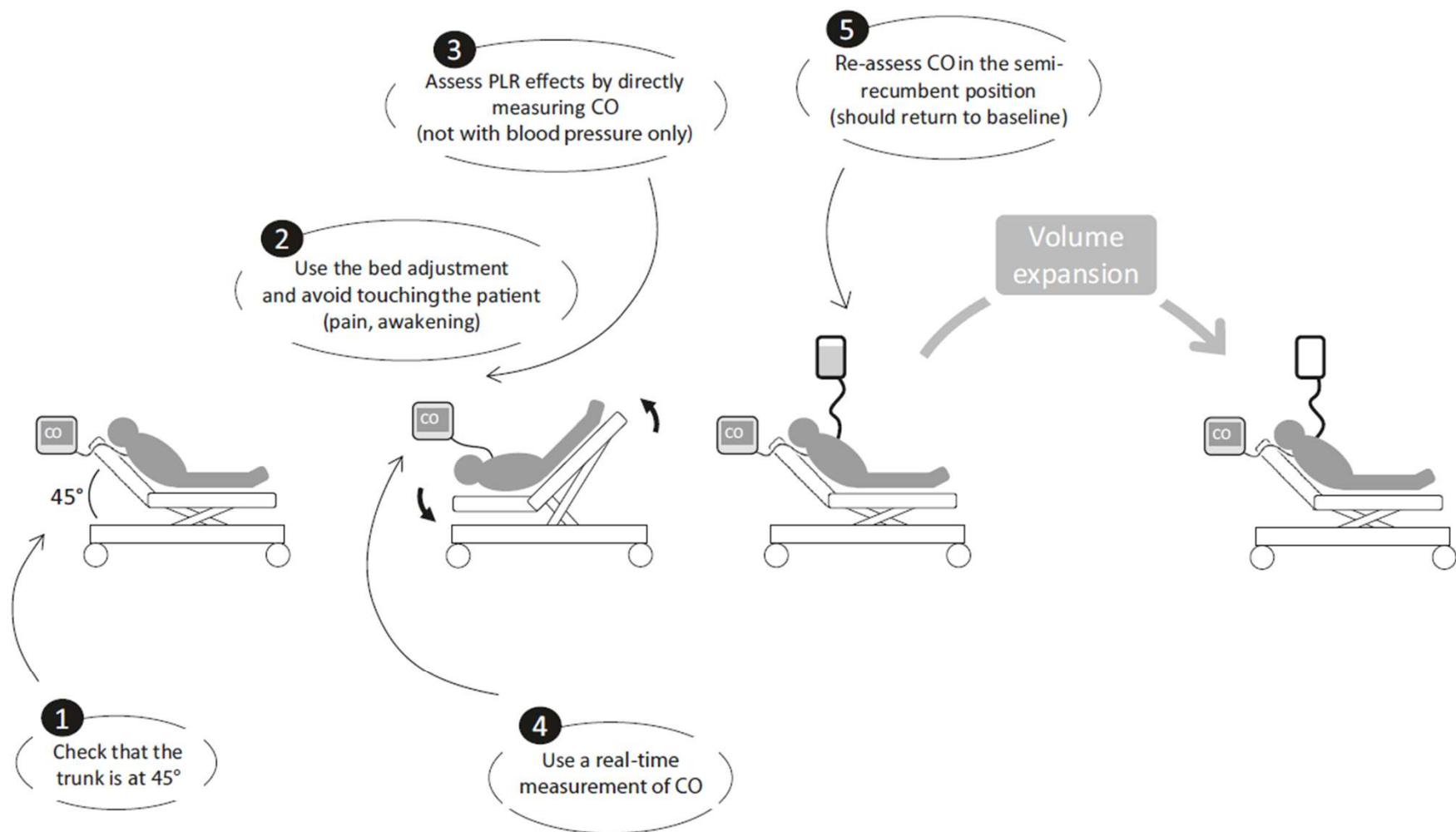
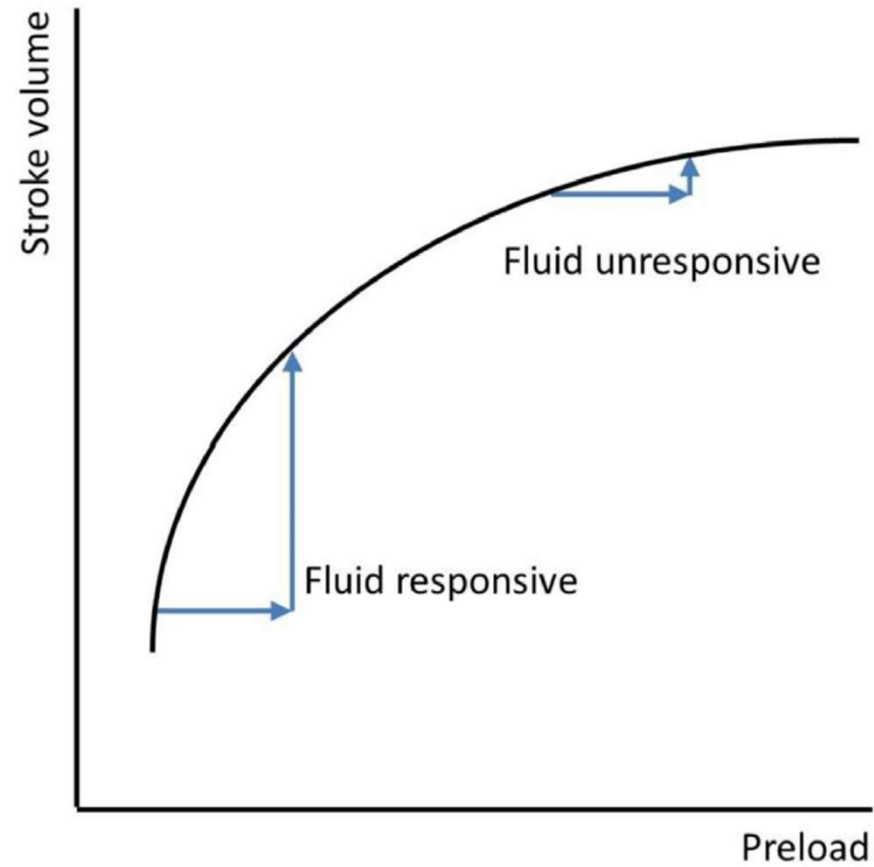


Figure 1 The best method for passive leg raising, indicating the five rules to be followed. CO, cardiac output; PLR, passive leg raising.



CHOKESLAM

FRANK-STURLING CURVE



Ilonka N. de Keijzer, MD*, Thomas W.L. Scheeren, MD, PhD

4 INDICATIONS

Resuscitation

Replacement

Maintenance

Nutrition



INDICATIONS

- **Resuscitation** – hypovolaemia , fluid responsive, hypoperfusion, no risk of FAS
- **Maintenance** : glucose ,water & electrolytes
- **Replacement** – replace what is lost
- **Nutrition** - dense calory feeds ,
transition from parenteral/enteral to oral when feasible

How much

- **Bolus** : 10-20ml/kg
NB! Reassess after each bolus
- **Maintenance fluids** : Holliday and Segar
4-2-1 formula
≥1yr & 10kg

Mortality after Fluid Bolus in African Children with Severe Infection

Maintenance fluids

Clinical Research Article | Published: 17 March 2021

Non-resuscitation fluid in excess of hydration requirements is associated with higher mortality in critically ill children

[Matthew F. Barhight](#) , [Delphine Nelson](#), [Grace Chong](#), [Rajit K. Basu](#) & [L. Nelson Sanchez-Pinto](#)

The determinants of fluid accumulation in critically ill children: a prospective single-center cohort study

Original
Article

AIM: To investigate the causes and impact of fluid accumulation in critically ill children.

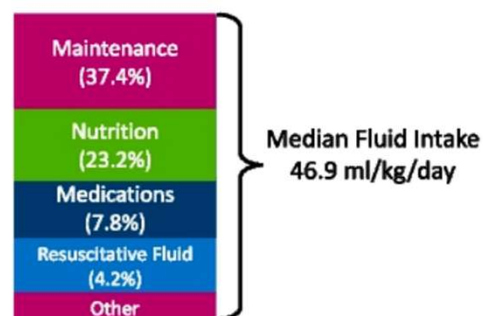
DESIGN & OUTCOMES:

99 PICU
patients



Prospective
Single Centre
Study

Contributors to Fluid Intake



Children with Peak Fluid accumulation $\geq 5\%$

- ▲ Total Fluid Intake and Output
- ▲ Maintenance, Nutrition,
Medication Fluid

Total Fluid Intake Associated with Fluid
Accumulation $>5\%$

Peak Fluid accumulation % associated with
decreased intensive-care-free days

CONCLUSION: Higher fluid intake, rather than reduced output, was the predominant factor in fluid accumulation, with maintenance fluid being the largest source of intake. Calculation of maintenance fluid requirements should be reconsidered, as the so-called "4-2-1" rule is excessive.

Mohoric et al. 2025



Pediatric Nephrology

Journal of the
International Pediatric Nephrology Association

4 Phases

Resuscitation

Optimization

Stabilization

Evacuation

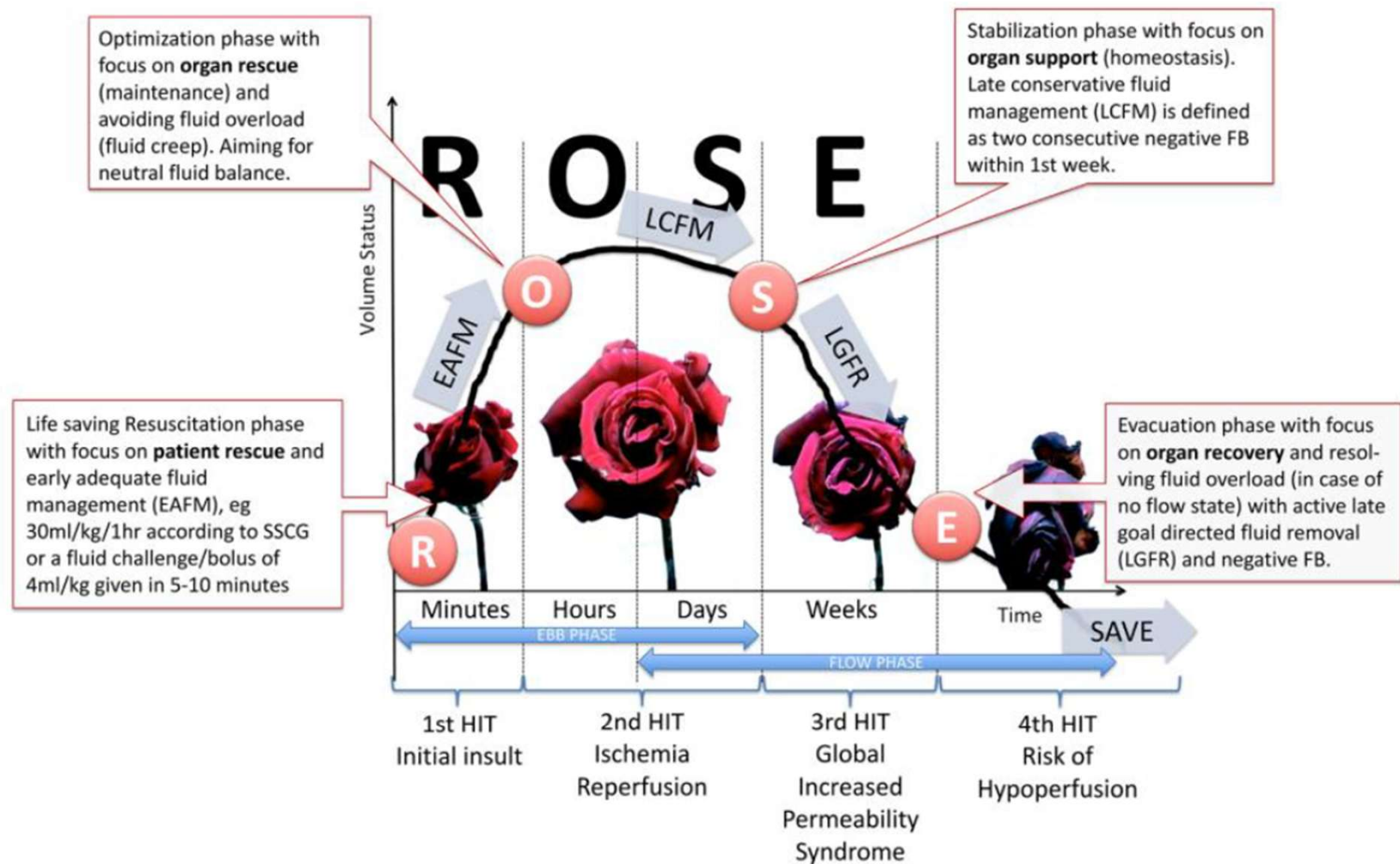


Figure 2. ROSE Concept Diagram³

Treating Fluids as Drugs: Four Questions About Fluid Therapy

- 1 When to start fluids? 
- 2 When to stop fluids? 
- 3 When to start fluid removal? 
- 4 When to stop fluid removal? 

Prevention Strategies

- Administer fluids with an indication
- Assess for fluid responsiveness
- Balanced crystalloids solution preferred over N/S
- Use vasoactive agents early
- Consider Albumin 20% if low ($<30\text{g/l}$)
- Limit fluid creep
- Use high density enteral formula
- De-escalate fluid as soon as tolerable

TREATMENT

- De-resuscitation should be initiated
- Pharmacological
 - * Diuretics
- Renal replacement therapy





SUMMARY

- Fluid accumulation is associated with higher mortality and morbidity
- Preventative strategies should be prioritized
- Patient centred fluid administration strategies
- Judicious fluid administration saves lives
- Continuous knowledge acquisition on fluids is KEY!!



"All things are poison and nothing is without poison; only the dose permits something not to be poisonous" Paracelsus

We need to continually and critically evaluate EACH patient at each phase of their disease process and decide on THE dose of "poison" that is acceptable

