

M U N I
M E D

Fluid therapy

Crystalloids and Colloids

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Learning outcomes

- The student will understand the basic principles of fluid therapy in intensive care medicine.
- The student can name and describe the basic types of infusion solutions.

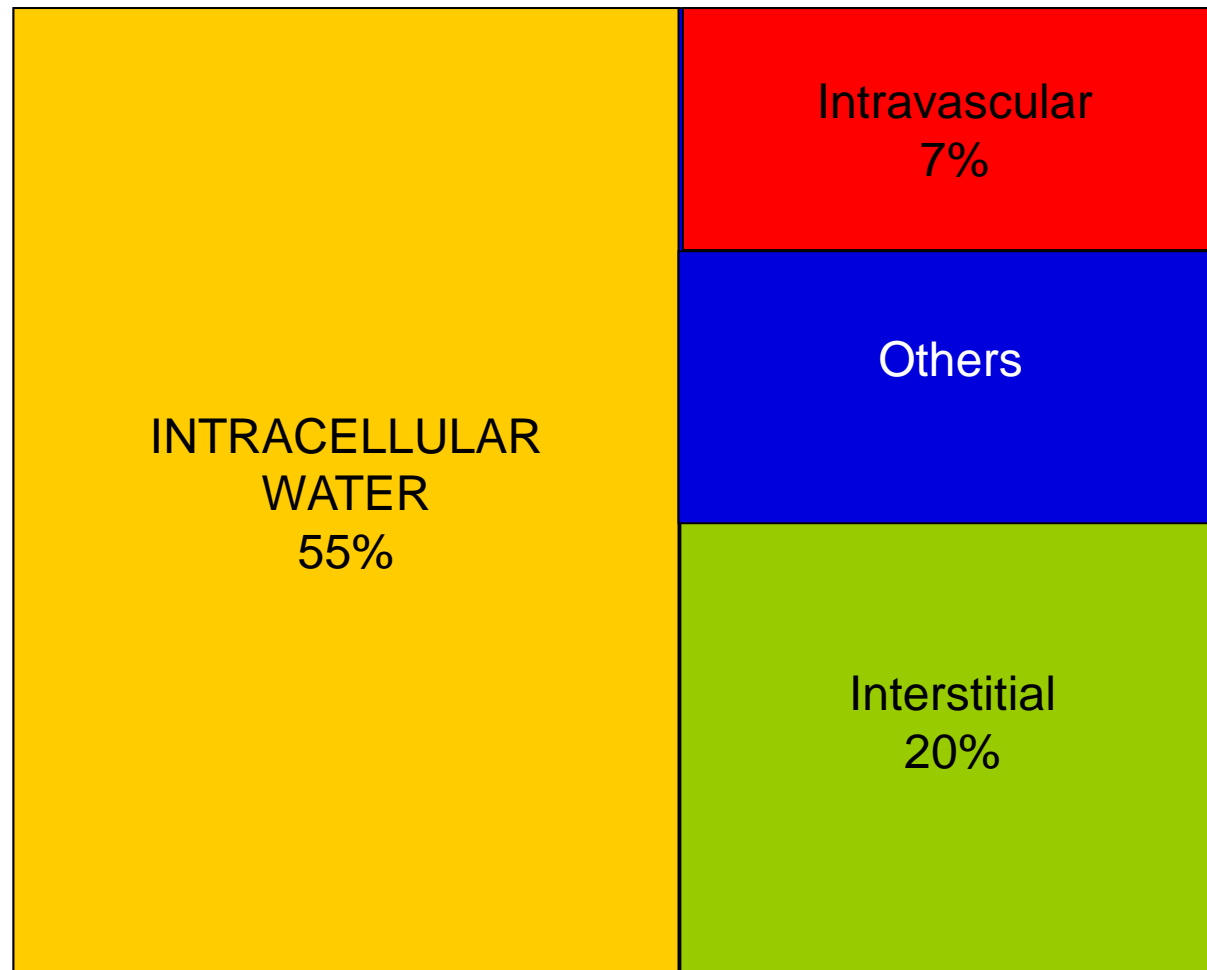
Fluid therapy – What is it?

Fluid therapy is one of the fundamental pillars of therapy of critically ill patients, both in intensive care units and operating theatres.

What are fluids used in Intensive Care Medicine for?

- Fluid resuscitation = volume expansion therapy in haemodynamic instability
- Fluid replacement therapy
- Therapy of ionic imbalances
- For administration of drugs as a carrier solution
- To maintain the patency of the venous access
- As part of parenteral nutrition

Distribution of body water



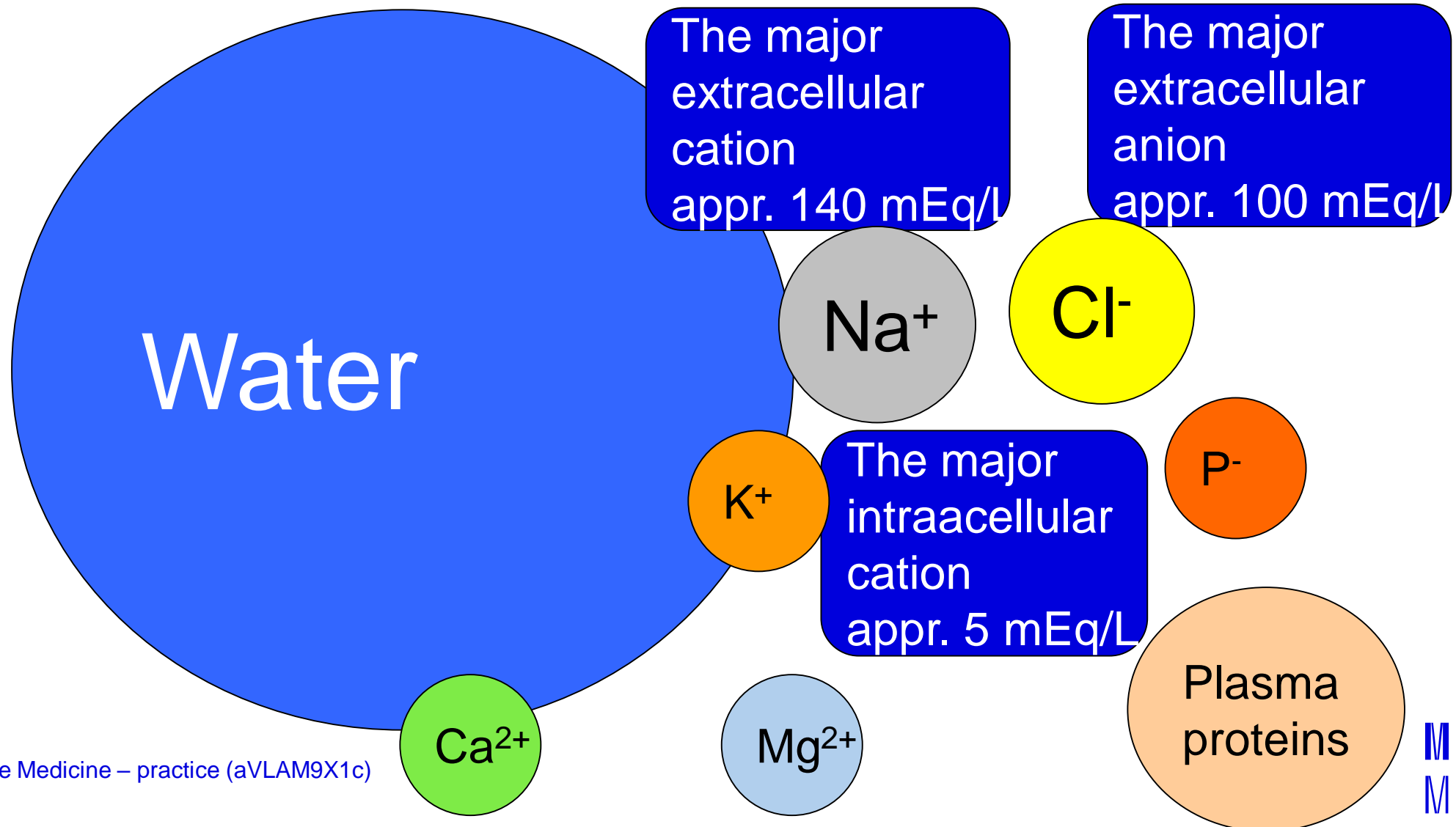
Volume expansion

- Used in **haemodynamically unstable patients**.
- It aims to **increase cardiac output**.
- Administered fluids intravascularly increase preload and thus SV.

Fluid replacement therapy

- Used in patients with signs of **dehydration**.
- It aims to **increase the amount of total body water**.

Normal ionic composition of plasma



What kinds of infusion solutions do we have?

Crystalloids

- Isotonic
- Hypotonic
- Hypertonic

- Unbalanced
- Balanced

Colloids

- Albumin
- Synthetic hydroxyethyl starch
- Gelatine
- (Dextrans)

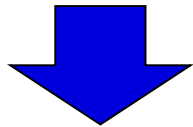
Crystalloids - isotonic

Normal saline - 0,9% NaCl

154 mEq/L Na⁺ (normal 140)

154 mEq/L Cl⁻ (normal 110)

pH 5,7 (normal 7,3^{+/-}0,04)



**Normal saline is NOT NORMAL,
but it is isotonic with plasma!**

CAVE hyperchloraemic metabolic acidosis!

Higher risk of interstitial oedema and AKI than with other crystalloids (higher content of sodium)!

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Stopped being broadly used, in practice most often to dilution of drugs, therapeutically in the treatment of hypochloraemic metabolic alkalosis.

Crystalloids - isotonic

Balanced crystalloids and Ringer's solution

- Lower content of **Na⁺** than Normal saline.
- **Also contain K⁺, Ca²⁺ a Mg²⁺.**
- **Contain a buffer** (lactate, acetate, malate, gluconate) to maintain pH neutrality.

Balanced crystalloids are the most used infusion solutions in modern intensive care medicine!

	plasma	FR	Ringerův laktátový r.	Ringerfundin	Plasmalyte	Isolyte	Benelyte
Na+	140	154	130	140	140	137	140
K+	4	-	5	4	5	4	4
Ca ²⁺	2,2	-	1	2,5	-	-	1
Mg ²⁺	1	-	1	1	1,5	1,5	1
Cl-	105	154	112	127	98	110	118
laktát	1	-	27	-	-	-	-
acetát	-	-	-	24	27	34	30
malát	-	-	-	5	-	-	-
glukonát	-	-	-	-	23	-	-
bikarbonát	22						
osmolarita	285	308	276	304	296	286	-
BE pot	-	-24	3	5	26	8	
glukóza	4,5	-	-	-	-	-	1 %
Na:Cl poměr	1,33:1	1:1	1,18:1	1,10:1	1,43:1	1,24:1	1,19:1

<https://www.akutne.cz/res/publikace/9-skulec.pdf>, used on 29.8.2021

Crystalloids - hypertonic

3% a 10% NaCl

They **increase the osmotic pressure** and thus **cause a rapid transfer of fluids** from the interstitial and intracellular space intravascularly.

- They are used to correct natremia and to treat intracranial hypertension.
- **CAVE:** risk of hyperchloraemic metabolic acidosis, deterioration of renal function and decreased platelet aggregation, pontine myelinolysis, ...

Crystalloids - hypotonic

Dextrose solutions, 1/2 NS, 1/2 R

- They are **not used** for volume expansion therapy of haemodynamically unstable patients.
- They are used to correct hypernatremia.
- Dextrose solutions, together with insulin, are used to correct glycaemia and hyperkalaemia.
- Dextrose solutions are often part of parenteral nutrition.

Colloids

They contain large molecules that do not penetrate the endothelium of intact vessels. The principle of action is **the increase of oncotic pressure** and subsequent retention of water intravascularly (= Plasma expanders).

Lasts 6-12 hours

Albumin

- Human albumin lyophilisate, 5%, 10% and 20% solution.
- 20% is used to correct hypoalbuminemia.
- Ideal volume replacement in burn and septic patients.
- Higher price.

Colloids

HES = hydroxyethyl starch

- Synthetic starches, 6% HES, are also available in the form of balanced colloids (Tetraspan, Volulyte)
- According to recent studies, they **increase the risk of kidney damage, increase the mortality of septic patients and are involved in coagulopathy.**
- Withdrawal from their use in the EU, they can only be used to treat hypovolemia due to acute blood loss when crystalloids alone are not considered sufficient.
- Max. dose 30mL/kg/day

Colloids

Gelatine based infusion solutions

- Gelaspan 4%, Gelofusine, Geloplasma
- They do not impair renal function.
- Risk of anaphylactic reaction.

Fluid therapy is also a therapy!

Unindicated therapy is contraindicated!

Even infusions can have side effects and harm the patient!



<https://www.medicalnewstoday.com/articles/320906>, used on 29.8.2021


Only about **25%** of the isotonic **crystalloid** remains intravascular! 75% leaks into the interstitial space and **contributes to tissue swelling and organ dysfunction.**



Colloids may impair renal function and contribute to **coagulopathy**. They are **forbidden in septic shock** because they pass through the damaged endothelium extravasally and worsen mortality.

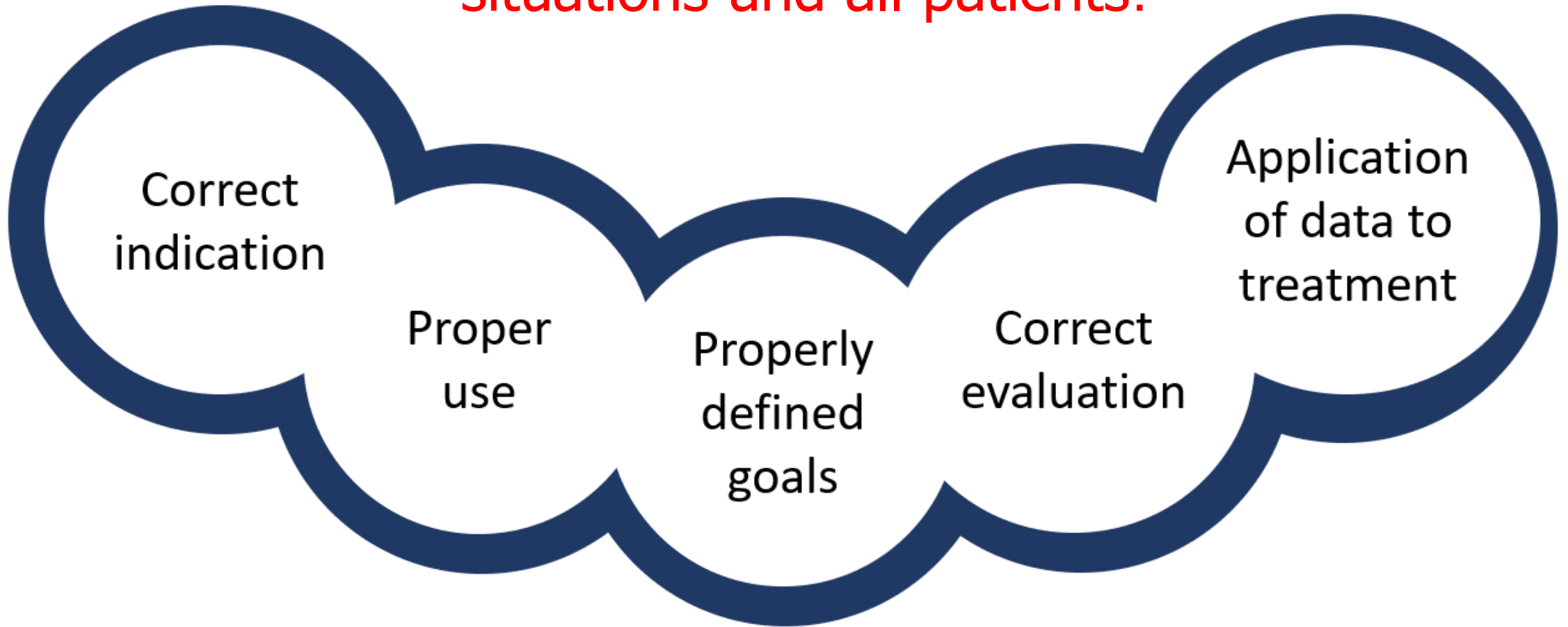


Fluid overload in all worsens organ dysfunction and increases mortality.
Patients with heart failure are particularly fragile.



In patients with **Life-threatening bleeding**, excessive fluid administration may contribute to **dilution coagulopathy** and thus worsening bleeding.

There is no single right
prescription for all clinical
situations and all patients!



Volume expansion therapy



Correct indication:

- In patients with evidence of tissue hypoperfusion.
- Only in those who will respond positively to fluids – in need to increase the preload (they have a low intravascular volume).

Proper use:

Leg raise test!

- In the form of fluid boluses (so-called fluid challenge) - 500 mL, resp. 10-30 mL/kg.
- Monitor response - increase SV, otherwise terminate.

Fluid replacement therapy



Correct indication:

- Depending on the situation and needs of the patient - signs of dehydration, weighing the patient (detection of a decrease in total body water).

Proper use:

- **Continuously.**
- Daily dose of fluids, considering compensation for losses.
- Beware of rapid rehydration, there may be a significant shift of fluids with the development of complications (brain swelling, pontine myelinolysis).

Take home messages

- Fluid therapy is one of the fundamental pillars of the treatment of haemodynamically unstable patients in intensive care medicine.
- Like any other therapy, it has its indications and side effects.
- There is a difference between volume expansion therapy and fluid replacement therapy.
- Normal saline is in fact not normal.
- Balanced crystalloids are the most used infusion solutions.
- HES is contraindicated in patients with renal impairment, sepsis and severe coagulopathy.
- The effect of fluid therapy needs to be re-evaluated repeatedly and fluids should not be given to non-responders.

Zdroje

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