
بسم الله الرحمن الرحيم

Normal saline and kidney

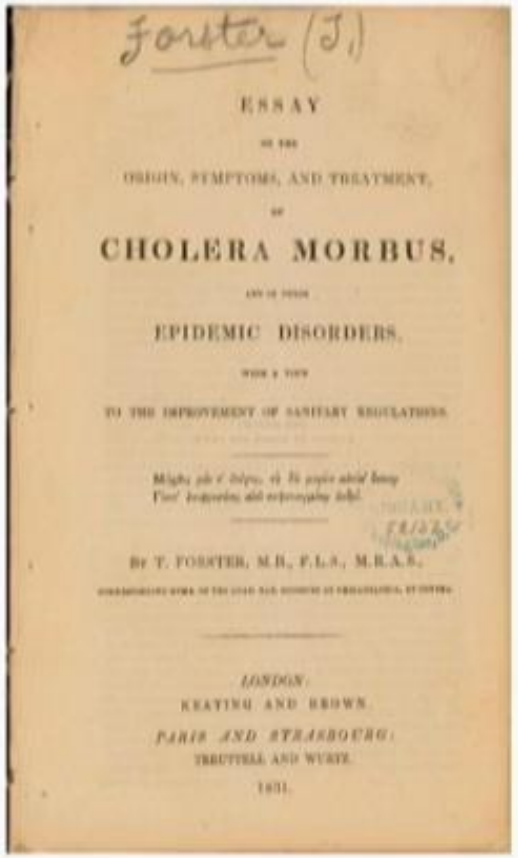
Dr.F.haghverdi MD

Outline

- 1. What about normal saline?
- 2. Normal saline indications
- **3. Normal saline side effects**
- 4. Normal saline vs colloid fluid for hypovolemia
- 5. Normal saline vs balanced crystaloids in critically ill patients

History of intravenous fluids

1831-32 British Cholera Epidemic



Forster (T.)

ESSAY

ON THE

ORIGIN, SYMPTOMS, AND TREATMENT,

OF

CHOLERA MORBUS,

AND OF THOSE

EPIDEMIC DISORDERS,

WITH A VIEW

TO THE IMPROVEMENT OF SANITARY REGULATIONS.

By T. FORSTER, M.B., F.L.S., M.R.A.S.

LONDON:
KEATING AND BROWN.
PARIS AND STRASBOURG:
TREUTTEL AND WURTZ.
1831.

MacGillivray J Inf Prev 2009;10(1):4–6.

Normal saline is not Normal !

Solute	Plasma	Crystalloids			
		Normal Saline	Ringer's Lactate	Hartmann's Solution	Plasma-Lyte
Na^+	135 - 145	154	130	131	140
K^+	4.0 - 5.0	0	4.5	5	5
Ca^{2+}	2.2 - 2.6	0	2.7	4	0
Mg^{2+}	1.0 - 2.0	0	0	0	1.5
Cl^-	95 - 110	154	109	111	98
Acetate	0	0	0	0	27
Lactate	0.8 - 1.8	0	28	29	0
Gluconate	0	0	0	0	23
Bicarbonate	23 - 26	0	0	0	0
Osmolarity	291	308	280	279	294
Colloid	35 - 45	0	0	0	0
Osmolarity (mOsm/L); Colloid (g/L); All other solutes (mmol/L)					

Characteristics of some crystalloids

	NaCl 0.9%	Lactated Ringer's	Hartmann's	Rehydrating III	Plasma Lyte	Sterofundin ISO	Dextrose 5%
Na^+	154	130	131	140	140	145	0
K^+	0	4	5	10	5	4	0
Ca^{2+}	0	3	4	5	0	5	0
Mg^{2+}	0	0	0	3	3	2	0
Cl^-	154	109	111	103	98	127	0
In-vivo SID	0	28	29	55	50	29	0

NephSim CORE IM

What's in a fluid?

	Tonicity	Osmolality mOsm/L	Na meq/L	Cl meq/L	K meq/L	Buffer
0.45% Saline (1/2 NS)	↓	154	77	77	0	
5% Dextrose (D5W)	↓	253	0	0	0	
Ringer's Lactate	✓	273	130	109	4	Lactate
Plasma	✓	290	140	103	4	HCO3
Plasma-lyte	✓	294	140	98	5	Gluconate, acetate
0.9% Saline (NS)	✓	308	154	154	0	
D5W + 150 meq NaHCO3	✓	480	150	0	0	HCO3
3% Saline	↑	1027	513	513	0	

↓ = hyPOtonic
✓ = ISOtonic
↑ = hyPERtonic

Adapted from www.nephsim.com

Theoretical Distribution of IV Fluids

	1L D5W	1L of 1/2 NS	1L NS or LR	1u pRBC	25g albumin (colloid)
ICF	667	333	0	0	0
ECF — INTERSTITIUM	250	500	750	0	0 (colloids draw water from the interstitium into the plasma)
PLASMA	83	167	250	300	450 (short half-life)

*All values reported in "ml"

Normal saline indications

- **1. Hypovolemia shock, hypovolemic hyponatremia,...**
- **2. Sepsis**
- **3. Hypercalcemia**
- **4.Metabolic alkalosis (saline responsive)**
- **5.HRS**
- **6. Maintenance fluid in neurosurgery and brain edema**
- **7. Packed RBC cell infusion**
- **8. Fluid for drugs infusion**
- **9. Contrast nephropathy prophylaxis**

.10. Rhabdomyolysis

Normal saline side effects

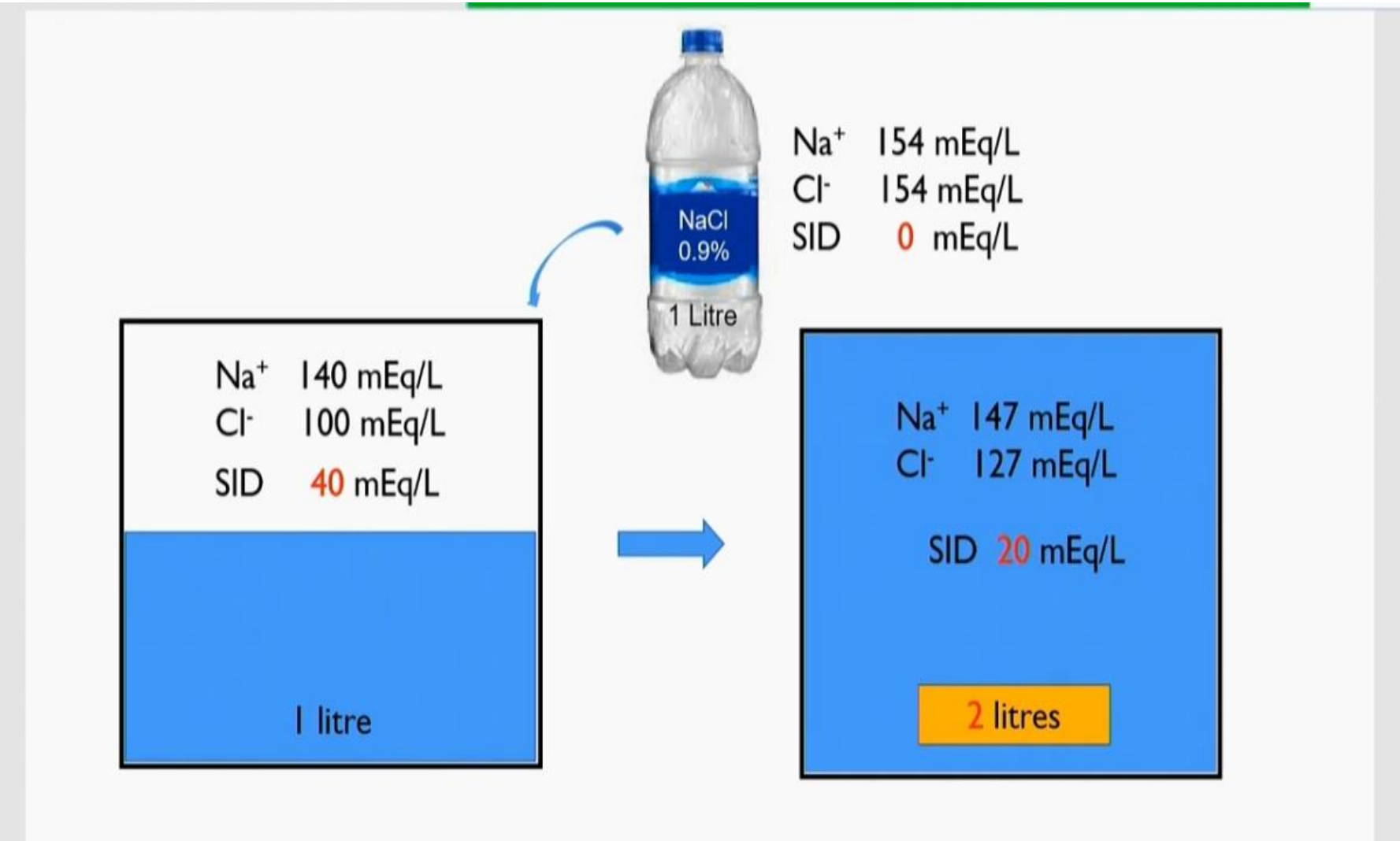
Metabolic	• Hyperchloremic acidosis • ↑Need for buffers to correct acidosis
Body water	• Possible damage to the endothelial glycocalyx • ↑Interstitial fluid volume leading to edema
Renal	• Renal edema and capsular stretch leading to intrarenal tissue hypertension • Renal vasoconstriction, ↓renal blood flow and renal tissue perfusion • ↓Glomerular filtration rate, urine volume, and sodium excretion
Gastrointestinal	• Gastrointestinal edema, intestinal stretch • Ileus, impaired anastomotic healing
Hematological	• ↑Intraoperative blood loss • ↑Need for blood product transfusion
Clinical outcomes	• ↑Postoperative complications • ↑Mortality • ↑Incidence of acute kidney injury and need for renal replacement therapy

Normal Saline (0.9% NaCl)

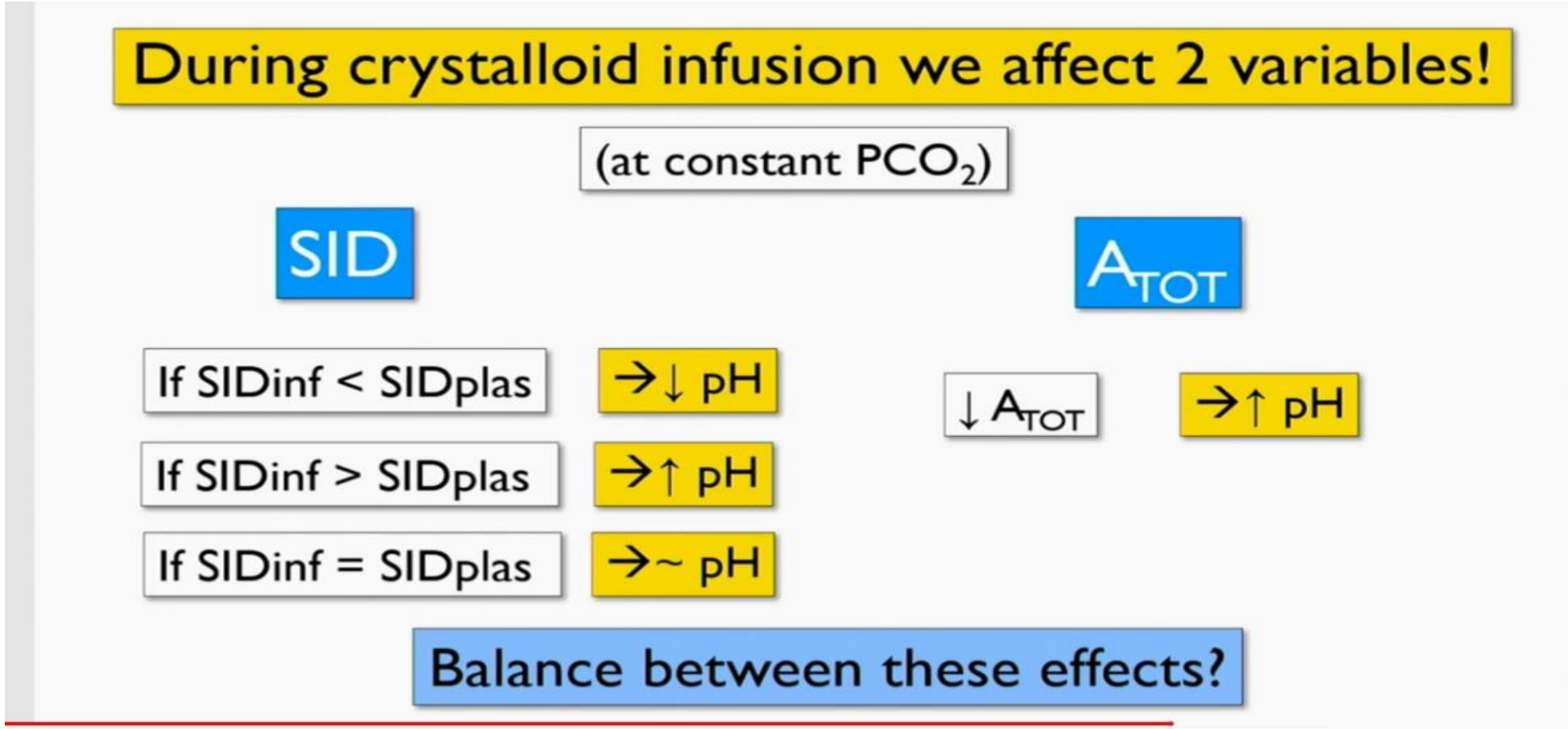
Adverse Effects

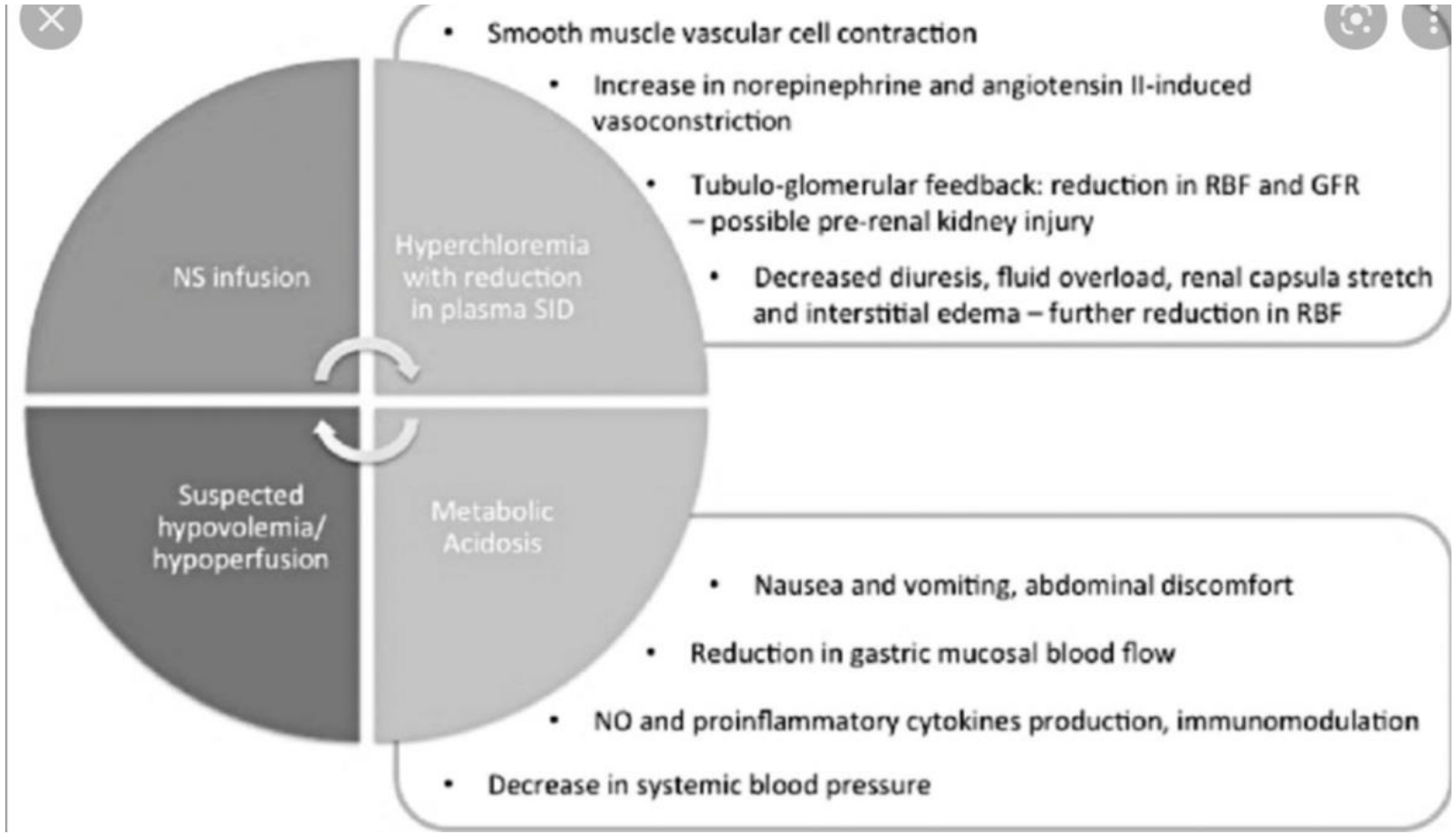
1. Fluid overload (peripheral and pulmonary oedema)
2. With high volume administration,
   - Dilutional reduction of normal plasma components such as calcium and potassium
   - Dilutional coagulopathy
   - Hyperchloraemic acidosis
3. Diuresis.

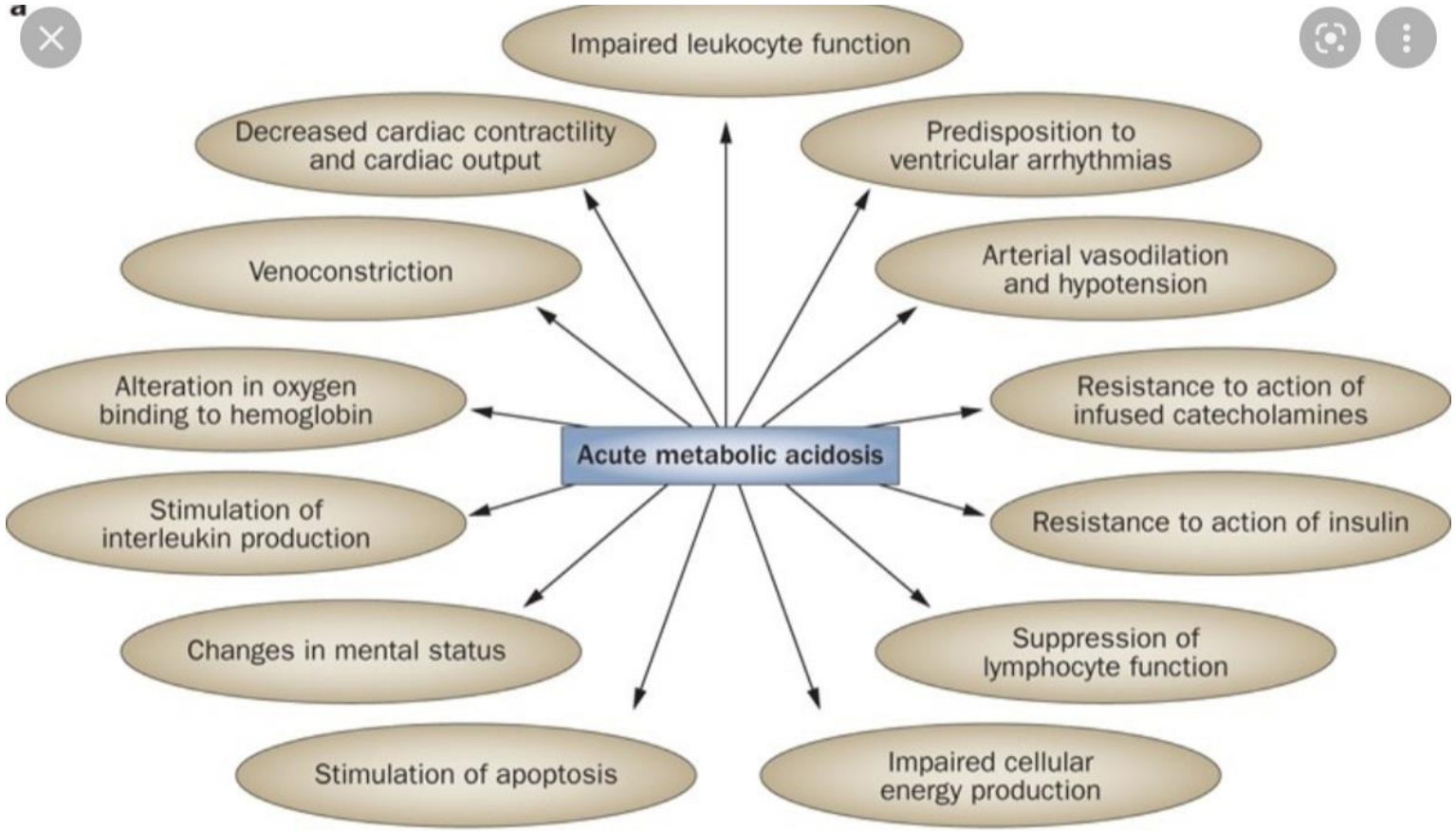
Normal saline and Hyperchloremic metabolic acidosis



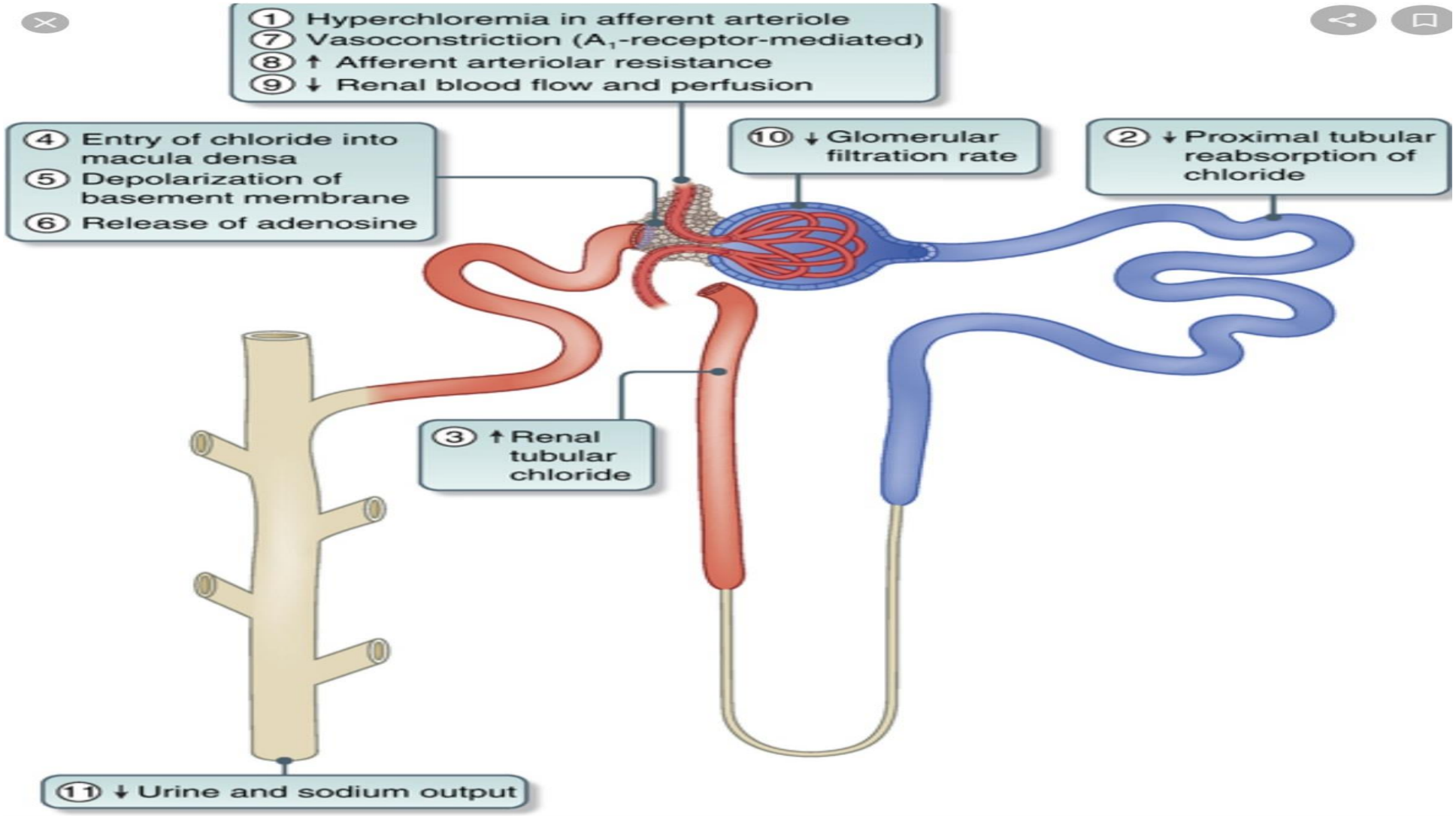
Stewart Approach




NS infusion
Hyperchloremia with reduction in plasma SID
Suspected hypovolemia/ hypoperfusion
Metabolic Acidosis
• Smooth muscle vascular cell contraction
• Increase in norepinephrine and angiotensin II-induced vasoconstriction
• Tubulo-glomerular feedback: reduction in RBF and GFR – possible pre-renal kidney injury
• Decreased diuresis, fluid overload, renal capsula stretch and interstitial edema – further reduction in RBF
• Nausea and vomiting, abdominal discomfort
• Reduction in gastric mucosal blood flow
• NO and proinflammatory cytokines production, immunomodulation
• Decrease in systemic blood pressure


Impaired leukocyte function
Decreased cardiac contractility and cardiac output
Predisposition to ventricular arrhythmias
Venoconstriction
Arterial vasodilation and hypotension
Alteration in oxygen binding to hemoglobin
Resistance to action of infused catecholamines
Acute metabolic acidosis
Stimulation of interleukin production
Resistance to action of insulin
Changes in mental status
Suppression of lymphocyte function
Stimulation of apoptosis
Impaired cellular energy production

Hyperchloremia induced AKI



Normal saline vs balanced fluids

infographic by Tommaso Scquizzato[1] @tscquizzato

Balanced Crystalloids vs. Normal Saline

Both balanced crystalloids and saline are used for intravenous fluid administration in critically and non-critically ill adults, but it is not known which results in better clinical outcomes.

in non-critically ill adults SALT-ED trial[2]

single-center, pragmatic, multiple-crossover trial comparing balanced crystalloids with saline in adults admitted in the ED and hospitalized outside an ICU

13,346
adult patients enrolled in 16 months who received at least 500 ml of crystalloids

Balanced	Saline
6,708 ml	6,639 ml

lower Cl- and higher HCO3- concentrations
less episodes of hyperchloremia or acidemia

results

1. Hospital-Free Days — days alive after discharge before day 28: Balanced 25 days, Saline 25 days
2. MAKE30 — Major Adverse Kidney Events at 30 days (in-hospital mortality, new RRT and persistent renal dysfunction): Balanced 4.7%, Saline 5.6%

AKI stage ≥ 2 and In-hospital mortality: Balanced ≈ Saline

conclusion

No difference in hospital-free days between treatment with BC and NS.

Stage ≥ 2 AKI patients or those with borderline renal failure or hyperchloremia had the largest benefit from balanced crystalloids.

in critically ill adults SMART trial[3]

pragmatic, cluster-randomized, multiple-crossover trial comparing balanced crystalloids with saline in adults admitted in 5 ICU

15,802
adult patients enrolled in 16 months randomized to NS or BC

Balanced	Saline
7,942 ml	7,860 ml

34.3% on ventilator
26.4% on vasopressors
14.7% are septic
8.8% have TBI

results

1. MAKE30 — Major Adverse Kidney Events at 30 days (in-hospital mortality, new RRT and persistent renal dysfunction): Balanced 14.3%, Saline 15.4%
2. In-hospital mortality — before ICU discharge or at 30 days: Balanced 25.2%, Saline 29.4%

Receipt of new renal replacement therapy: Balanced 2.5%, Saline 2.9%

No difference in ICU-free days, ventilator-free days, vasopressor-free days, RRT-free days

conclusion

The use of balanced crystalloids resulted in a lower rate of MAKE30 than the use of saline.

The largest benefit appears to be in the septic subset of patients with a NNT of 20.

[1]Vita-Salute San Raffaele University, Milan - Faculty of Medicine and Surgery, contact at t.scquizzato@studenti.unisr.it
[2]Self WH et al. Balanced Crystalloids Versus Saline in Noncritically Ill Adults. NEJM 2018
[3]Semler MW et al. Balanced Crystalloids Versus Saline in Critically Ill Adults. NEJM 2018

appeared first on www.empillsblog.com empills

Balanced Crystalloids versus Normal Saline as Intravenous Fluid Therapy among Critically Ill patients: A Meta-Analysis of Randomized Controlled Trials

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Abstract

Introduction: Recent studies on critically ill adults has shown that use of normal saline with its supraphysiologic chloride content has been associated with an increased incidence of hyperchloremic metabolic acidosis, acute kidney injury (AKI), renal replacement therapy (RRT), hypotension and death. The objective of this meta-analysis was to assess the clinical outcomes associated with the use of balanced crystalloids versus normal saline solution.

Methods: We searched PubMed/MEDLINE, Embase and Cochrane Library (CENTRAL) databases in accordance with PRISMA guidelines. Our inclusion criteria were the following: randomized controlled trials, adult critically ill patients, comparisons between patients receiving either balanced crystalloids (lactated ringer's solution, plasma-lyte) or normal saline, and at least one endpoint that measure intensive care unit mortality, risk of AKI (defined as stage 2 or greater in the RIFLE criteria) and risk of RRT. Risk ratios (RRs) and confidence intervals (C.I) were calculated via Review Manager Version 5.3 using the fixed-effect modelling.

Results: A total of four randomized controlled trials, which were all assessed to be good quality and low risk of bias, with 19,105 patients were included. Use of balanced crystalloids showed a trend towards lower incidence of AKI (RR 0.94, 95% C.I (0.87-1.02), *P*=0.69), RRT use (RR 0.91, 95% C.I. (0.77-1.07), *P*=0.29) and ICU mortality (RR 0.91, 95% C.I. (0.82-1.01), *P*=0.95). There is no significant heterogeneity identified.

Conclusion: Use of balanced crystalloids as intravenous fluid therapy among critically ill patients demonstrated a trend toward lower incidence of AKI, RRT and ICU mortality, compared to normal saline solution.

Keywords: intravenous fluids, acute kidney injury, critical illness

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Balanced crystalloids versus normal saline for fluid resuscitation in critically ill patients: A systematic review and meta-analysis with trial sequential analysis

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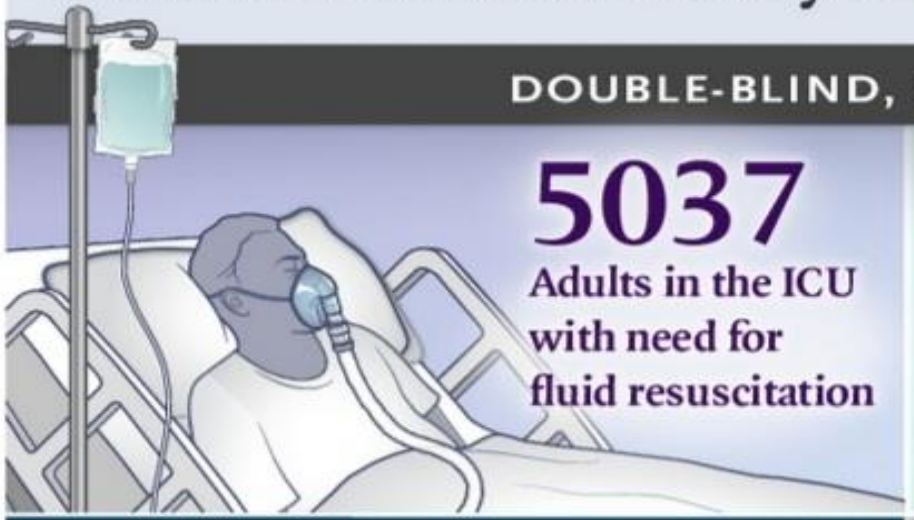
ABSTRACT

Introduction: Fluid resuscitation is a fundamental component of the management of critically ill patients, but whether choice of crystalloid affects patient outcomes remains controversial. Therefore, we performed this meta-analysis to compare the efficacy and safety of balanced crystalloids with normal saline.
Methods: We searched the MEDLINE, Cochrane Central and EMBASE up to October 2018 to identify randomized controlled trials (RCTs) that compared balanced crystalloids versus normal saline in critically ill patients. The primary outcome was mortality. The secondary results were the incidence of acute kidney injury (AKI) and risk of receiving renal replacement therapy (RRT). Two authors independently screened articles based on the inclusion and exclusion criteria. The meta-analysis was conducted using Revman 5.3, trial sequential analysis (TSA) 0.9 and STATA 12.0.
Results: Nine RCTs were identified. The pooled analyses showed that there were no significant differences in mortality (relative risk (RR) = 0.93, 95% confidence interval (CI) = 0.86, 1.01, P = 0.08), incidence of AKI (RR 0.94, 95% CI 0.88, 1.00, P = 0.06) or RRT use rate (RR 0.94, 95% CI 0.69, 1.27, P = 0.67) between balanced crystalloids and normal saline groups. However, TSA did not provide conclusive evidence.
Conclusions: Among critically ill patients receiving crystalloid fluid therapy, use of a balanced crystalloid compared with normal saline did not reduce the mortality, risk of severe AKI or RRT use rate. Further large randomized clinical trials are needed to confirm or refute this finding.
Trial registration: A protocol of this meta-analysis has been registered on PROSPERO (registration number: CRD42018094857).

The NEW ENGLAND JOURNAL of MEDICINE

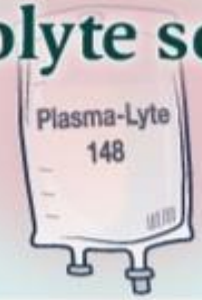
Balanced Multielectrolyte Solution vs. Saline in Critically Ill Adults

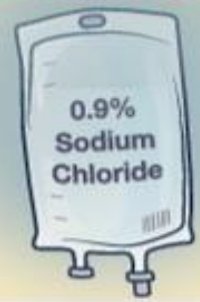


DOUBLE-BLIND, RANDOMIZED, CONTROLLED TRIAL

5037
Adults in the ICU with need for fluid resuscitation

	Balanced multielectrolyte solution (N=2515)	Saline (N=2522)
Death from any cause at day 90	21.8%	22.0%
	OR, 0.99; 95% CI, 0.86 to 1.14	
Newly initiated renal-replacement therapy	12.7%	12.9%
	Difference, −0.20 percentage points; 95% CI, −2.96 to 2.56	
Mean maximum increase in serum creatinine	0.41 mg/dl	0.41 mg/dl
	Difference, 0.01 mg/dl; 95% CI, −0.05 to 0.06	





Use of balanced multielectrolyte solution in critically ill adults did not result in a lower risk of death or acute kidney injury than use of saline.

S. Finfer et al. 10.1056/NEJMoa2114464

Normal saline vs Colloid fluids

TYPES OF I.V. FLUIDS

1. Crystalloids vs. Colloids

CRYSTALLOIDS	COLLOIDS
Normal (0.9%) saline	Human Albumin
Ringer's lactate solution (Hartmann's' solution)	Gelatin solutions (Haemaccel®,Gelafundin ®)
5% Dextrose	Dextran
	Hydroxyethyl starches (Hetastarch®)

Where the IV fluid goes

Crystalloids	Colloids
NS, RL	Albumin, HES
75 % Extravascular	Almost 100 %
25 % Intravascular/ Plasma Volume	Intravascular/ Plasma Volume

Normal saline vs colloid fluids

Table 1. **Comparative summary of crystalloid and colloid solutions**

Crystalloid solution	Colloid sollution
Half-life of 30-60 minutes	Half-life of several hours or days
Three times the volume needed for replacement	Replaces fluid volume for volume
Excessive use can cause peripheral and pulmonary oedema	Excessive use can precipitate cardiac failure
Molecules small enough to freely cross capillary walls, so less fluid remains in the intravascular spaces	Molecules too large to cross capillary walls, so fluid remains in intravascular spaces for longer
Inexpensive	More expensive than crystalloids
Non-allergenic	Risk of anaphylactic reactions
Suitable for vegetarian or vegan patients	Some preparations unsuitable for vegetarian or vegan patients

Source: Adapted from Pryke (2004)

Conclusion

- 1. **Normal saline is not Normal** and has Supra physiological chloride and PH =5.5

- 2. Large (more than 30 cc / kg) and rapid infusion of Normal saline may induce **Hyperchloremic metabolic acidosis.**

- 3.In non critically ill patients especially with **cl>110 meq/ l or Cr> 1.5mg/dl balanced crystaloids may be superior to Normal saline in hospital mortality rate.**