# *Perioperative fluids: which one, how much, how long?*

Chair: Daniela Ionescu

Saturday, May 25, 2024

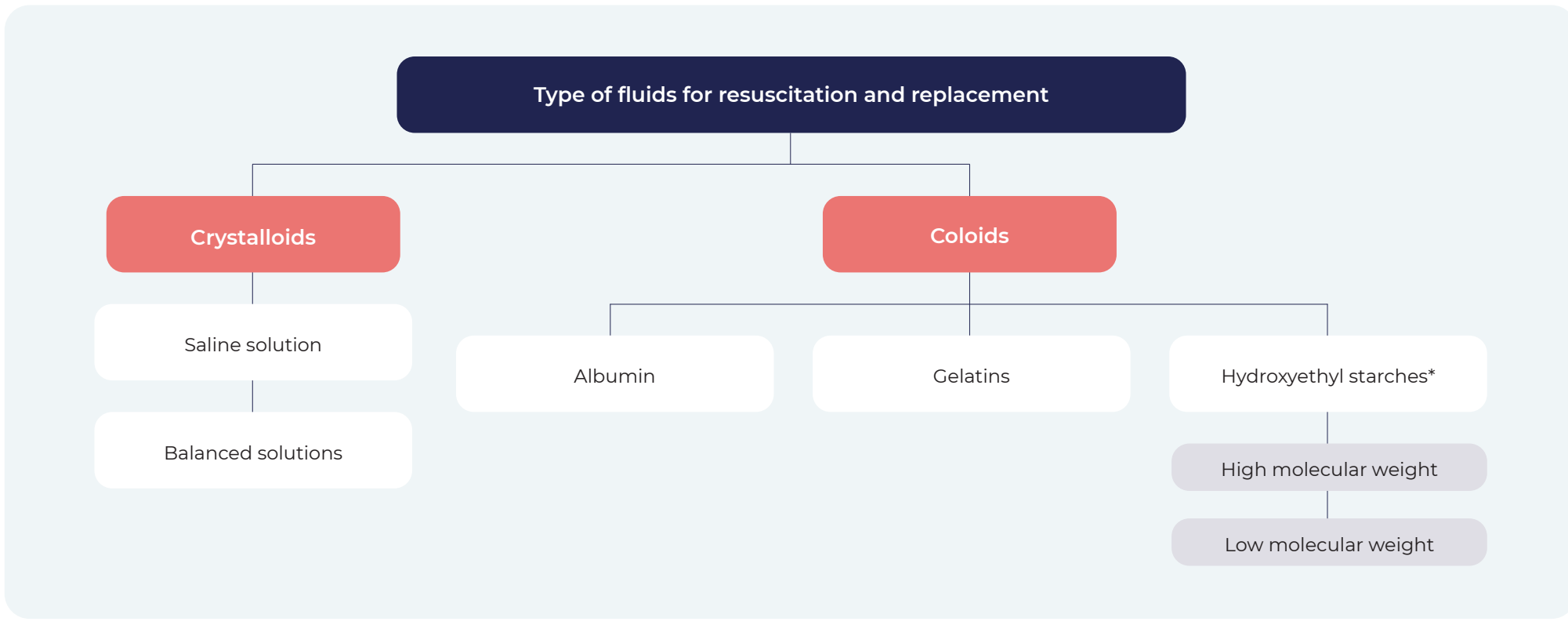
## 1. WHAT TO CHOOSE: CRYSTALLOIDS? COLLOIDS? ALBUMINS?

Michelle Chew

Indications for the use of intravenous fluids

| Resuscitation | Replacement | Maintenance |
|---|---|---|
| Correction of large volume deficiencies | Correction of existing or newly emerged deficiencies | Meeting water, electrolytes, and energy requirements |
| Treatment of acute hypovolemia | | |

The optimal fluid for perioperative use should allow the maintenance of organic perfusion and homeostasis.




* Currently not available in Europe

### BALANCED CRYSTALLOIDS

- Generally, they are the first choice.
- Lower chloride load, which can be relevant to prevent hyperchloremic acidosis and potential effects on the kidney function.
- In their perioperative use for fluid replacement, balanced crystalloids without calcium are not associated to lower mortality, but lower morbidity, than saline solution[1].
- They should be prioritized if large volumes of fluids must be administered.
- In certain profiles, for instance in neurocritical patients, saline solution is still the first choice.
- In critical patients:
  - ✓ No differences in terms of incidence of acute kidney damage, in mortality within 90 days, or in secondary outcomes[2-4].
  - ✓ Reduction in major renal adverse effects within 30 days[5].
  - ✓ A meta-analysis concluded that the effect on the mortality of patients with sepsis was consistent, with a 14% relative decrease and a 1% relative increase of the risk of death[6].

### HYDROXYETHYL STARCHES

- In abdominal surgery, a higher transfusion rate has been observed, yet with no differences in the incidence of kidney damage within 30 days, and similar rates in abdominal complications (non-robust evidence)[7].
- **In critical patients:** a deleterious effect has been observed in starches, with a higher incidence of renal dysfunction[8-10].

### ALBUMIN

- This is the protein determining plasma oncotic pressure, and it accounts for 50% of plasma protein.
- A recent study has associated the use of albumin with a higher risk of renal damage, pulmonary complications, and mortality within 30 days in patients undergoing major surgery[11]. However, a subsequent study did not observe differences in postoperative complications[12].
- In critical patients:
  - ✓ No differences in mortality within 28 days or in secondary outcomes[13].
  - ✓ Potential damage in patients with traumatic brain injury[13].
  - ✓ Reduction in mortality of patients with septic shock[14].

In summary, the measures to consider are the following:

| | | |
|---|---|---|
| **Avoiding chloride load, prioritizing balanced solutions** | **Avoiding hydroxyethyl starches** | **There is not enough evidence for the use of albumin** |

CSL Behring

# *Perioperative fluids: which one, how much, how long?*

Chair: Daniela Ionescu

Saturday, May 25, 2024

## 2. HOW TO ASSESS FLUID RESPONSIVENESS IN THE OPERATING ROOM?

Sheila Nainan Myatra

Excessive administration of fluids in the perioperative setting is associated with an increase in the rate of complications, mortality, and duration of stay in the ICU. As for hypovolemia, when not corrected, it can impact tissue oxygenation, and it can cause organ dysfunction and higher mortality.

Therefore, it is key to know:

- How much must be administered.
- Which patients will respond to fluid therapy.

**The fluid response is the state in which fluid administration brings about an improved ejection volume, and subsequently, an improved cardiac output.**

Currently there is no evidence backing the use of central venous pressure to guide fluid therapy, and this practice should be avoided[15].

The determination of the fluid response is associated with a decrease in mortality, and the duration of stay in the ICU and mechanical ventilation[16].

### METHODS TO QUANTIFY THE FLUID RESPONSE *"FLUID CHALLENGE"*:

- **Respiratory variations of systolic volume or related:**
  - **Pulse pressure variation (PPV), stroke volume variation (SVV), systolic pressure variation (SPV)**[17], although they present certain limitations:

| False positives | False negatives |
|---|---|
| Irregular beats | Extreme bradycardia or high-frequency ventilation |
| High abdominal pressure | Mechanical ventilation with low tidal volume |
| Spontaneous respiration | Open thorax |
| | Spontaneous respiration |

- **Echocardiographic variables** (transthoracic or transesophageal echocardiography)

| Variations in the diameter of the superior vena cava (SVC) | Variations in the diameter of the inferior vena cava (IVC) | Variations in the aortic root flow rate |
|---|---|---|

  - **Transesophageal echocardiography** presents certain limitations:
    - Sensitive to the patient's movement, so it is more often used in the OR than the ICU.
    - The aortic diameter depends on the transmural aortic pressure.
- **Pulse oximetry**
  - **Tidal volume challenge (TVC):** Monitoring of PPV and SVV change with the transient increase of tidal volume from 6 to 8 ml/kg[18].
  - **End-expiratory occlusion test (EEOT)**
    - Responders can be predicted if an increase in cardiac output > 5% is observed[19,20].
  - **Pulmonary recruitment maneuver**
    - It requires caution due the potential hypotension risk.
    - A decrease of 30% in systolic volume during the maneuver predicts fluid response with an 88% sensitivity and a 92% specifity[21].

### FLUID THERAPY IN THE OR

- If the clinical situation is clearly hypovolemic, a swift administration of fluids will be more effective than determining the fluid response.
- It is better to use dynamic rather than static parameters to predict fluid response during invasive ventilation.
- The existence of fluid response does not mean that fluid should be administered *per se*. There can be other variables determining that fluids may pose a risk to the patient.
- Dynamic determination of fluid response in goal-directed therapy reduces mortality, stay in the ICU, and duration of mechanical ventilation.
- The integration of several dynamic indexes with the clinical assessment is essential.

# *Perioperative fluids: which one, how much, how long?*

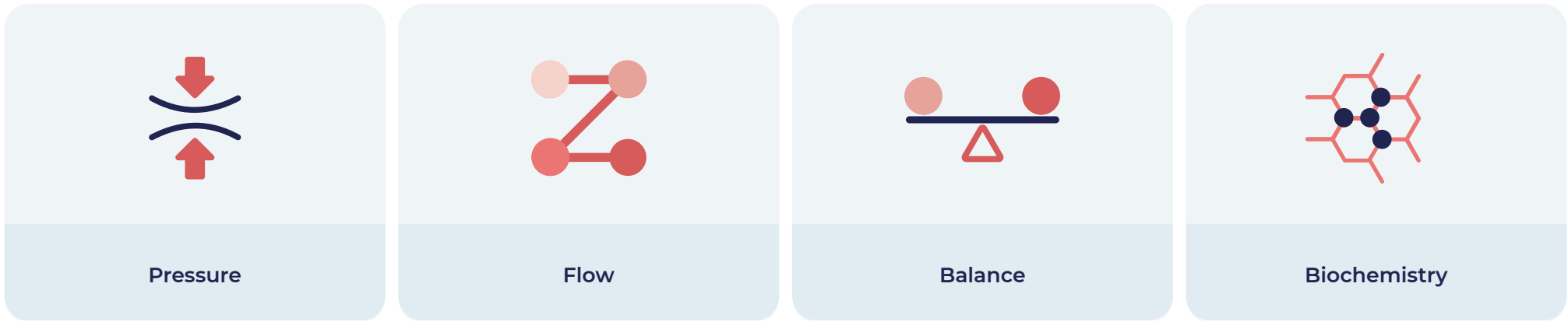
Chair: Daniela Ionescu

Saturday, May 25, 2024

## 3. (GOAL-DIRECTED) FLUID ADMINISTRATION DURING AND AFTER SURGERY

Brigitte Brandstrup

Goal-directed fluid therapy comprises several approaches:




The GAS-ART-trial compared pressure- and flow-guided fluid therapy in patients undergoing emergency gastrointestinal surgery (bowel obstruction or gastrointestinal perforation)[22,23].

- In the flow-guided group, a lower volume of fluids was administered during surgery, but not afterwards.

  **It is relevant to consider fluid therapy in the postoperative setting, and not exclusively during surgery.**

- Differences were observed in the survival of patients with obstruction and perforation.

  **It is relevant not to consider all patients undergoing abdominal surgery as similar patients, to compare trials including different profiles between them, and to be more specific when presenting the features of patients in trials.**

- Flow-directed fluid therapy to an almost maximal systolic volume does not improve the outcome after surgery, and it can extend the time of hospital stay.

**Fluid therapy should be guided by a combination of balance (maximal strategy of 2 L of fluid in a perioperative setting), pressure, and biochemical parameters.**

It has been observed that different types of complications emerging from an emergency gastrointestinal surgery are associated with different fluid balance numbers[24]:

- Lowest risk of cardiopulmonary complications if balance = 0 - 2 L
- Lowest risk of renal complications if balance = 1.5 - 3.5 L
- Highest risk of general and cardiopulmonary complications if balance > 2.5 L

**A balance above 2L is associated to a higher incidence of complications.**

### IN THE POSTOPERATIVE SETTING:

- The content of electrolytes and pH of different gastrointestinal fluids is diverse.

  **Replacement should be carried out with a similar amount of fluids to what the patient lost, but also with a similar quality.**

- Replacing losses, both normal and pathological.
- Maintaining a near-zero fluid balance.
- Examining patients with low blood pressure or low diuresis: identifying and treating the cause.
- Initiating nutrition as soon as possible. If the patient is not able to eat, initiating enteral or parenteral nutrition as soon as possible.

## LITERATURE


1. Shaw AD, Bagshaw SM, Goldstein SL, Scherer LA, Duan M, Schermer CR, et al. Major complications, mortality, and resource utilization after open abdominal surgery: 0.9% saline compared to Plasma-Lyte. Ann Surg [Internet]. 2012 May [cited 2024 Jun 12];255(5):821–9. Available from: https://pubmed.ncbi.nlm.nih.gov/22470070/

2. Zampieri FG, Machado FR, Biondi RS, Freitas FGR, Veiga VC, Figueiredo RC, et al. 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. JAMA [Internet]. 2021 Sep 7 [cited 2024 Jun 12];326(9):818–29. Available from: https://jamanetwork.com/journals/jama/fullarticle/2783039

3. Finfer S, Micallef S, Hammond N, Navarra L, Bellomo R, Billot L, et al. Balanced Multielectrolyte Solution versus Saline in Critically Ill Adults. New England Journal of Medicine [Internet]. 2022 Mar 3 [cited 2024 Jun 12];386(9):815–26. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa2114464

4. Young P, Bailey M, Beasley R, Henderson S, Mackle D, McArthur C, et al. Effect of a Buffered Crystalloid Solution vs Saline on Acute Kidney Injury Among Patients in the Intensive Care Unit: The SPLIT Randomized Clinical Trial. JAMA [Internet]. 2015 Oct 27 [cited 2024 Jun 12];314(16):1701–10. Available from: https://jamanetwork.com/journals/jama/fullarticle/2454911

5. Semler MW, Self WH, Wanderer JP, Ehrenfeld JM, Wang L, Byrne DW, et al. Balanced Crystalloids versus Saline in Critically Ill Adults. New England Journal of Medicine [Internet]. 2018 Mar 1 [cited 2024 Jun 12];378(9):829–39. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa1711584

6. Hammond NE, Zampieri FG, Tanna GL Di, Garside T, Adigbli D, Cavalcanti AB, et al. Balanced Crystalloids versus Saline in Critically Ill Adults — A Systematic Review with Meta-Analysis. NEJM Evidence [Internet]. 2022 Jan 18 [cited 2024 Jun 12];1(2). Available from: https://evidence.nejm.org/doi/full/10.1056/EVIDoa2100010

7. Pensier J, Deffontis L, Rollé A, Aarab Y, Capdevila M, Monet C, et al. Hydroxyethyl Starch for Fluid Management in Patients Undergoing Major Abdominal Surgery: A Systematic Review With Meta-analysis and Trial Sequential Analysis. Anesth Analg [Internet]. 2022 Apr 1 [cited 2024 Jun 12];134(4):686–95. Available from: https://pubmed.ncbi.nlm.nih.gov/34854822/

8. Perner A, Haase N, Guttormsen AB, Tenhunen J, Klemenzson G, Åneman A, et al. Hydroxyethyl starch 130/0.42 versus Ringer's acetate in severe sepsis. N Engl J Med [Internet]. 2012 Jul 12 [cited 2024 Jun 12];367(2):124–34. Available from: https://pubmed.ncbi.nlm.nih.gov/22738085/

9. Myburgh JA, Finfer S, Bellomo R, Billot L, Cass A, Gattas D, et al. Hydroxyethyl starch or saline for fluid resuscitation in intensive care. N Engl J Med [Internet]. 2012 Nov 15 [cited 2024 Jun 12];367(20):1901–11. Available from: https://pubmed.ncbi.nlm.nih.gov/23075127/

10. Brunkhorst FM, Engel C, Bloos F, Meier-Hellmann A, Ragaller M, Weiler N, et al. Intensive insulin therapy and pentastarch resuscitation in severe sepsis. N Engl J Med [Internet]. 2008 Jan 10 [cited 2024 Jun 12];358(2):125–39. Available from: https://pubmed.ncbi.nlm.nih.gov/18184958/

11. Lazzareschi D V., Fong N, Mavrothalassitis O, Whitlock EL, Chen CL, Chiu C, et al. Intraoperative Use of Albumin in Major Noncardiac Surgery: Incidence, Variability, and Association With Outcomes. Ann Surg [Internet]. 2023 Oct 1 [cited 2024 Jun 12];278(4):e745. Available from: /pmc/articles/PMC10481928/

12. Schaller SJ, Fuest K, Ulm B, Schmid S, Bubb CAB, Eckstein HH, et al. Goal-directed Perioperative Albumin Substitution Versus Standard of Care to Reduce Postoperative Complications: A Randomized Clinical Trial (SuperAdd Trial). Ann Surg [Internet]. 2024 Mar 1 [cited 2024 Jun 12];279(3):402–9. Available from: https://pubmed.ncbi.nlm.nih.gov/37477023/

13. Finfer S, Bellomo R, Boyce N, French J, Myburgh J, Ch B, et al. A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit. New England Journal of Medicine [Internet]. 2004 May 27 [cited 2024 Jun 12];350(22):2247–56. Available from: https://www.nejm.org/doi/full/10.1056/NEJMoa040232

14. Caironi P, Tognoni G, Masson S, Fumagalli R, Pesenti A, Romero M, et al. Albumin replacement in patients with severe sepsis or septic shock. N Engl J Med [Internet]. 2014 Apr 10 [cited 2024 Jun 12];370(15):1412–21. Available from: https://pubmed.ncbi.nlm.nih.gov/24635772/

15. Marik PE, Cavallazzi R. Does the central venous pressure predict fluid responsiveness? An updated meta-analysis and a plea for some common sense. Crit Care Med [Internet]. 2013 Jul [cited 2024 Jun 12];41(7):1774–81. Available from: https://pubmed.ncbi.nlm.nih.gov/23774337/

16. Bednarczyk JM, Fridfinnson JA, Kumar A, Blanchard L, Rabbani R, Bell D, et al. Incorporating Dynamic Assessment of Fluid Responsiveness Into Goal-Directed Therapy: A Systematic Review and Meta-Analysis. Crit Care Med [Internet]. 2017 Sep 1 [cited 2024 Jun 13];45(9):1538. Available from: /pmc/articles/PMC5555977/

17. Messina A, Caporale M, Calabrò L, Lionetti G, Bono D, Matronola GM, et al. Reliability of pulse pressure and stroke volume variation in assessing fluid responsiveness in the operating room: a metanalysis and a metaregression. Crit Care [Internet]. 2023 Dec 1 [cited 2024 Jun 13];27(1):1–12. Available from: https://ccforum.biomedcentral.com/articles/10.1186/s13054-023-04706-0

18. Myatra SN, Prabu NR, DIvatia JV, Monnet X, Kulkarni AP, Teboul JL. The Changes in Pulse Pressure Variation or Stroke Volume Variation After a "Tidal Volume Challenge" Reliably Predict Fluid Responsiveness During Low Tidal Volume Ventilation. Crit Care Med [Internet]. 2017 Mar 1 [cited 2024 Jun 12];45(3):415–21. Available from: https://pubmed.ncbi.nlm.nih.gov/27922879/

19. Monnet X, Osman D, Ridel C, Lamia B, Richard C, Teboul JL. Predicting volume responsiveness by using the end-expiratory occlusion in mechanically ventilated intensive care unit patients. Crit Care Med [Internet]. 2009 [cited 2024 Jun 13];37(3):951–6. Available from: https://pubmed.ncbi.nlm.nih.gov/19237902/

20. Gavelli F, Shi R, Teboul JL, Azzolina D, Monnet X. The end-expiratory occlusion test for detecting preload responsiveness: a systematic review and meta-analysis. Ann Intensive Care [Internet]. 2020 Dec 1 [cited 2024 Jun 13];10(1). Available from: https://pubmed.ncbi.nlm.nih.gov/32449104/

21. Biais M, Lanchon R, Sesay M, Le Gall L, Pereira B, Futier E, et al. Changes in Stroke Volume Induced by Lung Recruitment Maneuver Predict Fluid Responsiveness in Mechanically Ventilated Patients in the Operating Room. Anesthesiology [Internet]. 2017 Feb 1 [cited 2024 Jun 13];126(2):260–7. Available from: https://pubmed.ncbi.nlm.nih.gov/27922547/

22. Voldby AW, Aaen AA, Møller AM, Brandstrup B. Goal-directed fluid therapy in urgent GAstrointestinal Surgery-study protocol for A Randomised multicentre Trial: The GAS-ART trial. BMJ Open [Internet]. 2018 Nov 1 [cited 2024 Jun 13];8(11). Available from: https://pubmed.ncbi.nlm.nih.gov/30429144/

23. Aaen AA, Voldby AW, Storm N, Kildsig J, Hansen EG, Zimmermann-Nielsen E, et al. Goal-directed fluid therapy in emergency abdominal surgery: a randomised multicentre trial. Br J Anaesth. 2021 Oct 1;127(4):521–31.

24. Voldby AW, Aaen AA, Loprete R, Eskandarani HA, Boolsen AW, Jønck S, et al. Perioperative fluid administration and complications in emergency gastrointestinal surgery—an observational study. Perioperative Medicine [Internet]. 2022 Dec [cited 2024 Jun 13];11(1). Available from: /pmc/articles/PMC8862386/