



Goal-Directed Fluid Therapy

Which one is better for us?



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FECLS

in severe trauma



8th

Annual APEL SO Confere

Asia-Pacific Extracorporeal Life Support Org



Challenging Spirit!

June 11-13, 2026

Hamamatsucho Convention Hall & Hybrid Studio

Final Program

- ▶ Committee Members
- ▶ Scientific Program Overview
- ▶ Floorplan
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- ▶ Sponsors





Schlieffen-Plan (1905)



The image contains two maps from World History Encyclopedia. The top map, titled 'WORLD WAR 1: THE SCHLIEFFEN PLAN, 1905', shows the German Empire's planned route through Belgium and France to reach the English Channel. The bottom map shows the 'Farthest German Advance Sep 1914', illustrating the actual progress of German forces in 1914, including the capture of Paris and the establishment of the Lorraine defensive line.

WORLD HISTORY ENCYCLOPEDIA

WORLD WAR 1: THE SCHLIEFFEN PLAN, 1905

SCHLIEFFEN PLAN VS. 1914 REALITY

- Day 1 - 4 Aug 1914
Plan: German armies cross Belgium, seize Liège, advance unopposed.
In 1914: Began resistance at Liège halts the timetable - siege begins 6-16 Aug.
- Day 3 - 6 Aug 1914
Plan: Right wing curves through Belgium, cavalry crosses reach Brussels.

1. 서부방면군으로 벨기에를 통해 프랑스를 침공한다.

2. 그 사이 오스트리아를 내세워 러시아를 막는다.

3. 만일, 러시아가 침략한다면 독일 영토를 내주고 시간을 번다.

4. 프랑스를 6주 이내 격파 후 서부군 병력은 동부전선으로 이동한다.

5. 동부방면군과 합세하여 러시아를 점령하여 전쟁을 승리한다.

WORLD HISTORY ENCYCLOPEDIA

Farthest German Advance Sep 1914

GERMAN 7TH ARMY
Upper Rhine & Alsace defence, guard southern frontier.

Lorraine defensive line,
hold Moselle-Vosges sector.

GERMAN 7TH ARMY
Upper Rhine & Alsace defence, guard southern frontier.

Farthest German Advance Sep 1914
Stabilised Western Front Dec 1914

worldhistory.org



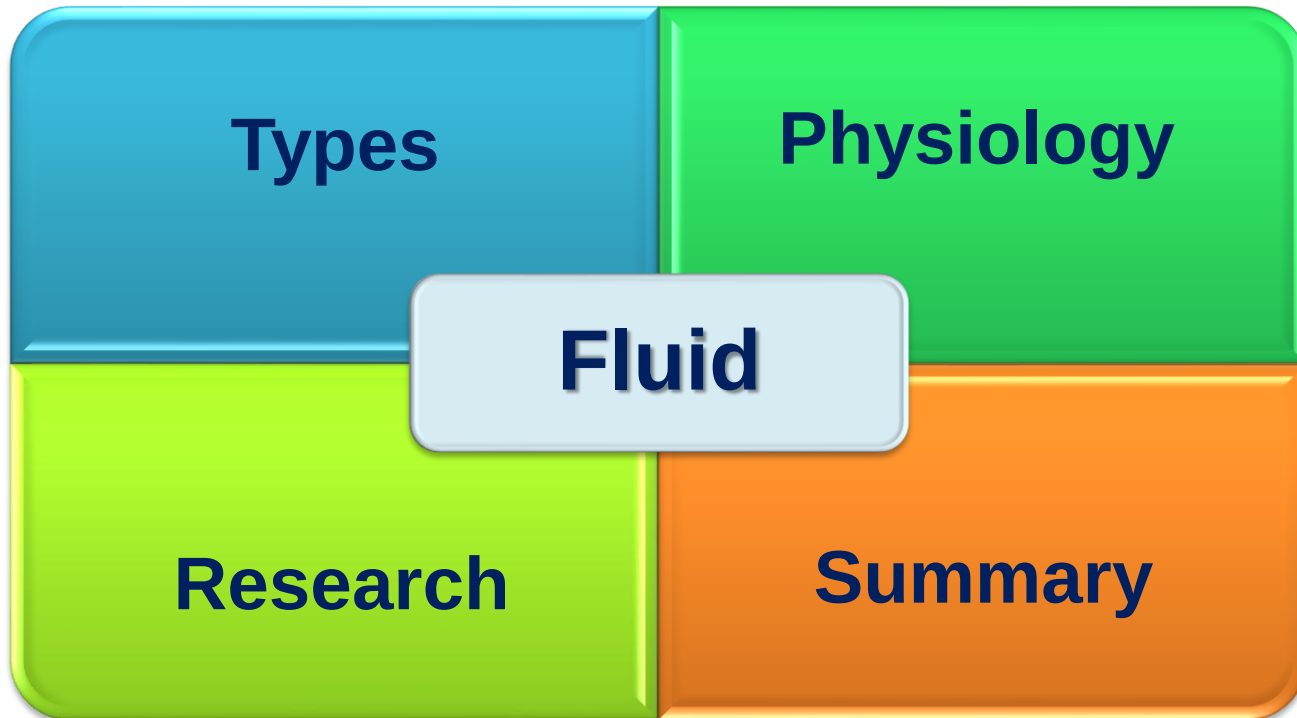


Karl Bernhard von Moltke
1800 - 1891

**Kein Plan überlebt die erste Feindberührung.
(적과의 첫 접촉 이후 살아남는 계획은 없다.)**

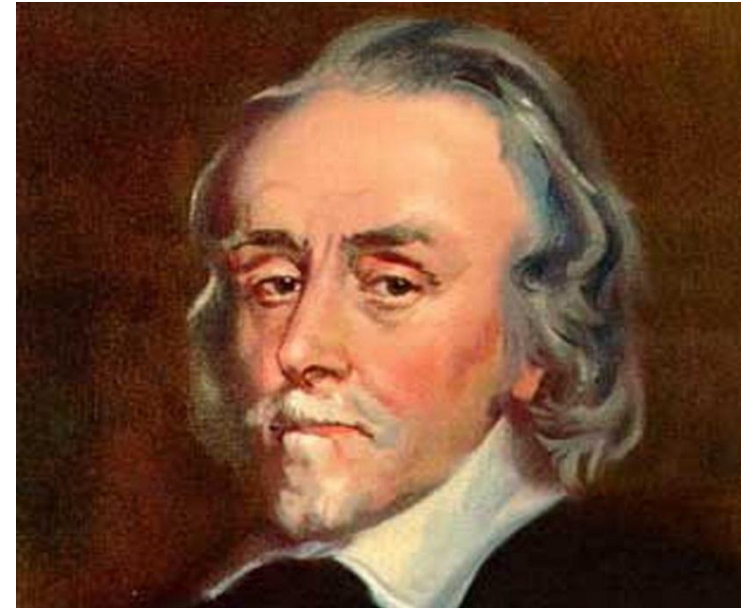


Contents

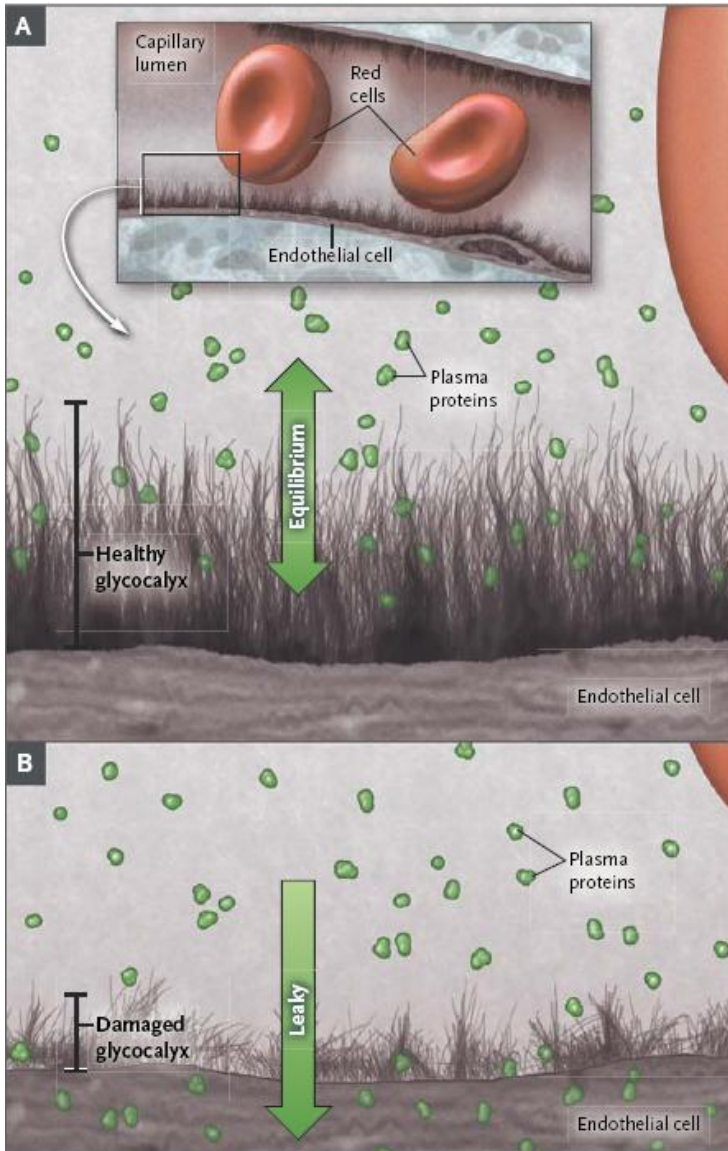


History

- 1638 – William Harvey : first described the circulatory system
- 1832 – Physiologic saline due to pandemic cholera
- 1915 – James Hogan: first published of colloid in JAMA
- 1960 – Large volume infusion (crystalloid) during battlefield



Homeostasis

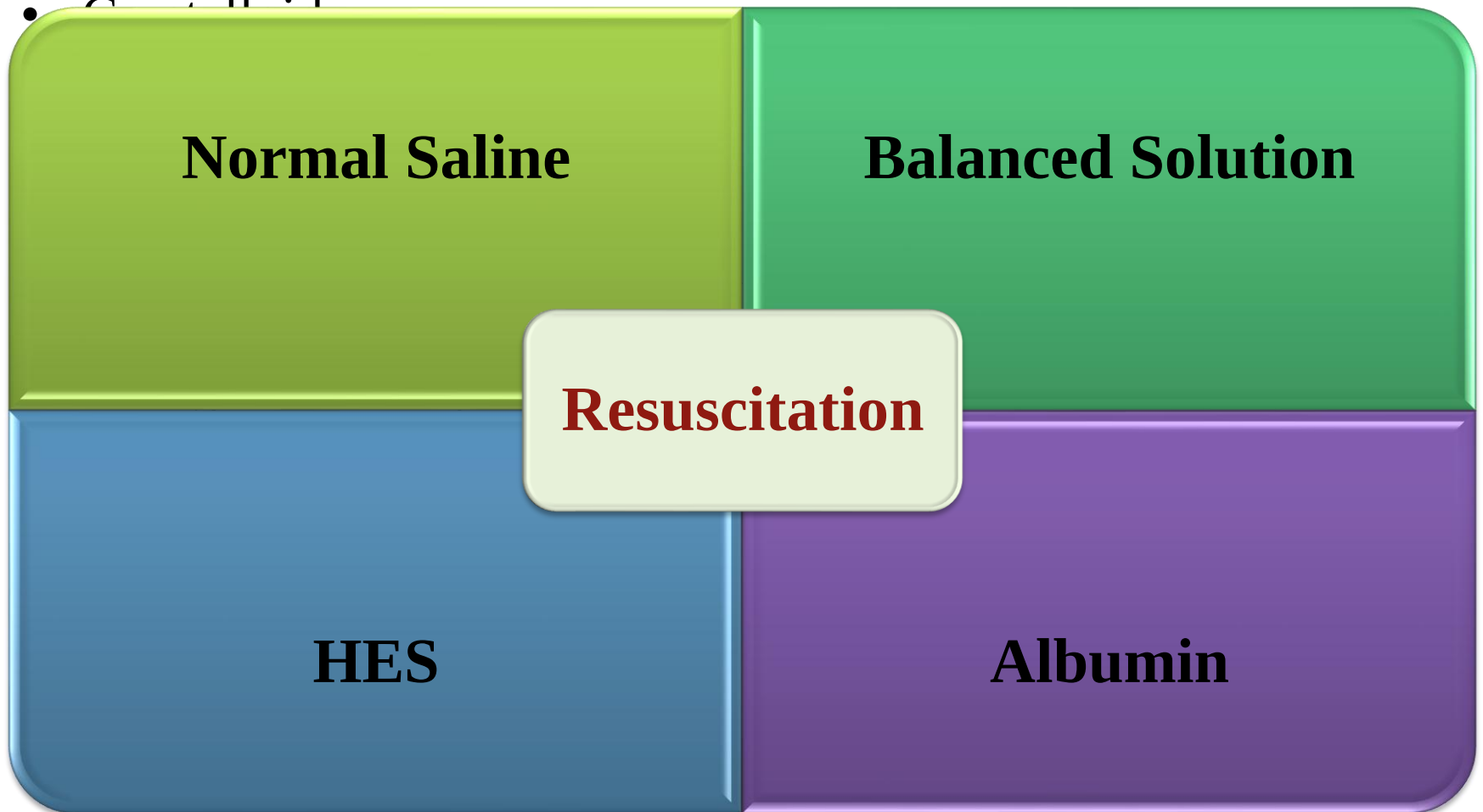


Produce colloid oncotic pressure

Inflammatory condition: sepsis, trauma, surgery

Development of interstitial edema

Type of fluid



Fluids

Fluid	pH	Na	Cl	K	Ca	Mg	Buffer	Osmol
Plasma	7.4	141	103	4-5	5	2	Bicarbonate	289
Normal Saline	5.7	154	154				None	308
Lactated Ringer's	6.4	130	109	4	3		Lactate	273
Plasmalyte	7.4	140	98	5		2	Acetate/ Gluconate	295

Fluid	M.W.	Osmotic pressure	Effect	Half life
5% albumin	69,000 Dalton	20 mmHg	0.7-1.3	16 hours
6% Hetastarch	69,000 Dalton	30 mmHg	1.0-1.3	17 days

Crystalloid

- First line fluid, cheap
 - Initial fluid for sepsis-induced hypoperfusion within first 3 hours
 - Fluid challenge on pre-renal AKI
- Normal saline (0.9% NS)
- Balanced (buffered) solution
- Hypertonic saline (3.5%, 5%, 7.5%)
- Free in extracellular space
- Fluid distribution
 - 75 % ECF & 25 % Intravascular
 - Plasma expansion effect ??

Normal saline

- Used for over 50 years
- No overall difference in mortality any other fluids
- Hyperchloremic metabolic acidosis
- Interstitial edema
- Really normal?
 - Neither normal nor physiologic fluid, event not balance

Chloride in fluid

- Supraphysiological concentration of chloride
- Exacerbate hyperchloremia and metabolic acidosis
- Cause renal vasoconstriction and decreased GFR
- Renal failure and RRT
- Restricting IV Cl administration in ICU

Balanced Solution

- Mild hypotonic solution (Osmol 270 ~ 280)
- Buffered by bicarbonate containing fluid
- Restoration of acid-base homeostasis
- Reduction of detrimental effects of infection, AKI, etc...
- Indication
 - Major surgery
 - Trauma
 - Diabetic ketoacidosis

Colloid

- **Natural**
 - Albumin
- **Artificial**
 - Gelatin
 - Dextran
 - Hydroxyethyl Starches (HES)
 - Pentastarch
 - Hexastarch
 - Tetrastarch

Colloid

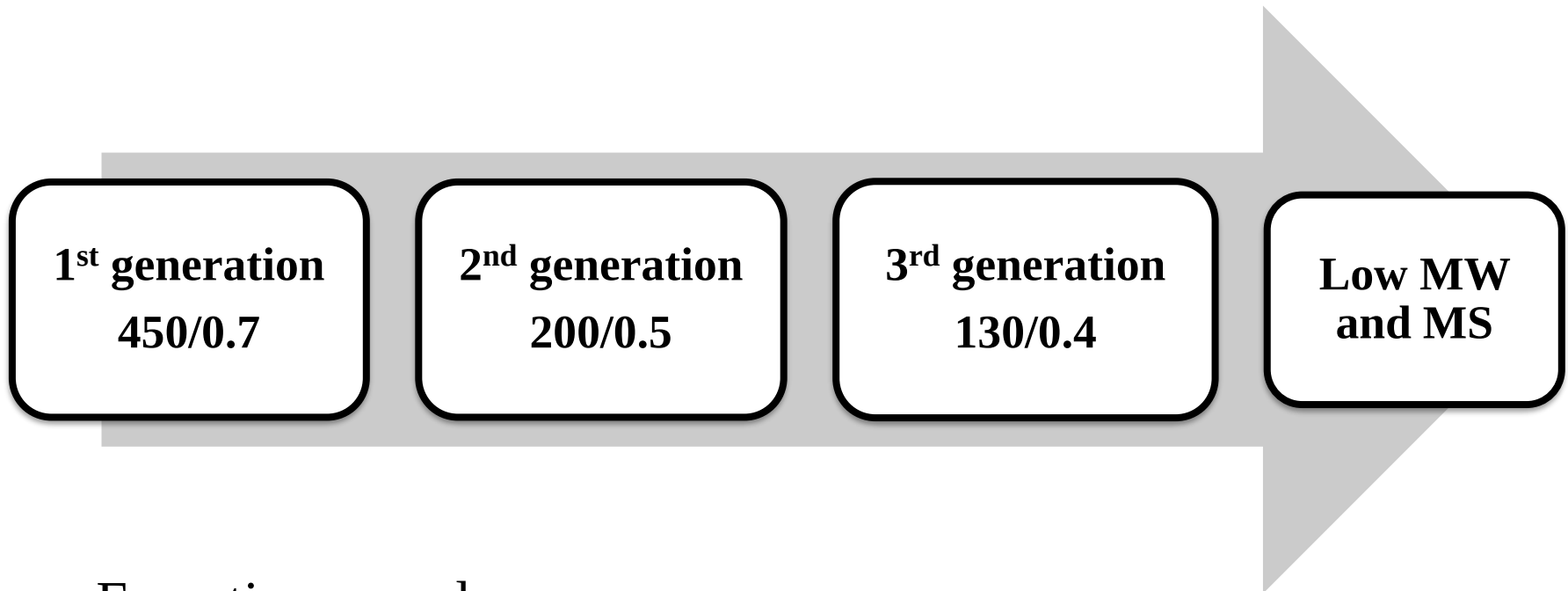
- High molecular weight substance
 - Create osmotic pressure → to keep volume in the vascular space
 - Where the IV fluid goes?
 - 30 % Extravascular
 - 70 % Intravascular Volume
- Plasma expansion effect↑ , volume sparing effect

1:3 ratio of colloids to crystalloids

Albumin

- Natural colloid
- Antioxidant and anti-inflammatory properties
- Buffering system in the regulation of the acid–base balance
- Suggesting using in addition to crystalloids resuscitation
- Volume resuscitation of critically ill patients
 - Leads to 80% initial volume expansion whereas 25% of other solution

Hydroxyethyl starch



- Excretion : renal
- 6% HES 130/0.4
 - concentration/ molecular weight/ molar substitution
- Volume sparing effect d/t long half-life and plasma expansion

Advantages of HES

- Key role : volume expander
 - Minimal fluid administration
 - Avoidance of over-resuscitation
- More effective in osmotic pressure
- Maintain of bowel function
- Patients with penetrating injury : lower mortality

Disadvantages of HES

- A systematic review and stratified meta-analysis
- Sepsis
- Resuscitation is supported by a crystalloid and eventually by a colloid that stays within the circulation
- Kidney injury due to renal vasoconstriction
- Increased blood loss was found among patients receiving HES
- 3rd generation HES products did not influence the results

FDA safety information

- RECOMMENDATION: Patients should be aware of the risks associated with the use of HES solutions and discuss these risks with their healthcare provider
- Do not use HES solutions in critically ill adult patients including those with sepsis, and those admitted to the ICU
- Avoid use in patients with pre-existing renal dysfunction.
- Discontinue use of HES at the first sign of renal injury.
- Continue to monitor renal function for at least 90 days in all patients.
- Avoid use in patients undergoing open heart surgery in association with cardiopulmonary bypass due to excess bleeding.
- Discontinue use of HES at the first sign of coagulopathy.

Classic concept

- Shock
 - insufficient mitochondrial oxidative phosphorylation
- Large amount crystalloid resuscitation in hypovolemia
 - a ratio of 3 mL per 1 mL of blood loss
- 2L lactate solution – ATLS 7th edition 1990's
- Continuing replacement until clinical signs return to normal
- No role defined for colloids in resuscitation
- 1990- : consider of adverse effect

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Number 17

IMMEDIATE VERSUS DELAYED FLUID RESUSCITATION FOR HYPOTENSIVE PATIENTS WITH PENETRATING TORSO INJURIES

Methods. We conducted a prospective trial comparing immediate and delayed fluid resuscitation in 598 adults with penetrating torso injuries who presented with a pre-

- Penetrating injury
 - Liberal vs restrictive
 - Mortality
 - LOS
 - Complication
- Restrictive group

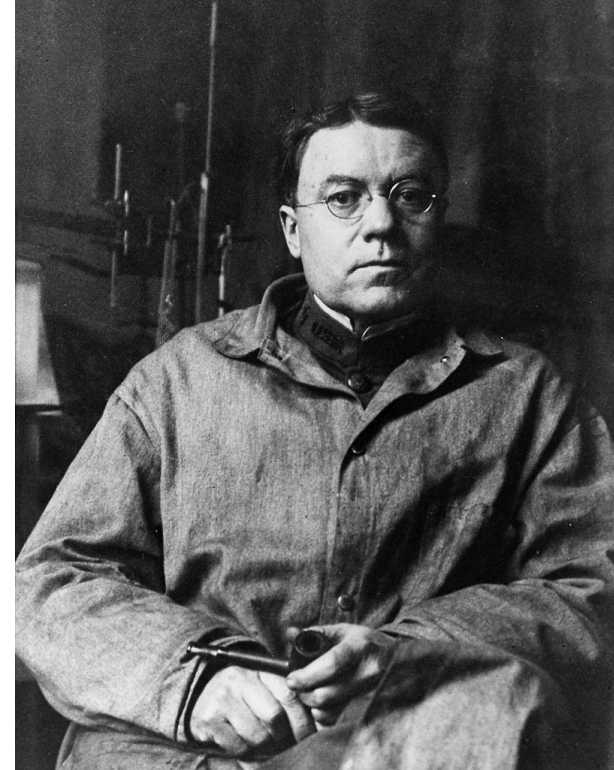
Resuscitation injury

- Reduces body temperature
- Dilutes clotting factor
- Impairs organ perfusion
- Gastrointestinal dysfunction
- Abdominal compartment syndrome
- Cellular dysfunction
- Fluid overload and edema lead to further edema

**Do not over resuscitation,
but effective circulation**

New concept ?

- In 1918, Walter B. Cannon described the disadvantages of NS
- “Not only does ordinary salt solution fail to combat acidosis, it actually increases an already existent acidosis.”



1871 ~ 1945

Fluid therapy

- Maintenance: which replaces the normal ongoing losses
 - Formula
 - 4/2/1 rule (Weight in Kg + 40)
 - 5/2/1 rule
 - 100 ml/kg/day for first 10 kg (=1000ml/day)
 - Then 50 ml/kg/day for next 10 kg (=500ml/hr)
 - Then 20 ml/kg/day
- Replacement: which corrects water and electrolyte deficits
 - Hypovolemia, ARF, etc...
 - No definitive formula for assessing the degree of hypovolemia

Background

- Since 2000s, a number of randomised trials reported that 0.9% saline and hydroxyethyl starch(HES), albumin, colloids, etc..
- These fluids are associated with adverse outcomes
- Geographical location : strong predictor of the fluid resuscitation
- Overall, there is a preferential use of crystalloids, specifically buffered salt solutions, over colloids

**Immunomodulation :
minimizing neutrophil
activation**

**Restore cellular perfusion :
improved microcirculation
& endothelial integrity**

**Minimum tissue
edema**

Volume expansion

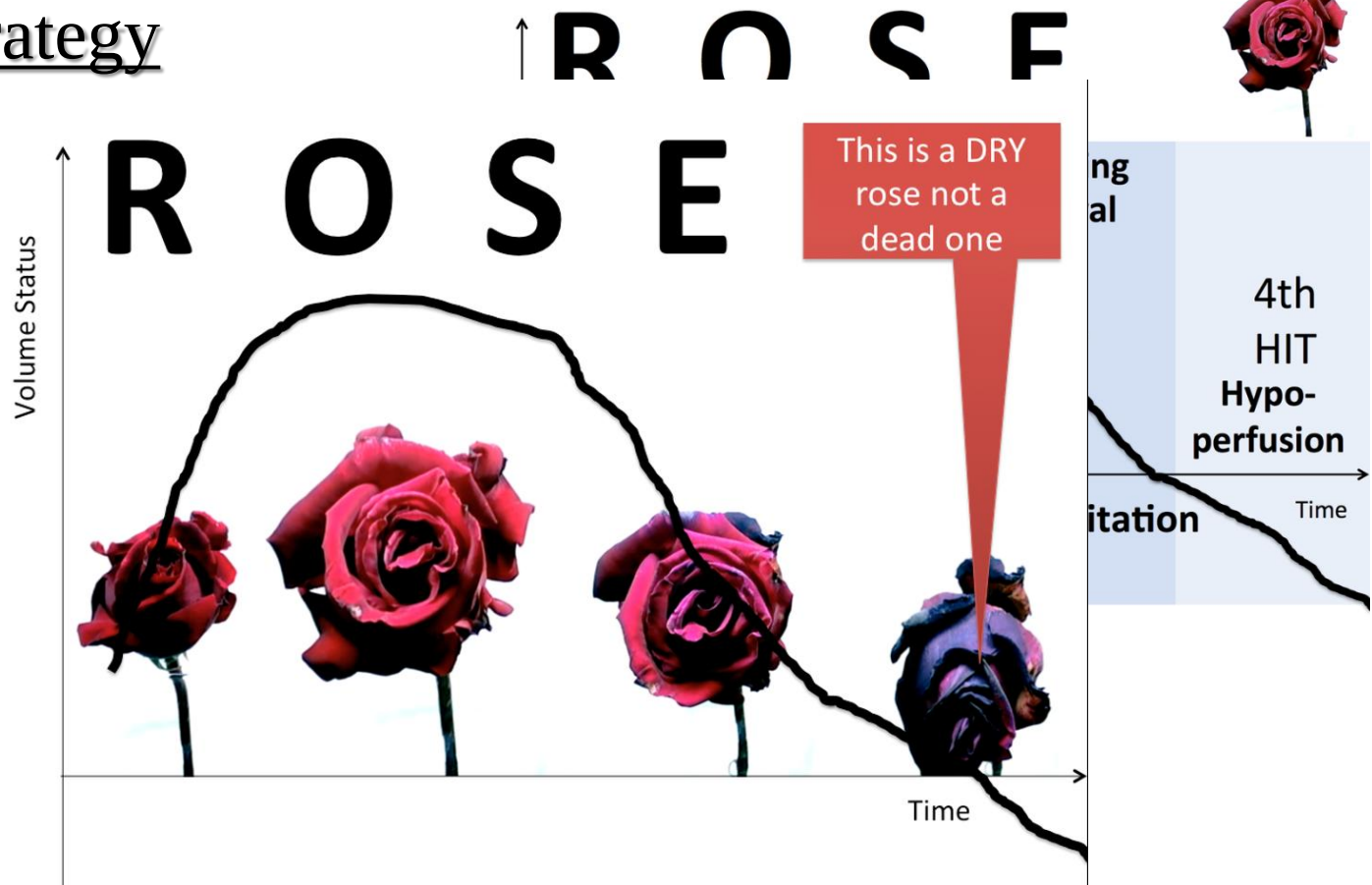
**Effective
Resuscitation**



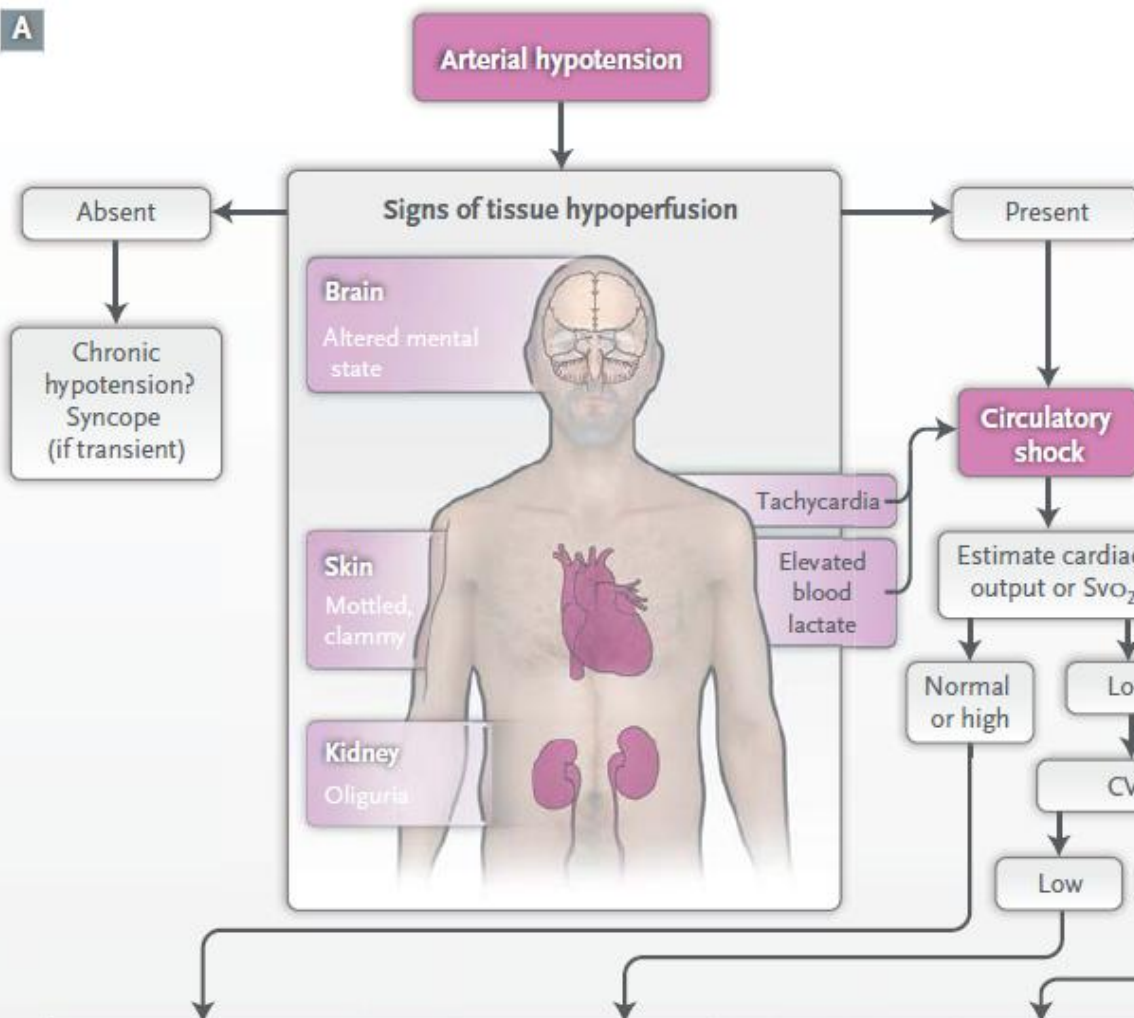
ROSE concept

4 phase strategy

- Resuscitation
- Optimization
- Stabilization
- Evacuation

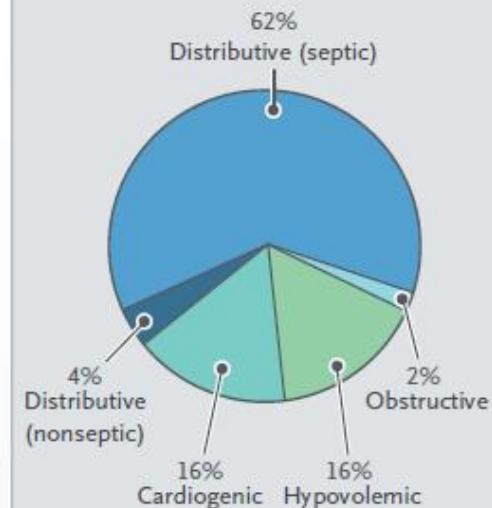


A



B

Types of shock



Echocardiography

Normal cardiac chambers and (usually) preserved contractility

Distributive shock

Small cardiac chambers and normal or high contractility

Hypovolemic shock

Large ventricles and poor contractility

Cardiogenic shock

In tamponade: pericardial effusion, small right and left ventricles, dilated inferior vena cava; in pulmonary embolism or pneumothorax: dilated right ventricle, small left ventricle

Obstructive shock

Shock

- Clinical expression of circulatory failure
- Inadequate cellular oxygen utilization
 - Systemic arterial hypotension
 - Tissue hypoperfusion
 - Hyperlactatemia
- Thoracic and Cardiovascular surgeon
 - Initial: cardiogenic shock or hypovolemic state in postoperative
 - Late: cardiogenic shock or septic shock or combination

Pathophysiology

- Unstable hemodynamic system
- Intravenous effective volume  interstitial space
- Oxygen delivery : cardiac output $>$ blood pressure
- Critical ill patients
 - Pulse and blood pressure were not proportional to severe illness & tissue hypoxia
 - Cardiac output cannot be inferred by blood pressure
 - Cryptic shock

Acute myocardial responses

- Crystalloid vs. colloid: SBP, HR, E/A, VTI, LVEDD, IVC
- RV strain: diastolic changes, up to +2% after colloid; about twice the crystalloid magnitude
- LA strain: reservoir and conduit phases +2% to +6% with colloid
- Colloid: more preload effect, A-fib, HR – suspicious risk factor

Research

Hyperchloremic Metabolic Acidosis

CHEST[®]

Official publication of the American College of Chest Physicians

Hyperchloremic Metabolic Acidosis Following Resuscitation of Shock

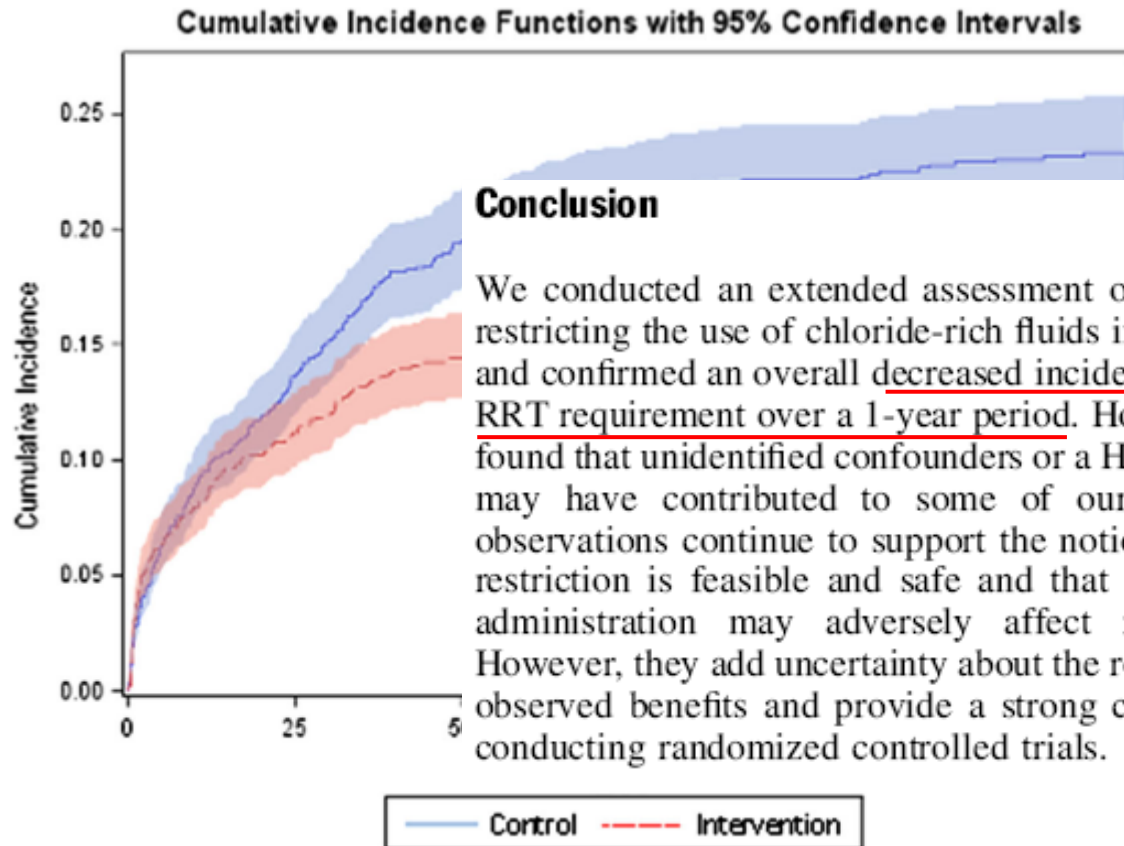
Cristina Gheorghe, Ramona Dadu, Cristina Blot, Fidel Barrantes,
Rodrigo Vazquez, Florentina Berianu, Yan Feng, Irwin Feintzig, Yaw
Amoateng-Adjepong and Constantine A. Manthous

Chest 2010;138:1521-1522
DOI 10.1378/chest.10-1458

The online version of this article, along with updated information and
services can be found online on the World Wide Web at:
<http://chestjournal.chestpubs.org/content/138/6/1521.full.html>

In conclusion, this limited retrospective study suggests that HMA is common during resuscitation of patients with a primary diagnosis of shock, and that HMA is associated with volume of infused saline. The limitations of this retrospective, medical records review preclude precise estimates of frequency and risk of this phenomenon, but the findings suggest hypotheses for a prospective study.

Chloride in fluid



Chloride in fluid

RESEARCH

Open Access



Effects of chloride content of intravenous crystalloid solutions in critically ill adult patients: a meta-analysis with trial sequential analysis of randomized trials

Table 2 (continued)

Outcomes	Balanced crystalloids	0.9% Saline	Risk ratio/standard mean difference (95% CI)	
Conclusions: Limited evidence supported statistical survival benefit with balanced crystalloid solutions, while it benefited in reducing organ support duration and fluctuations in serum electrolyte and base excess and was associated with <u>decreased in-hospital mortality in subpopulation with sepsis and non-TBI</u> . Large-scale rigorous randomized trials with better designs are needed to provide robust evidence for clinical management.				
Outcomes	Balanced crystalloids	0.9% Saline	Risk ratio/standard mean difference (95% CI)	
RRT-free days	Mean $\pm$ SD, No.	Mean $\pm$ SD, No.	Fixed models	Random models
Semler et al. [25]	24.9 $\pm$ 9.7, 520	23.7 $\pm$ 10, 520	0.12 [– 0.00, 0.25]	0.12 [– 0.00, 0.25]
Semler et al. [10]	25.6 $\pm$ 8.6, 7942	24.8 $\pm$ 8.9, 7860	0.09 [0.06, 0.12]	0.09 [0.06, 0.12]
Summary			0.09 [0.06, 0.12]	0.09 [0.06, 0.12]
Fixed model heterogeneity: $\chi^2 = 0.38$, $df = 1$ ($p = 0.54$); $I^2 = 0\%$; test for overall effect: $Z = 6.02$ ($p < 0.00001$)				
Random model heterogeneity: $\tau^2 = 0.00$; $\chi^2 = 0.21$, $df = 1$ ($p = 0.65$); $I^2 = 0\%$; test for overall effect: $Z = 6.03$ ($p < 0.00001$)				
CI confident interval. AKI acute kidney injury. RRT renal replacement therapy. SD standard difference. SMD standard mean difference				

Resuscitation With Normal Saline (NS) vs. Lactated Ringers (LR) Modulates Hypercoagulability and Leads to Increased Blood Loss in an Uncontrolled Hemorrhagic Shock Swine Model

Parameter	Study Fluid	Mean ± SE	Statistical Significance
Baseline Hct	NS		
	LR		
HCT 120 min post injury	NS		
	LR		
Baseline PTT	NS		
	LR		
PTT 120 min post injury	NS		
	LR		
Baseline PT	NS		
	LR		
PT 120 min post injury	NS		
	LR		
Baseline Fibrinogen	NS		
	LR		
Fibrinogen 120 min post injury	NS		
	LR		

Signifies statistical significance

Lactated Ringer's is Superior to Normal Saline in the Resuscitation of Uncontrolled Hemorrhagic Shock

Table 2 Comparisons of Laboratory Values Upon Study Completion Between Groups

	Normal Saline	Lactated Ringer's Solution	p Value
Sodium (mEq/L)	149 ± 3.0	138 ± 1.6	<0.001
Chloride (mEq/L)	119 ± 5.6	105 ± 2.9	<0.001
pH	7.28 ± 0.12	7.45 ± 0.06	<0.01
Base excess (mMol/L)	-4.6 ± 7.9	7.2 ± 4.2	<0.01
Lactate (mg/dL)	1.7 ± 1.7	4.7 ± 2.2	<0.01
Fibrinogen (mg/dL)	99 ± 21	123 ± 20	0.02

■ LR MEAN pH
▲ NS MEAN pH

Balanced Solution

Study	Population	Groups	Crystalloid administration protocol	Principal outcome	Secondary outcomes
Ramanathan and colleagues ¹⁶	Elective Coesarean	NS (15) RL (15) PL (15)	BA: 1200 ml in 1 h	NS decrease in pH	No differences in glucose, pyruvate, arterial pressure, or ephedrine needs. Greater increase in lactate levels in RL and PL groups
Veroli and Benhamou ¹⁷	Minor orthopaedic surgery with lumbar epidural anaesthesia	NS (10) RL (10)	BA: 20 min bolus with same amount of sodium (15 ml kg ⁻¹ with RL and 13 ml kg ⁻¹ with NS)	No differences in required volumes	Same doses of ephedrine, similar HR and MAP in both groups
McFarlane and Lee ¹⁸	Scheduled elective major hepatobiliary or pancreatic surgery	NS (15) PL (15)	Intraoperative: 15 ml kg ⁻¹ h ⁻¹	Greater increase in postoperative chloride using NS	Greater decrease in BE and HCO ₃ ⁻ with NS concordant with hyperchloraemic acidosis. No differences in chloride levels, Na or K levels, PaCO ₂ , lactate concentrations, dose of crystalloids or bleeding after surgery
Butscher and colleagues ⁹	Scheduled lumbar intervertebral disc surgery	NS (10) RL (10)	Intraoperative: 2000 ml in 2 h	Greater decrease in osmolarity after RL	No differences in Na, glucose or protein concentrations after crystalloid infusion
Kashimoto and colleagues ¹⁹	General surgery lasting more than 2 h using isoflurane	RA (15) RL (15)	Intraoperative: 8 ml kg ⁻¹ in the first hour and 5 ml kg ⁻¹ in the second hour	Higher central temperature with RA	No differences in digital and forearm temperature, or fingertip blood flow
Scheingraber and colleagues ²⁰	Lower gynaecological system procedures	NS (12) RL (12)	Intraoperative: 30 ml kg ⁻¹ h ⁻¹	Lower pH at second hour with NS	Lower values of BE, lactate, and calculated SID at 2 h with NS. Lower Na and Cl ⁻ at 2 h with RL. No differences in P _{CO₂} , blood loss or diuresis at 2 h
Deng ¹⁰	Hysterectomy and myomectomy	NS (12) RA (12)	Intraoperative: 20 ml kg ⁻¹ h ⁻¹	Lower pH at 120 min with NS	Lower BE and higher Na and Cl ⁻ levels with NS at 120 min. Higher lactate levels with RA at 120 min. Lower PaCO ₂ at 30 min in the NS group
Waters and colleagues ²¹	Aortic reconstructive surgery	NS (33) RL (33)	Intraoperative: titrated during surgery. The mean volume of 6871 ml with RL and 7000 ml with NS	Greater decrease in intraoperative pH with NS	Greater decrease in intraoperative HCO ₃ ⁻ and BE, higher levels of Cl ⁻ , greater need for blood product transfusions and greater urine output with NS. No significant changes in lactate levels, ventilation hours or LOS
Takil and colleagues ²²	Elective major spine surgery	NS (15) RL (15)	Intraoperative and 12 h postoperative: 20 ml kg ⁻¹ h ⁻¹ intraoperative and 2.5 ml kg ⁻¹ h ⁻¹ thereafter	Transient respiratory acidosis in first postoperative hours with RL	Transient hyperchloraemic acidosis (pH, HCO ₃ ⁻ , and BE) intraoperative and until 12 h postoperative with NS. Mild hyponatraemia in first postoperative hours with RL. No significant differences in crystalloid volume, urinary output, and blood losses
O'Malley and colleagues ²³	Renal transplantation	NS (26) RL (25)	Intraoperative: titrated during surgery. Mean volume of 5600 ml with RL and 6100 ml with NS	No differences in creatinine at postoperative third day, 1 week or 6 months	More cases of hyperkalaemia, use of intraoperative HCO ₃ ⁻ and higher Cl ⁻ levels at end of surgery with NS. No significant differences in blood loss or patients transfused

ORIGINAL ARTICLE

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

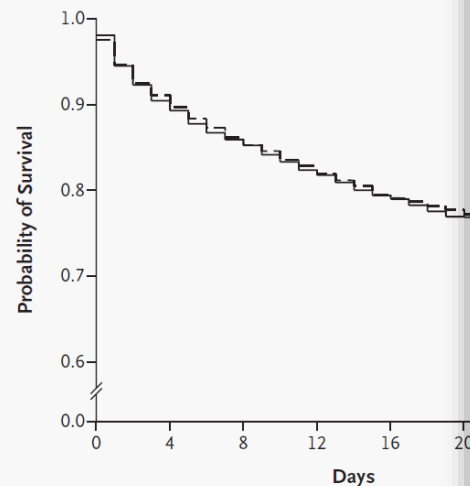


Figure 1. Kaplan–Meier Estimates of the Probability of Survival. $P=0.96$ for the comparison between patients assigned to albumin and those assigned to receive saline.

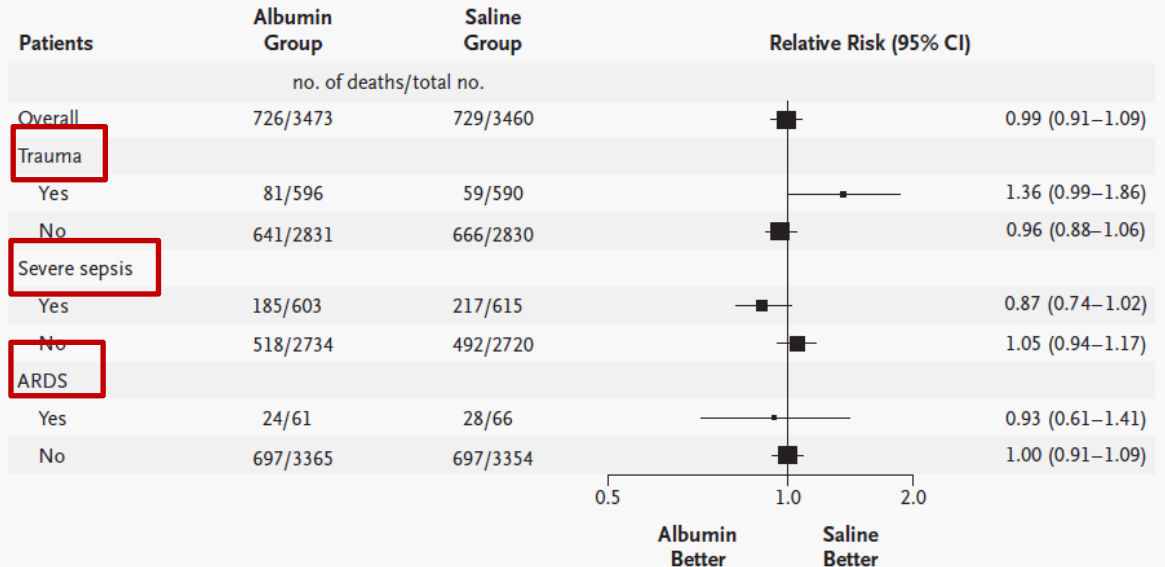


Figure 2. Relative Risk of Death from Any Cause among All the Patients and among the Patients in the Six Predefined Subgroups.

The size of each symbol indicates the relative number of events in the given group. The horizontal bars represent the confidence intervals (CI). ARDS denotes the acute respiratory distress syndrome.

- Albumin versus normal saline
- 6997 patients
- Primary outcome: 28-day death

Outcome	Albumin Group	Crystalloid Group	Relative Risk (95% CI)	P Value
Primary outcome: death at 28 days — no./total no. (%)	285/895 (31.8)	288/900 (32.0)	1.00 (0.87–1.14)	0.94
Secondary outcomes				
Death at 90 days — no./total no. (%)	365/888 (41.1)	389/893 (43.6)	0.94 (0.85–1.05)	0.29
New organ failures — no./total no. (%)*				0.99
None	372/836 (44.5)	383/841 (45.5)		
1 organ	283/836 (33.9)	287/841 (34.1)		
2 organs	130/836 (15.6)	123/841 (14.6)		
3 organs	40/836 (4.8)	36/841 (4.3)		
4 organs	10/836 (1.2)	11/841 (1.3)		
5 organs	1/836 (0.1)	1/841 (0.1)		
SOPA score†			—	0.23
Median	6.00	5.62		
Interquartile range	4.00–8.50	3.92–8.28		
SOPA subscore†				
Cardiovascular			—	0.03
Median	1.20	1.42		
Interquartile range	0.14–2.14	0.07–2.00		
Coagulation			—	0.04
Median	0.64	0.50		
Interquartile range	0.00–1.62	0.00–1.59		
Liver			—	0.02
Median	0.28	0.20		
Interquartile range	0.00–1.00	0.00–0.92		
Length of stay — days				
In ICU			—	0.42
Median	9	9		
Interquartile range	4–18			
In hospital‡				
Median	20			
Interquartile range	10–36			

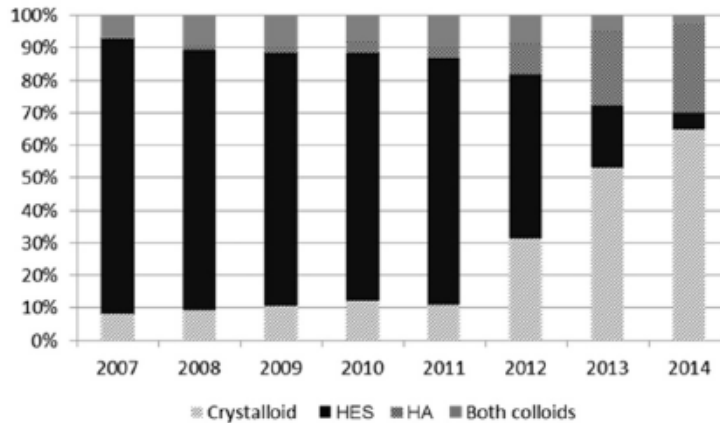
Effect of albumin :
trend of lower cardiovascular failure, HR low, MBP high

CONCLUSIONS

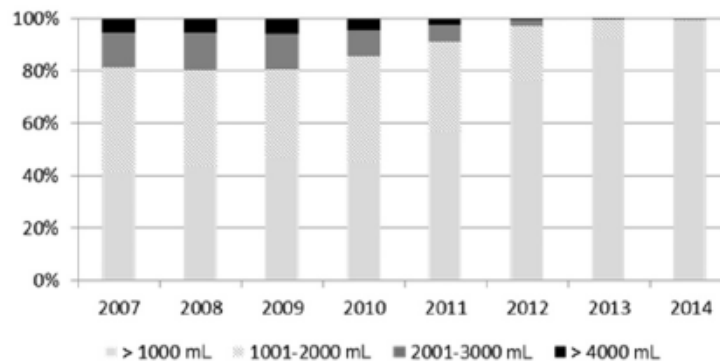
In patients with severe sepsis, albumin replacement in addition to crystalloids, as compared with crystalloids alone, did not improve the rate of survival at 28 and 90 days. (Funded by the Italian Medicines Agency; ALBIOS ClinicalTrials.gov number, NCT00707122.)

HES

Fluids divided by types

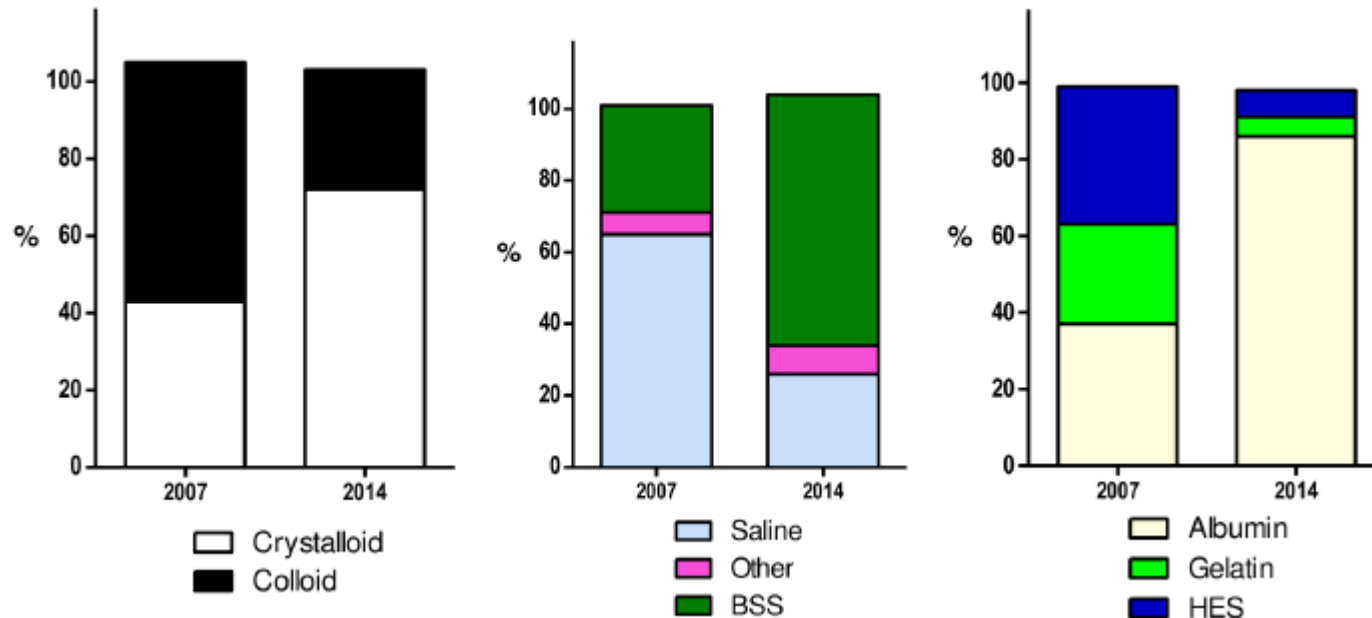


Administered amount of HES



- Concerned point
 - Have not been fully evaluated
 - Against use in sepsis (strong recommendation, high quality of evidence)
 - Renal toxicity
 - Coagulation dysfunction

Patterns of fluid resuscitation

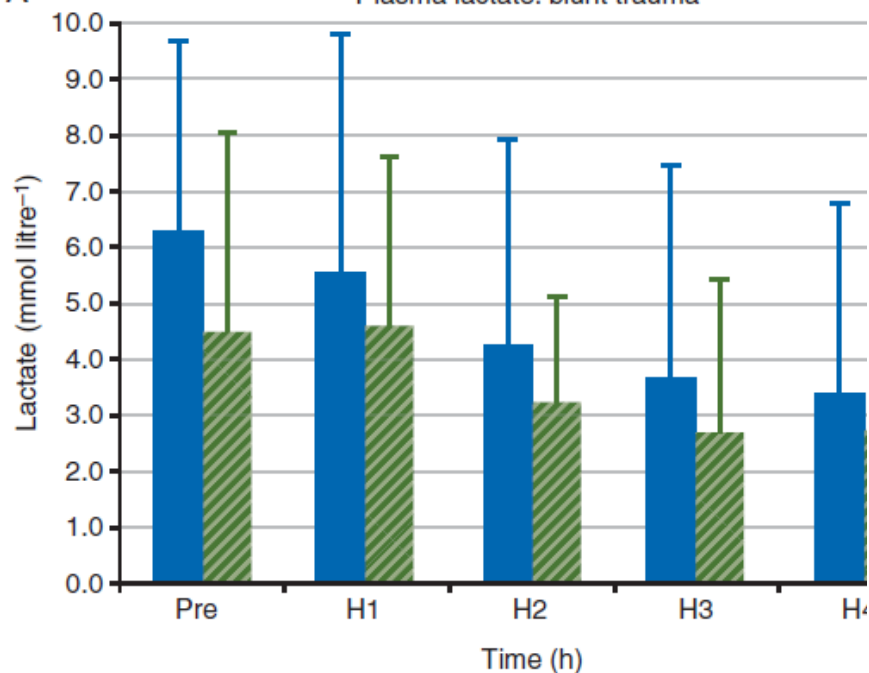


Resuscitation with hydroxyethyl starch improves renal function and lactate clearance in penetrating trauma in a randomized controlled study: the FIRST trial (Fluids in Resuscitation of Severe Trauma)

Conclusions. In penetrating trauma, HES provided significantly better lactate clearance

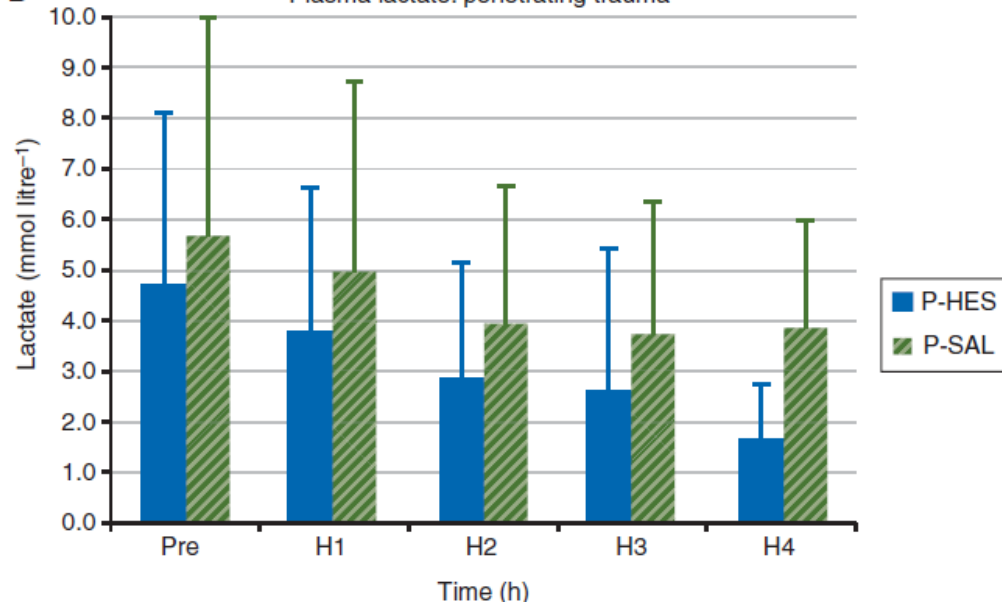
A

Plasma lactate: blunt trauma



B

Plasma lactate: penetrating trauma



Is Hydroxyethyl Starch Safe in Penetrating Trauma Patients?

*Casey J. Allen, MD; Xiomara D. Ruiz, MD; Jonathan P. Meizoso, MD; Juliet J. Ray, MD;
Alan S. Livingstone, MD; Carl I. Schulman, MD, PhD; Nicholas Namias, MD;
Kenneth G. Proctor, PhD*

- Military setting : Voluven
 - Recommended for battlefield resuscitation, if blood products are not immediately available
 - Penetrating injury > Blunt injury
 - Smaller volumes are required
 - No increase risk of AKI
 - No increase risk of mortality



ELSEVIER

Association of high volumes of hydroxyethyl starch with acute kidney injury in elderly trauma patients

R. Leberle ^{a,*}, A. Ernstberger ^{b,1}, M. Loibl ^{b,1}, J. Merkl ^{a,2}, M. Bunz ^{a,2}, M. Creutzenberg ^{a,2}, B. Trabold ^{a,2}

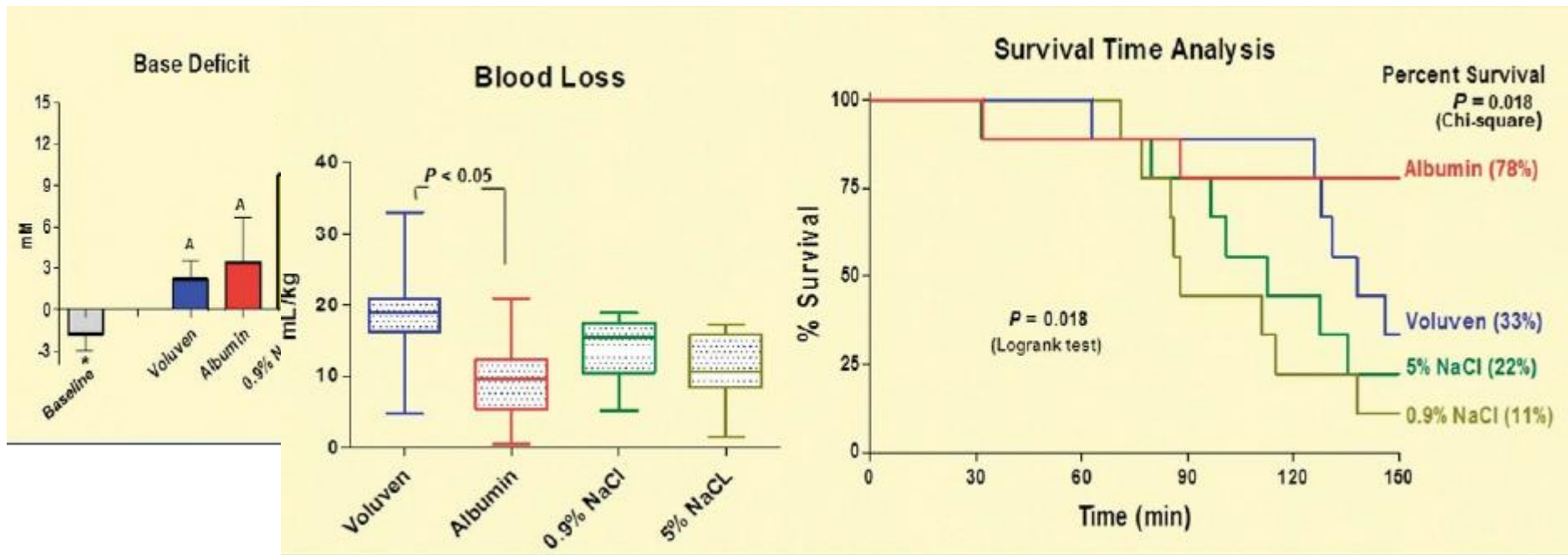
^a Department of Anesthesiology, University Medical Center, Germany

^b Department of Trauma Surgery, University Medical Center, Germany

- First 24 hours
 - > 2,000 ml HES (130kD/0.4)
 - < 2,000 ml HES (130kD/0.4)
- Not increased incidence of AKI or need for RRT in patients

Does small-volume resuscitation with crystalloids or colloids influence hemostasis and survival of rabbits subjected to lethal uncontrolled hemorrhage?

Bijan Shams Kheirabadi, PhD, Nahir Miranda, MS, Irasema B. Terrazas, MS, Mary D. Gonzales, MS, Rose C. Grimm, DVM, and Michael A. Dubick, PhD, *Houston, Texas*



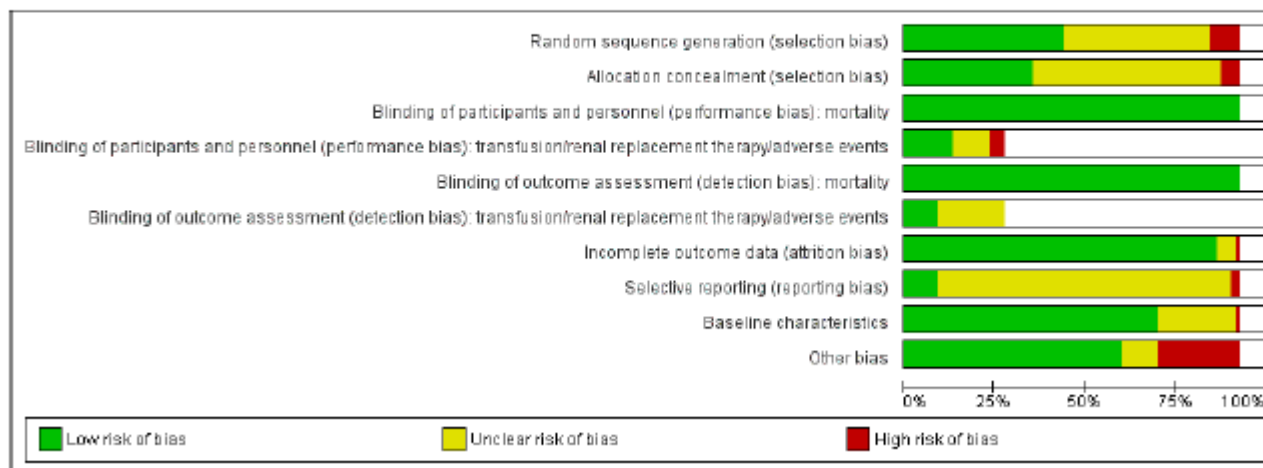
- Small-volume resuscitation with crystalloids appeared inadequate
- 6% HES 130/0.4 was effective hemodynamically but detrimental to hemostasis
- Albumin produced the best outcomes

Crystalloids vs. colloids



DATA AND ANALYSES	175
Analysis 1.1. Comparison 1 Starches vs crystalloid, Outcome 1 Mortality at end of follow-up.	177
Analysis 1.2. Comparison 1 Starches vs crystalloid, Outcome 2 Mortality within 90 days.	179

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies. We did not make judgements for studies that did not report outcomes of interest in the review, which are indicated by blank spaces



Crystalloids vs. colloids

Starches compared to crystalloid for fluid resuscitation in critically ill patients

Participants: critically ill people requiring fluid resuscitation

Setting: in hospital, in Algeria, Argentina, Belgium, Brazil, Canada, China, France, Germany, India, the Netherlands, Phillipines, South Africa, Switzerland, Tunisia, the UK, USA and Vietnam

Intervention: starches to include hydroxyethyl starch, hetastarch, and pentastarch

Comparison: crystalloids to include normal saline, hypertonic saline, Ringer's lactate and Ringer's acetate

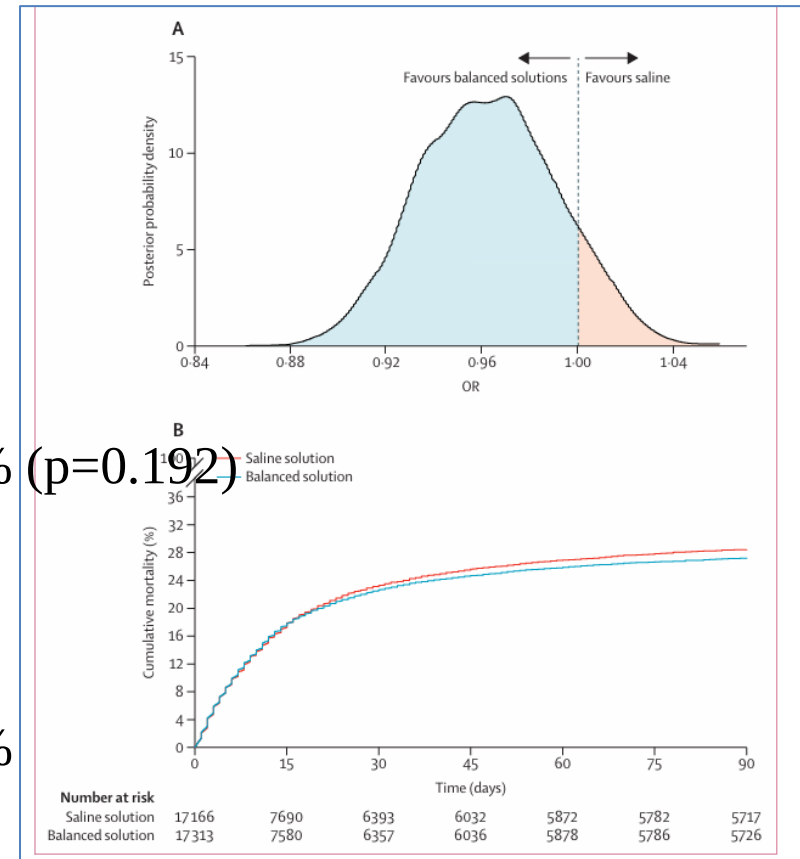
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with crystalloids	Risk with starches				

AUTHORS' CONCLUSIONS: Using starches, dextrans, albumin or FFP (moderate-certainty evidence), or gelatins (low-certainty evidence), versus crystalloids probably makes little or no difference to mortality. Starches probably slightly increase the need for blood transfusion and RRT (moderate-certainty evidence), and albumin or FFP may make little or no difference to the need for renal replacement therapy (low-certainty evidence). Evidence for blood transfusions for dextrans, and albumin or FFP, is uncertain. Similarly, evidence for adverse events is uncertain. Certainty of evidence may improve with inclusion of three ongoing studies and seven studies awaiting classification, in future updates.

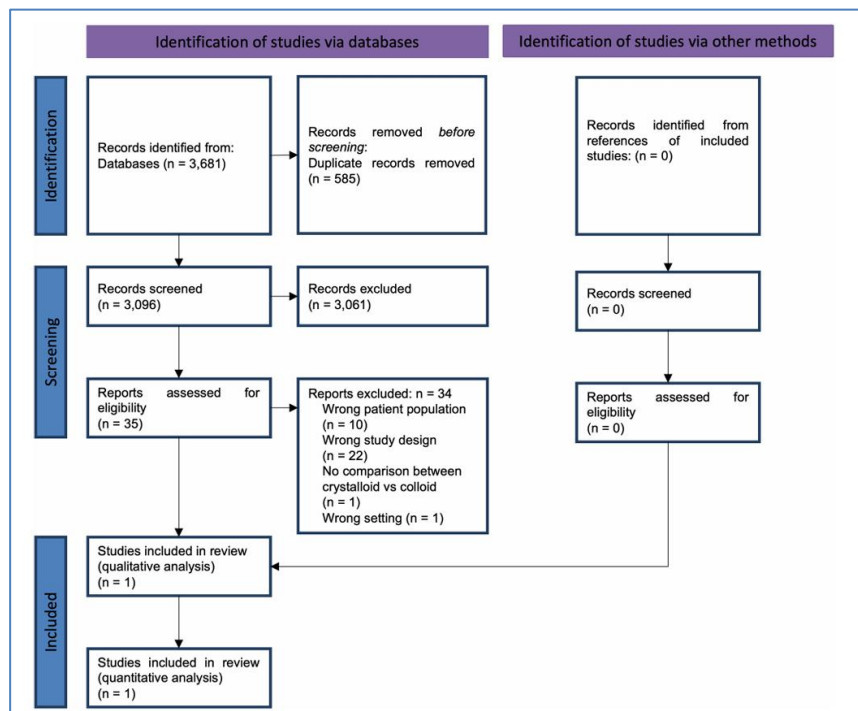
	238 per 1000	241 per 1000 (214 to 272)				could not be certain whether it accounted for attrition
All-cause mortality (within 30 days)	Study population		RR 0.99 (0.90 to 1.09)	10,135 (11 studies)	⊕⊕⊕○ Moderate ^b	We excluded data from 1 study because we could not be certain whether it accounted for attrition
	191 per 1000	189 per 1000 (172 to 208)				
Transfusion of blood products	Study population		RR 1.19 (1.02 to 1.39)	1917 (8 studies)	⊕⊕⊕○ Moderate ^a	1 study included different types of colloids (HES, gelatins, or albumin). We did not include this in analysis

ICU

- BEST-Living study: BSS vs. NS
- Overall mortality
 - OR 0.962, 95% CI 0.909–1.019
 - In-hospital mortality: 16.8% vs. 17.3% (p=0.192)
 - TBI: OR 1.42495% CI 1.100–1.818
 - In-hospital mortality: 19.1% vs. 14.7%
- Grade: mortality, RRT - moderate



Hypovolemic shock



- 35 study enroll: 1 RCT included
- CRYSTAL trial (JAMA 2013)
- 28 mortality: HR 1.19 (95% CI 0.54–2.62), $p = 0.67$

DuBose et al	2010	Clinical Experience Using 5% Hypertonic Saline as a Safe Alternative Fluid for Use in Trauma	Wrong study design
Ertmer et al	2018	Fluid therapy and outcome: a prospective observational study in 65 German intensive care units between 2010 and 2011	Wrong study design
Evans	2015	Effects of fluid resuscitation with colloids vs. Crystalloids on mortality in critically ill patients presenting with hypovolemic shock	Wrong study design
Gonzales-Castro et al	2016	The SPLIT trial: Anything new in critical care fluid therapy?	Wrong patient population
Hamada et al	2015	European trauma guideline compliance assessment: the ETRAUSS study	Wrong study design
Hartog et al	2012	Volume replacement after trauma: an update	Wrong study design
Holcomb	2010	Optimal Use of Blood Products in Severely Injured Trauma Patients	Wrong study design
Hwang et al	2018	Implementation of Trauma Center and Massive Transfusion Protocol Improves Outcomes for Major Trauma Patients: A Study at a Single Institution in Korea	Wrong study design
James et al	2011	Resuscitation with hydroxyethyl starch improves renal function and lactate clearance in penetrating trauma in a randomized controlled study: the FIRST trial (Fluids in Resuscitation of Severe Trauma)	Wrong patient population
Kramer	2003	Hypertonic resuscitation: Physiologic mechanisms and recommendations for trauma care	Wrong study design
Krishan et al	2018	Comparative characteristics of liberal and restrictive fluid resuscitation in multiple trauma	Wrong study design
Kruer et al	2012	Colloids in the intensive care unit	Wrong study design
Orbegozo Cortés et al	2015	Crystalloids versus colloids: exploring differences in fluid requirements by systematic review and meta-regression	Wrong patient population
Perel et al	2013	Colloids versus crystalloids for fluid resuscitation in critically ill patients	Wrong patient population
Qureshi et al	2016	Meta-analysis of colloids versus crystalloids in critically ill, trauma and surgical patients	Wrong patient population
Ramesh et al	2019	Fluid resuscitation in trauma: what are the best strategies and fluid?	Wrong setting

SSC 2026

49



For adults with sepsis or septic shock, we **suggest** using dynamic measures to guide initial fluid resuscitation over physical examination or static measures alone.

Remark: Dynamic measures include response to a passive leg raise or a fluid bolus using stroke volume (SV), stroke volume variation (SVV), pulse pressure (PP), or pulse pressure variation (PPV).

2021 STATEMENT



For adults with sepsis or septic shock, we **suggest** using dynamic measures to guide fluid resuscitation, over physical examination, or static parameters alone.

SSC meta-analysis of 18 RCTs: Dynamic measure-guided fluid resuscitation → lower mortality trend (**RR 0.91, 95% CI 0.79–1.06**) and significantly less need for RRT (**RR 0.75, 95% CI 0.58–0.98**).

FRESH trial: Passive leg raise–guided fluid management in sepsis-induced hypotension/shock → lower 72-h net fluid balance (**MD –1.37 L, 95% CI –2.53 to –0.21 L**), with less RRT and invasive mechanical ventilation.

SSC 2026

45



For adults with sepsis or septic shock, we **suggest** using crystalloids alone over crystalloids with supplemental albumin for fluid resuscitation.

Remark: Use of supplemental albumin may be appropriate for patients who already received large crystalloid volumes or have cirrhosis. Supplemental albumin should be avoided in patients with traumatic brain injury.

2021 STATEMENT



For adults with sepsis or septic shock, we **suggest** using albumin in patients who received large volumes of crystalloids.

2021 guideline: crystalloid + supplemental albumin

SSC pooled analysis of 6 RCTs (n=4,383): Supplemental albumin → no reduction in 28-day mortality (RR 1.01, 95% CI 0.90–1.14); also no meaningful benefit in 90-day mortality, organ dysfunction, ventilator-/vasopressor-free days, or RRT.

Higher cost without demonstrated clinical benefit drove the more conservative recommendation.

SSC 2026

48



For adults with sepsis or septic shock who have already received fluid resuscitation with 30 ml/kg and have persistent hypoperfusion, we **suggest** using either a liberal or a restrictive fluid resuscitation strategy based on individual patient and health system factors.

Remark: There was wide variability in the protocols used and the volume of fluids received in the liberal versus restrictive arms across trials. Patient and health system factors to be considered include patients' current clinical conditions and chronic illnesses (e.g., heart failure), and the availability of monitored beds (i.e., if a restrictive approach necessitates vasopressor use).

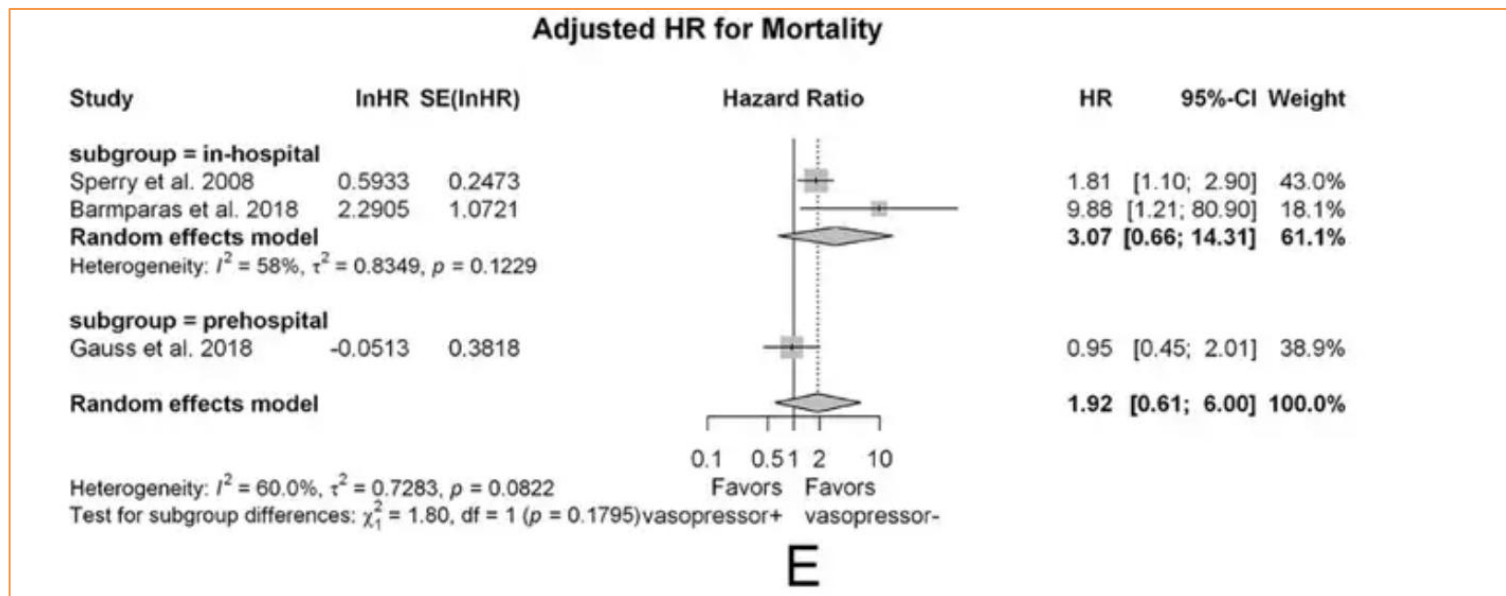
2021 STATEMENT

There is **insufficient evidence** to make a recommendation on the use of restrictive versus liberal fluid strategies in the first 24 hours of resuscitation in patients with sepsis and septic shock who still have signs of hypoperfusion and volume depletion after the initial resuscitation.

SSC pooled analysis of 4 RCTs (n=3,320): Restrictive vs. liberal strategy → essentially identical mortality (**RR 1.00, 95% CI 0.91–1.10**), with no meaningful differences in ventilator-free days, RRT, renal replacement-free days, or vasopressor-free days.

CLOVERS and CLASSIC: Both demonstrated that a more restrictive fluid strategy **did not improve mortality**, but also did not result in major harm → supports individualized rather than universally restrictive management.

Effect of early vasopressor use on mortality in trauma patients with hemorrhagic shock: a systematic review and meta-analysis



Vasopressors were administered within 24 hours demonstrated a significant increase in mortality among observational studies (OR, 5.95; 95% CI, 2.63–13.44; $k = 5$).

SSC 2026

89



For adults with septic shock after the acute resuscitation phase, we **suggest** using active fluid removal.

Remark: Acute resuscitation refers to escalating doses of vasopressors, ongoing high doses of vasopressors, or needing ongoing volume expansion. Active fluid removal refers to diuretics and, if diuretics are insufficient, ultrafiltration or extracorporeal fluid removal. Factors to be considered when deciding to initiate active fluid removal include cardiorespiratory function; vasopressor dose; clinical course; peripheral edema; weight; and fluid balance.

Meta-analysis of 13 RCTs (n=2,517): Active fluid removal → uncertain effect on mortality (**RR 0.92, 95% CI 0.81–1.04**); no clear benefit in RRT, ICU LOS, or vasopressor-free days.

Only **3 RCTs (n=184)** specifically enrolled patients with sepsis; sepsis-subgroup mortality was also uncertain (**RR 1.33, 95% CI 0.75–2.34**).

Summary – balanced solution

- Real balanced ?
- Trend
 - Decrease postoperative infection
 - Decrease postoperative transfusion
 - Decreased renal injury in ICU patients

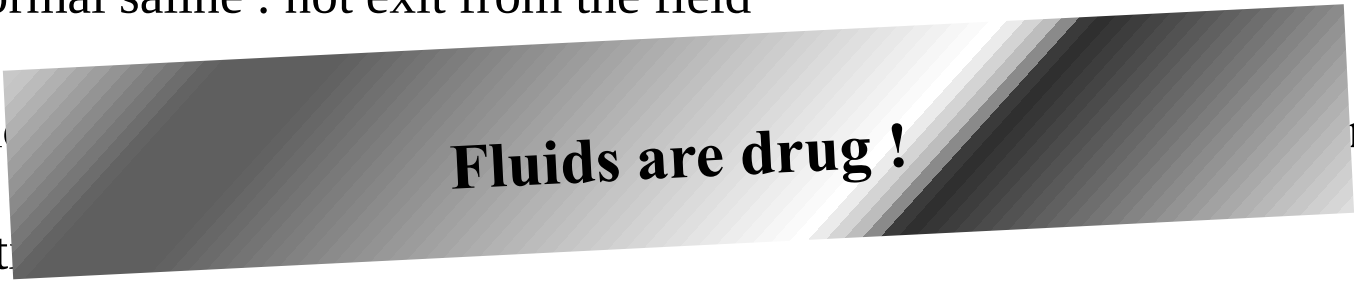
Summary - albumin

- Albumin Resuscitation
 - Increased mortality in traumatic brain injury
 - Acute illness : relative safe, hemodynamic improvement
 - No evidence of benefit in mortality of critically ill patients
 - Early sepsis phase : lesser consideration

Summary - HES

- HES resuscitation
 - Good plasma expansion
 - Relative expansive
 - Increase renal injury, transfusion, septic condition
 - No recommendation
 - Underlying infection, renal dysfunction, hematologic dysfunction

In my opinion

- Type of fluid : no effect on outcome
- Normal saline : not exit from the field
- The  Fluids are drug ! r the
pat
- Recognition of fluid type
- Balanced > non-balanced
- Cl : restrictive > rich
- Large volume crystalloid resuscitation: individualized

THANK YOU FOR YOUR ATTENTION !

