UNIVERSITY HOSPITAL BRNO
FACULTY OF MEDICINE
MASARYK UNIVERSITY

DEPARTMENT OF PAEDIATRIC
ANAESTHESIOLOGY
AND INTENSIVE CARE MEDICINE

Tekutiny v pediatrické intenzivní péči

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FAKULTNÍ NEMOCNICE BRNO

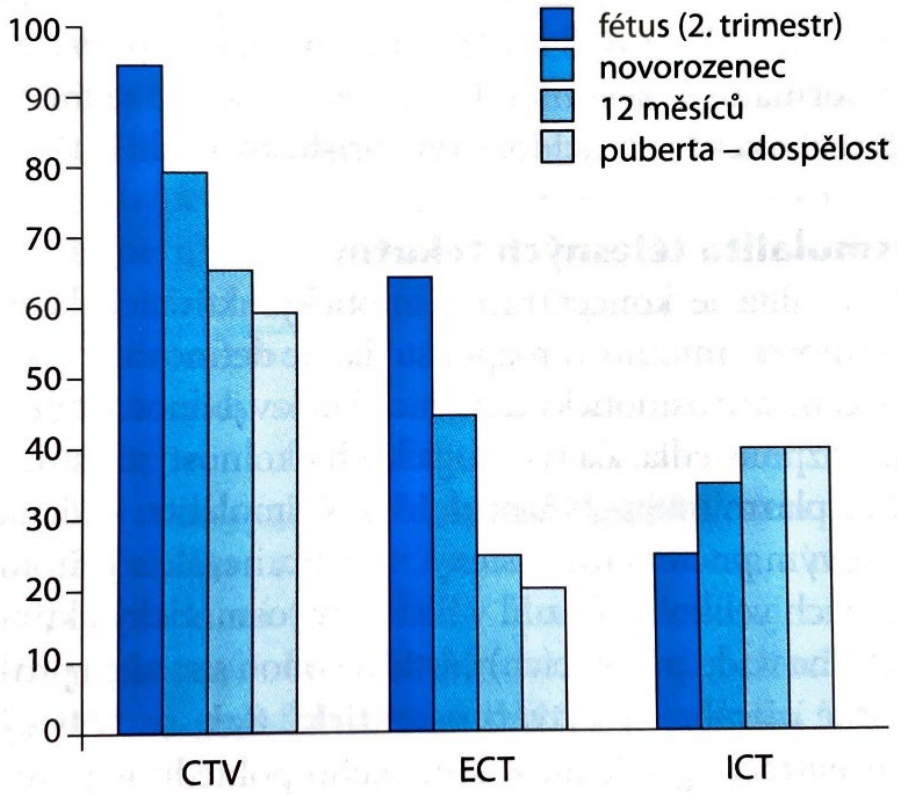
MUNI MED

Osnova

- Proč?
- Jak?
- Co?
- Kolik?

NO CONFLICT OF INTEREST

Proč podávat tekutiny?



	Množství krve (ml/kg)
Novorozenec (nedonošený)	80 (90)
Dospělý	65-70

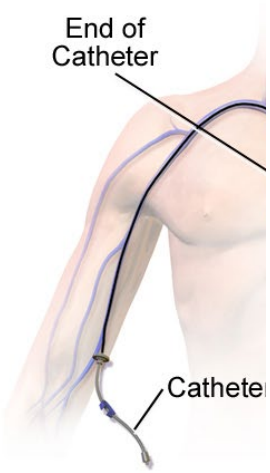
Proč podávat tekutiny?

- Náhrada ztrát
- Zachování homeostázi vnitřního prostředí
- Korekce vnitřního prostředí
- Hemodynamická stabilizace

Jak tekutiny aplikovat?

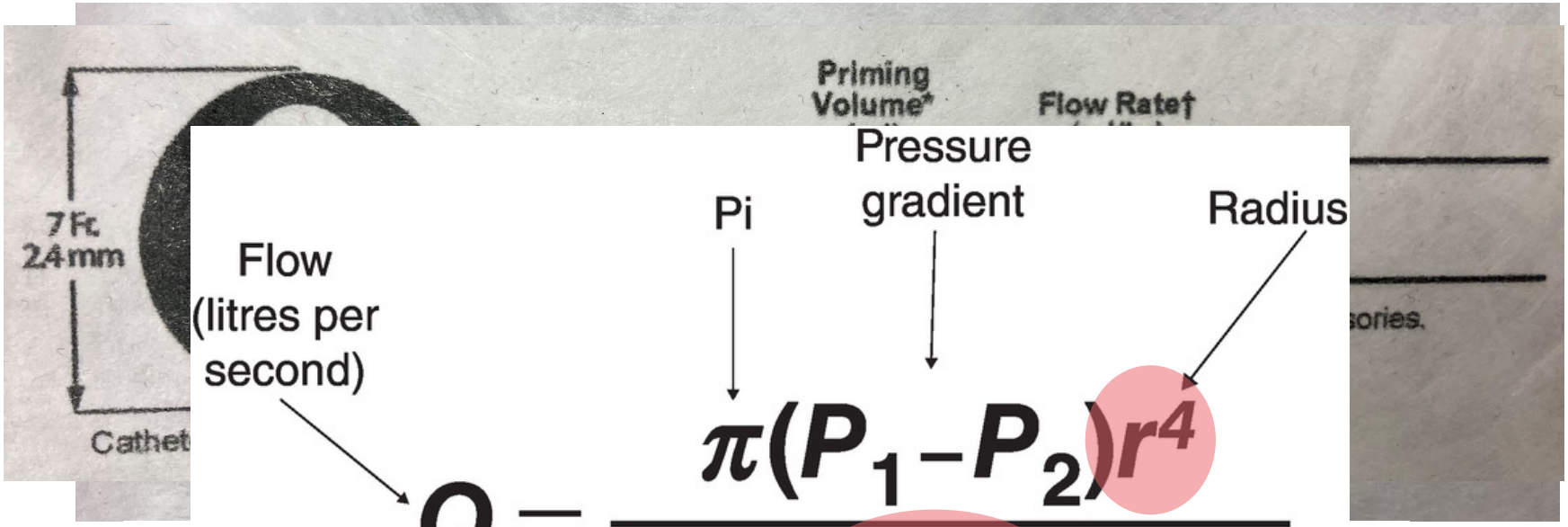
- Preferenčně enterální podání
- PŽK/I.O.
- Midline/PICC
- CVK

Barevné značení žilních k				
Velikost v Gauge	24	22	20	18
Barva	žlutá	modrá	růžová	zelen
Zevní průměr (mm)	0,7	0,9	1,1	1,3
Vnitřní průměr (mm)	0,4	0,6	0,8	1,0
Průtok (ml/min)	13	36	61	103/9
Délka vpichu (mm)	19	25	33	33/45



PICC

PVK x CVK/PICC?



Délka vpichu (mm)	19	25	33	33/45	45	50	50

PVK – jak?

- Výběr místa
  - Prosvěcování-infrared, **UZ**

Jaké roztoky zvolit?

- **Krystaloidy**
  - **Balancované**, nebalancované, hypotonické, glukóza
- Koloidy
  - Syntetické: HES, želatina, dextran
  - Lidský albumin
  - NE: sepse, koagulopatie, tek. resuscitace

Jaké roztoky zvolit?

- Krystaloidy
- Izotonické

Maintenance fluid management in pediatrics: Current practice and quality improvement achievements

Wendla Sensing, DO, FAAP,* Megan Wenker, DO, FAAP, and Eric Whitney, MD, FAAP

maLyte, 24 mmol/l in Sterofundin), gluconate (23 mmol/l in PlasmaLyte), and maleate (5 mmol/l in Stero-

Clinical Practice Guideline: Maintenance Intravenous Fluids in Children

Leonard G. Feld, MD, PhD, MMM, FAAP,[a] Daniel R. Neuspiel, MD, MPH, FAAP,[b] Byron A. Foster, MD, MPH, FAAP,[c] Michael G. Leu, MD, MS, MHS, FAAP,[d] Matthew D. Garber, MD, FHM, FAAP,[e] Kelly Austin, MD, MS, FAAP, FACS,[f] Rajit K. Basu, MD, MS, FCCM,[g,h] Edward E. Conway Jr, MD, MS, FAAP,[i] James J. Fehr, MD, FAAP,[j] Clare Hawkins, MD,[k] Ron L. Kaplan, MD, FAAP,[l] Echo V. Rowe, MD, FAAP,[m] Muhammad Waseem, MD, MS, FAAP, FACEP,[n] Michael L. Moritz, MD, FAAP,[o] SUBCOMMITTEE ON FLUID AND ELECTROLYTE THERAPY

Jaké roztol

- Balancované

FEATU

OPEN

Balan
Child

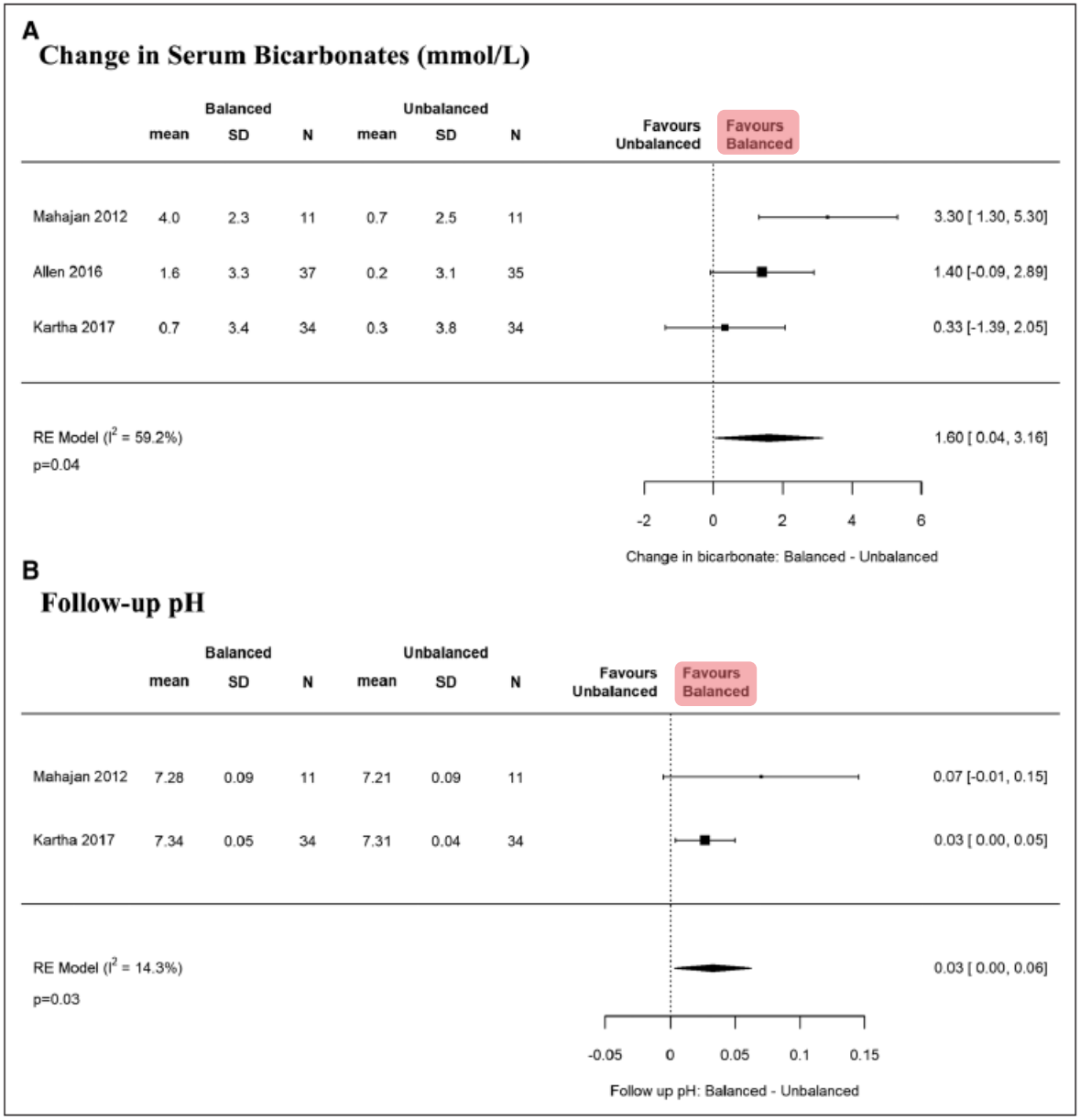


Figure 2. Acidosis forest plot: forest plot comparing change in serum bicarbonate from baseline to follow-up post exposition (**A**) and forest plot comparing follow-up pH (**B**) in critically ill children exposed to balanced versus unbalanced fluids. RE = random effect.

Table 2. Fluids Administered and Physiological Effects of Treatment *

Variable	Insulin Therapy				Fluid Resuscitation		
	All Patients (N=537)	Conventional (N=290)	Intensive (N=247)	P Value†	Ringer's Lactate (N=275)	HES (N=262)	P Value‡
Hypoglycemia (≤40 mg/dl)				<0.001			0.85
No. of patients/total no.	54/537	12/290	42/247		27/275	27/262	
Percent (95% CI)	10.1 (7.5–12.6)	4.1 (1.9–6.4)	17.0 (12.3–21.7)		9.8 (6.3–13.3)	10.3 (6.6–14.0)	
Acute renal failure				0.25			0.002
No. of patients/total no.	153/533	77/289	76/244		62/272	91/261	
Percent (95% CI)	28.7 (24.9–32.6)	26.6 (21.6–31.7)	31.1 (25.3–37.0)		22.8 (17.8–27.8)	34.9 (29.1–40.7)	
Renal-replacement therapy				0.19			0.001
No. of patients/total no.	132/533	65/289	67/244		51/272	81/261	
Percent (95% CI)	24.8 (21.1–28.4)	22.5 (17.7–27.3)	27.5 (21.9–33.1)		18.8 (14.1–23.4)	31.0 (25.4–36.7)	
Red-cell transfusion				0.02			0.06
No. of patients/total no.	388/537	197/290	191/247		189/275	199/262	
Percent (95% CI)	72.3 (68.5–76.0)	67.9 (62.6–73.3)	77.3 (72.1–82.6)		68.7 (63.3–74.2)	76.0 (70.8–81.1)	

B

degraded gelatin in saline) in pediatric septic shock

ORIGINAL ARTICLE

Intensive Insulin Therapy and Pentastarch Resuscitation in Severe Sepsis

Frank M. Brunkhorst, M.D., Christoph Engel, M.D., Frank Bloos, M.D., Ph.D., Andreas Meier-Hellmann, M.D., Max Ragaller, M.D., Norbert Weiler, M.D., Onnen Moerer, M.D., Matthias Gruendling, M.D., Michael Oppert, M.D., Stefan Grond, M.D., Derk Olthoff, M.D., Ulrich Jaschinski, M.D., et al., for the German Competence Network Sepsis (SepNet)

A Comparison of Albumin and Saline for Fluid Resuscitation in the Intensive Care Unit

The SAFE Study Investigators*

Albumin u kriticky nemocných dětí?

Seru
Clinic
of

Heito
Simo

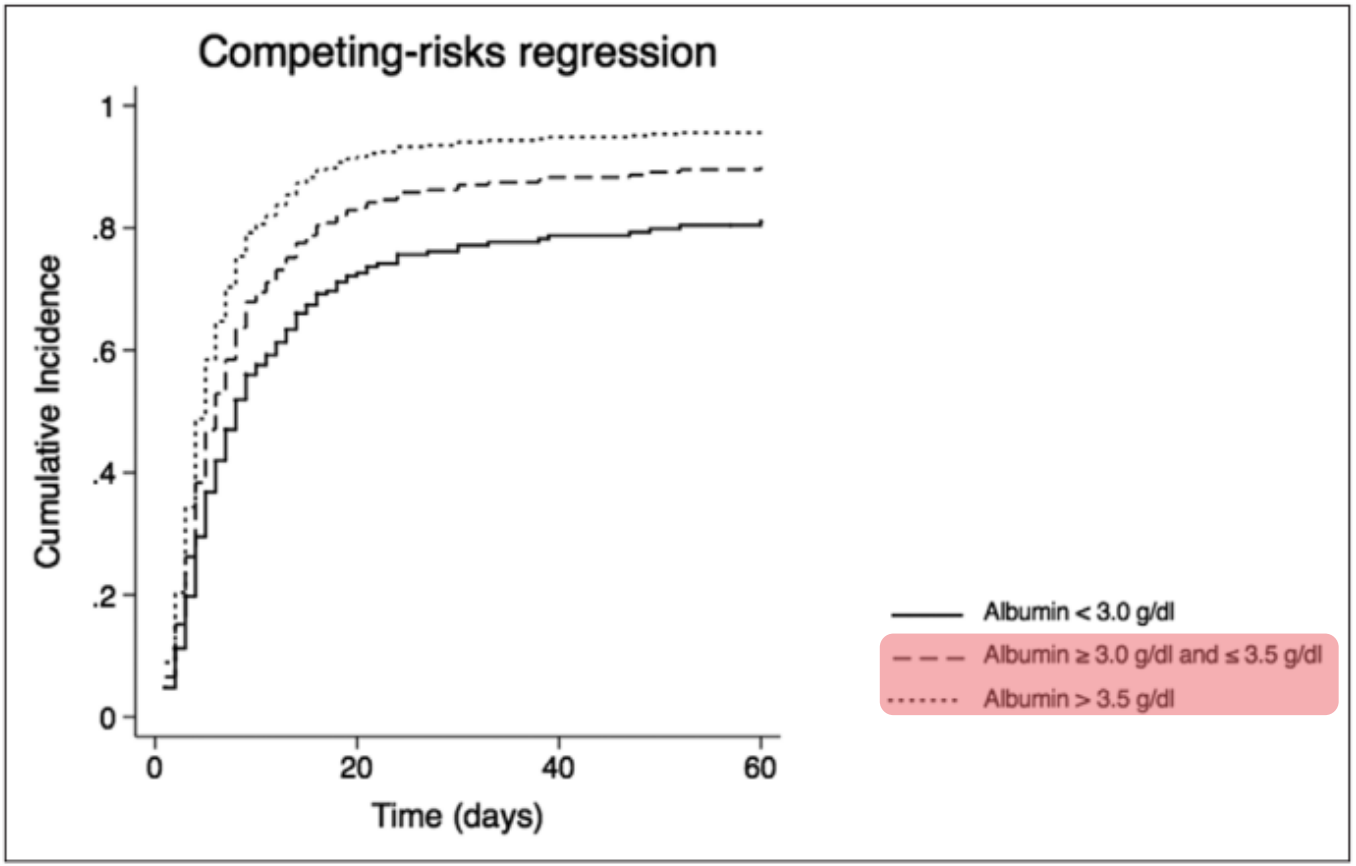
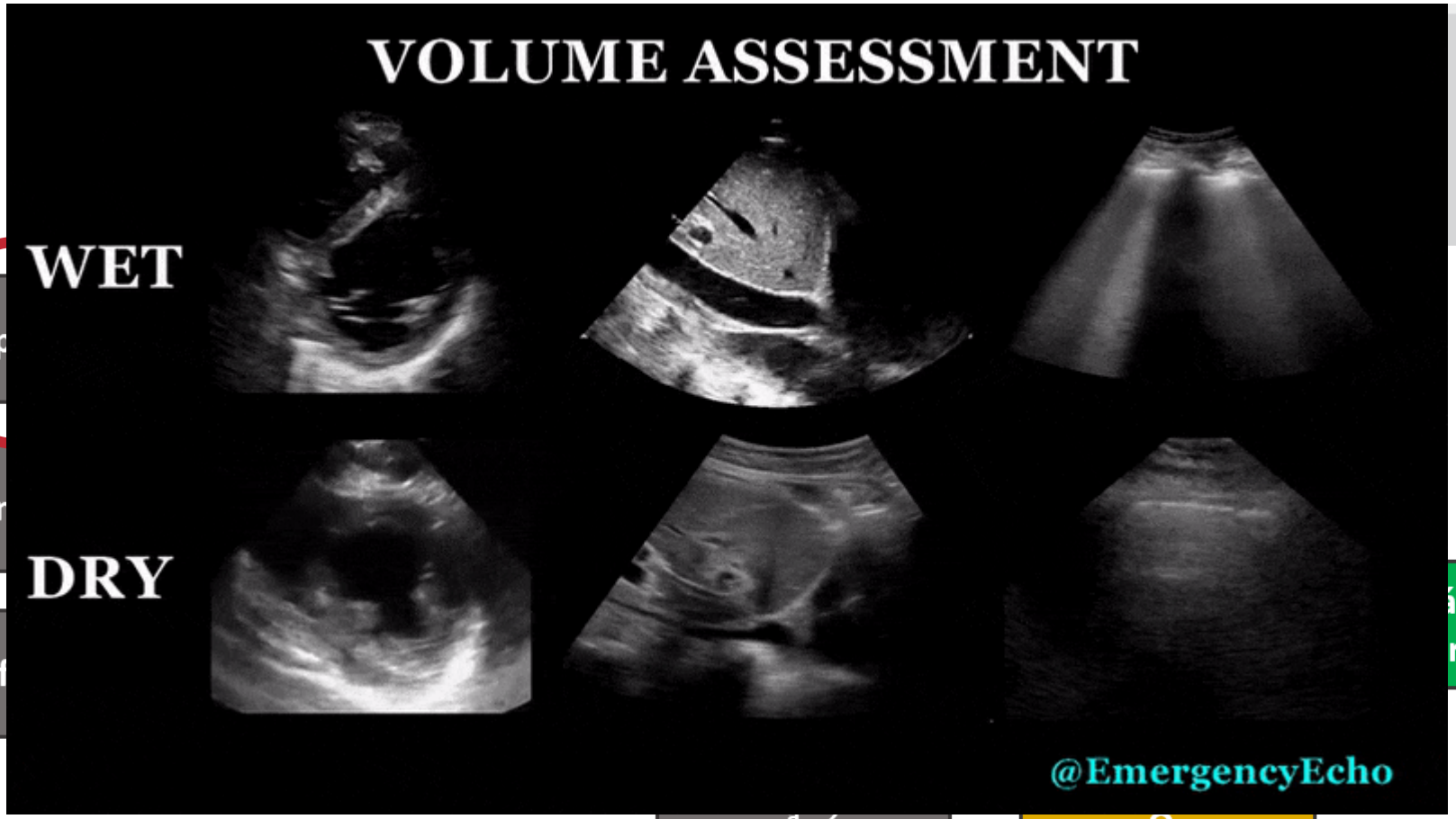


Figure 2. Cumulative incidence of ICU discharge for patients according to serum albumin concentration (< 3.0 g/dL; ≥ 3.0 and ≤ 3.5 g/dL; > 3.5 g/dL).

Režimy infuzní terapie



Režimy infuzní terapie

- **Udržovací**=maintanance fluids

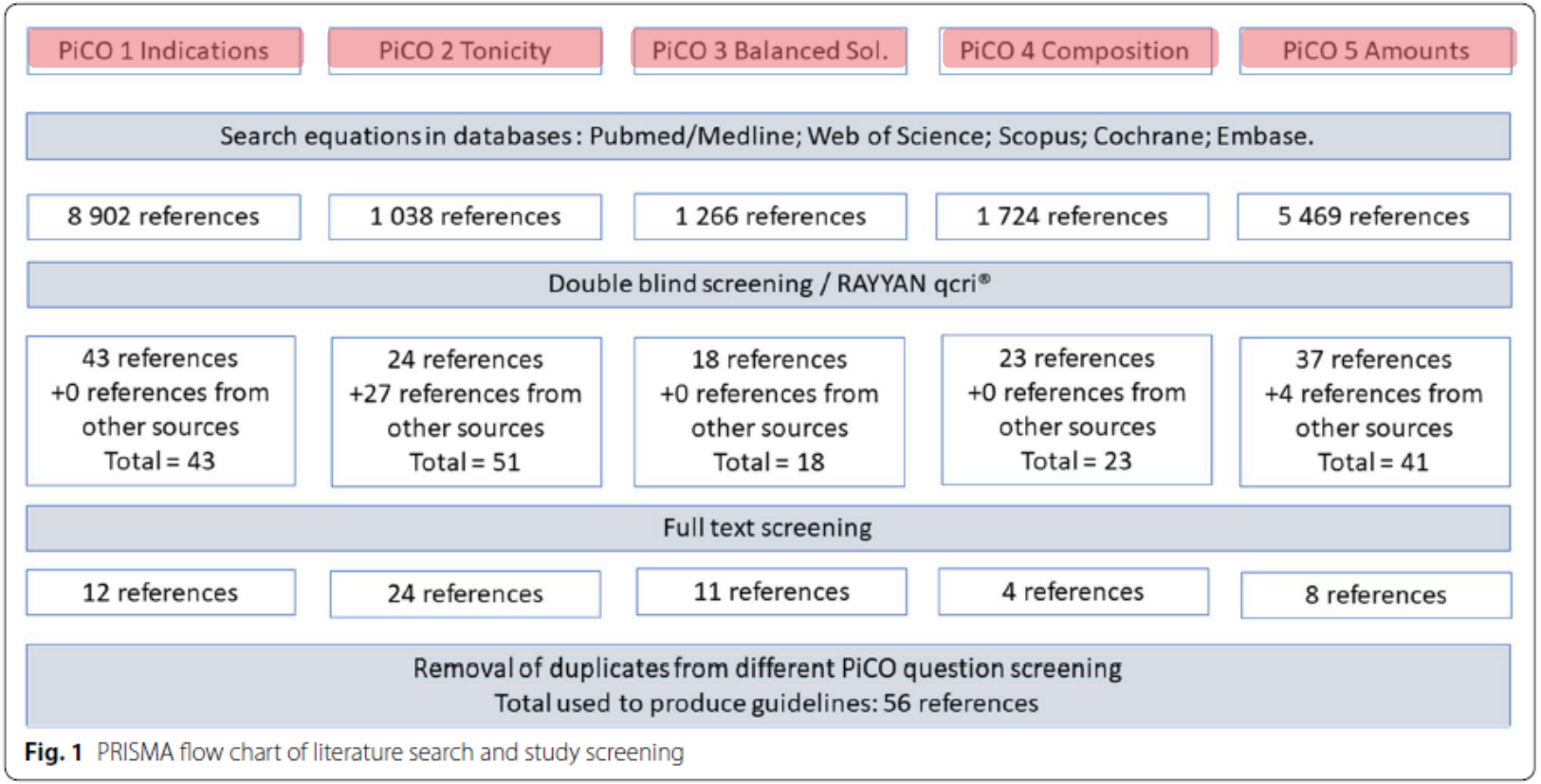


Fig. 1 PRISMA flow chart of literature search and study screening

Režimy infuzní terapie

PiCO 1: IV-MFT indications

In acutely ill children, the enteral or oral route for the delivery of maintenance fluid therapy should be considered, if tolerated, to reduce the failure rate of hydration access and costs	C	Strong consensus
In critically ill children with improving hemodynamic state, the enteral or oral route for the delivery of maintenance fluid therapy should be considered, if tolerated, to reduce length of stay in term neonates	GCP	Strong consensus

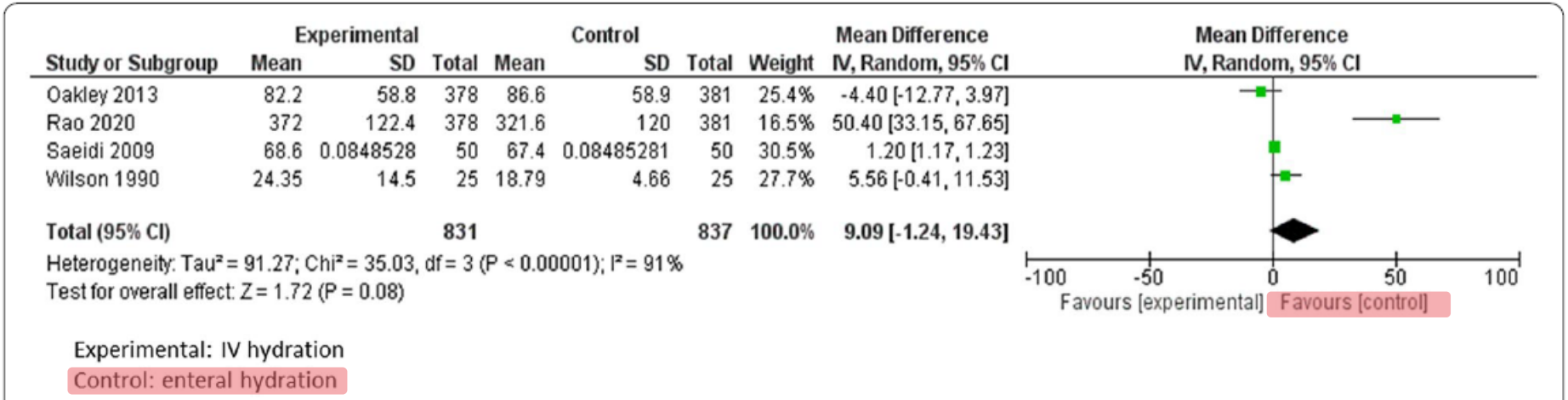
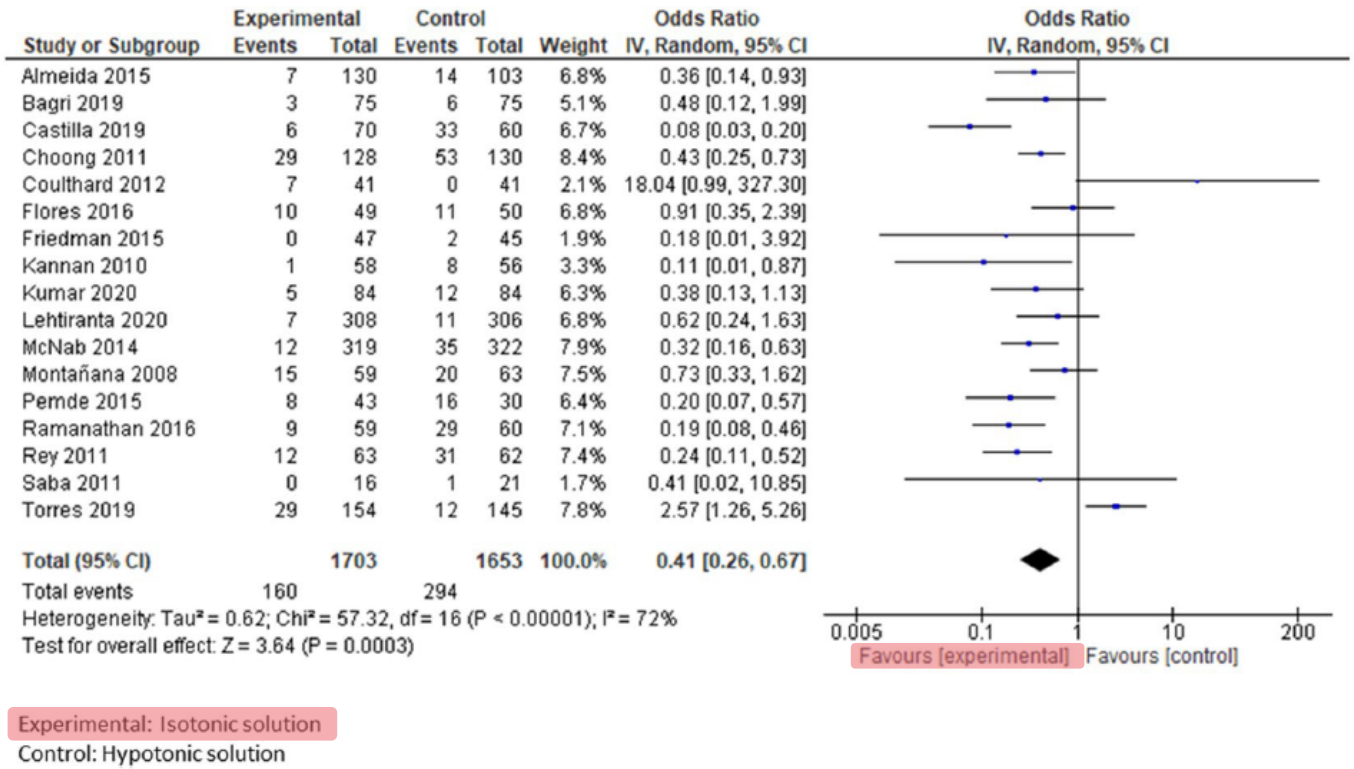


Fig. 2 Meta-analysis of studies comparing the impact on length of stay of intravenous versus enteral hydration

Režimy infuzní terapie

PiCO 2: use of isotonic fluids

In acutely and critically ill children, isotonic maintenance fluid should be used to reduce the risk of hyponatremia A Strong consensus



Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Odds Ratio IV, Random, 95% CI
Almeida 2015	7	130	14	103	6.8%	0.36 [0.14, 0.93]
Bagri 2019	3	75	6	75	5.1%	0.48 [0.12, 1.99]
Castilla 2019	6	70	33	60	6.7%	0.08 [0.03, 0.20]
Choong 2011	29	128	53	130	8.4%	0.43 [0.25, 0.73]
Coulthard 2012	7	41	0	41	2.1%	18.04 [0.99, 327.30]
Flores 2016	10	49	11	50	6.8%	0.91 [0.35, 2.39]
Friedman 2015	0	47	2	45	1.9%	0.18 [0.01, 3.92]
Kannan 2010	1	58	8	56	3.3%	0.11 [0.01, 0.87]
Kumar 2020	5	84	12	84	6.3%	0.38 [0.13, 1.13]
Lehtiranta 2020	7	308	11	306	6.8%	0.62 [0.24, 1.63]
McNab 2014	12	319	35	322	7.9%	0.32 [0.16, 0.63]
Montañana 2008	15	59	20	63	7.5%	0.73 [0.33, 1.62]
Pemde 2015	8	43	16	30	6.4%	0.20 [0.07, 0.57]
Ramanathan 2016	9	59	29	60	7.1%	0.19 [0.08, 0.46]
Rey 2011	12	63	31	62	7.4%	0.24 [0.11, 0.52]
Saba 2011	0	16	1	21	1.7%	0.41 [0.02, 10.85]
Torres 2019	29	154	12	145	7.8%	2.57 [1.26, 5.26]
Total (95% CI)		**1703**		**1653**	**100.0%**	**0.41 [0.26, 0.67]**
Total events	160		294			

Heterogeneity: Tau² = 0.62; Chi² = 57.32, df = 16 (P < 0.00001); I² = 72%

Test for overall effect: Z = 3.64 (P = 0.0003)

Experimental: Isotonic solution

Control: Hypotonic solution

Fig. 3 Meta-analysis of studies comparing the impact on hyponatremia occurrence of isotonic versus hypotonic solutions

Režimy infuzní terapie

PiCO 3: use of balanced solutions		
In critically ill children, balanced solutions should be favoured when prescribing intravenous maintenance fluid therapy to slightly reduce length of stay	B	Strong consensus
In acutely ill children, balanced solutions should be used when prescribing intravenous maintenance fluid therapy to slightly reduce length of stay	A	Strong consensus
In acutely and critically ill children, lactate buffer solution should not be considered in the case of severe liver dysfunction to avoid lactic acidosis	D	Consensus

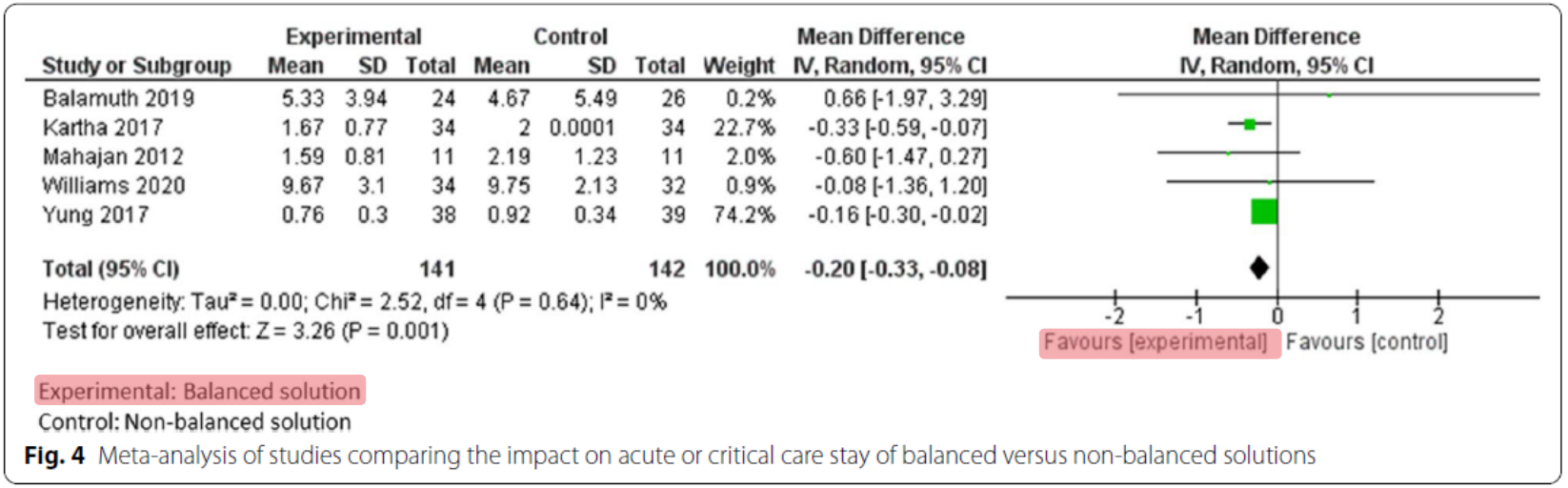


Fig. 4 Meta-analysis of studies comparing the impact on acute or critical care stay of balanced versus non-balanced solutions

Režimy infuzní terapie

PiCO 4: IV-MFT fluid composition (Ca, Mg, P, Micronutrients, Glucose)		
In acutely and critically ill children, glucose provision in intravenous maintenance fluid therapy should be considered in sufficient amount and guided by blood glucose monitoring (at least daily) to prevent hypoglycaemia	GCP	Consensus
In critically ill children, glucose provision in intravenous maintenance fluid therapy should not be excessive and guided by blood glucose monitoring (at least daily) to prevent hyperglycaemia	B	Consensus
In acutely and critically ill children, there is insufficient evidence to recommend routine supplementation of magnesium, calcium and phosphate in intravenous maintenance fluid therapy	GCP	Strong consensus
In acutely and critically ill children, an appropriate amount of potassium should be considered and added to intravenous maintenance fluid therapy, based on the child's clinical status and regular potassium level monitoring to avoid hypokalemia	GCP	Consensus
In acutely and critically ill children, there is insufficient evidence to recommend routine supplementation of vitamins and trace elements in intravenous maintenance fluid therapy, in the absence of signs of deficiency	GCP	Strong consensus

Režimy infuzní terapie

PiCO 5: volume of IV-MFT administered		
In acutely and critically ill children, in order to prevent fluid creep and reduce fluid intake, the total daily amount of maintenance fluid therapy should be considered including: IV fluids, blood products, all IV medications (both infusions and bolus drugs), arterial and venous line flush solutions and enteral intake, but does not include replacement fluids and massive transfusion	D	Strong consensus
In acutely and critically ill children, avoidance of fluid overload and cumulative positive fluid balance should be considered, to avoid prolonged mechanical ventilation and length of stay	D	Strong consensus
In acutely and critically ill children, who are at risk of increased endogenous secretion of ADH, restriction of total intravenous maintenance fluid therapy volume (calculated by Holliday and Segar formula) should be considered to some extent, to avoid a decrease in natremia but the amount and duration of this restriction is uncertain	C	Strong consensus
In acutely and critically ill children who are at risk of increased endogenous secretion of ADH, restricting maintenance fluid therapy volume to between 65–80% of the volume calculated by the Holliday and Segar formula should be considered to avoid fluid overload In children at greater risk of oedematous states, e.g., heart failure, renal failure or hepatic failure, restricting maintenance fluid therapy volume to between 50% to 60% of the volume calculated with the Holiday and Segar formula should be considered to avoid fluid overload	GCP	Strong consensus
Whilst receiving intravenous maintenance fluid therapy, re-assessment of acutely and critically ill children should be considered at least daily in terms of fluid balance and clinical status and regularly regarding electrolytes, especially sodium level	D	Consensus

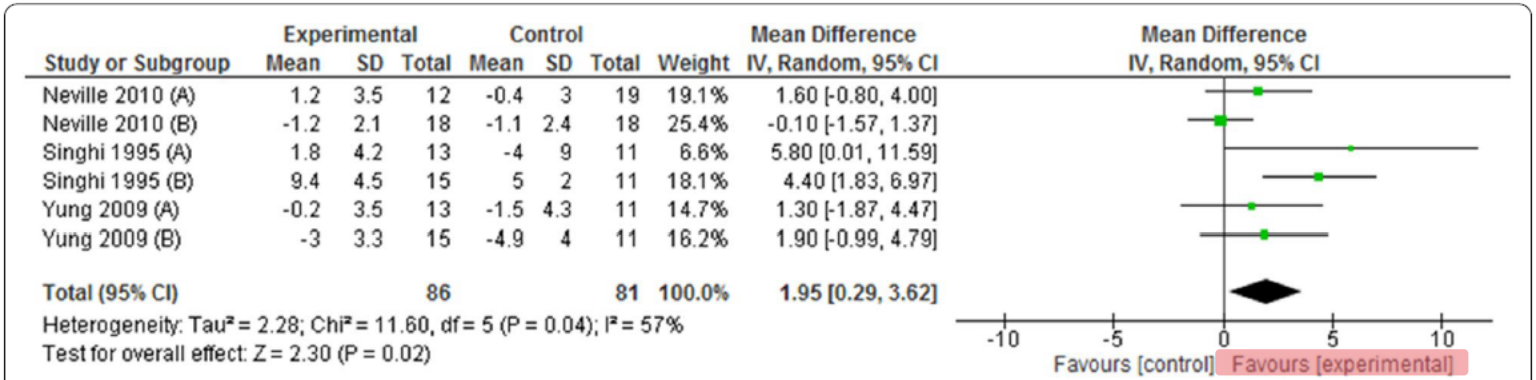


Fig. 5 Meta-analysis of studies comparing the impact on natremia of a restrictive versus a non-restrictive fluid strategy

Závěr

- Tekutinová terapie je základní intervencí
- Pokud lze, podáváme enterálně
- Ne vždy je indikován CVK
- Užíváme balancované izotonické krystaloidy
- Koloidy ne: koagulopatie, tek. resuscitace, sepse
- Resuscitace: 10 ml/kg
- Množství? Holliday-Segarova rovnice jako základní orientace (dle ESPNIC 65-80% u kriticky nemocných)