Liệu pháp bù hoàn thể tích tuần hoàn (volume therapy)

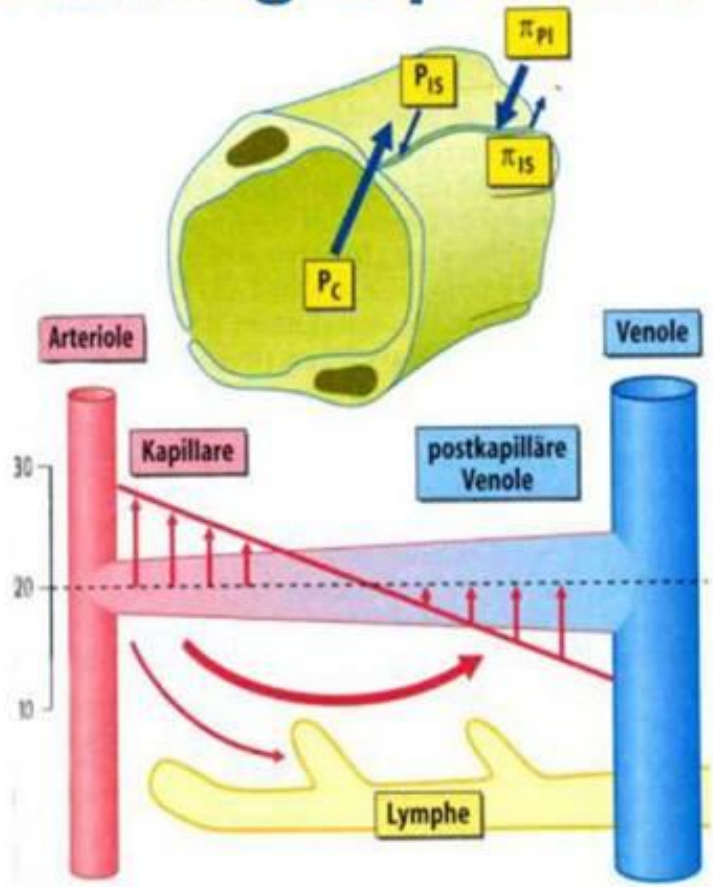
GS.TS Nguyễn Quốc Kính
Khoa GMHS, bv Việt Đức

Hypofusion = Shock

- Sốc là hội chứng lâm sàng được định nghĩa bởi lưu lượng máu không đủ và sự vận chuyển oxy không đầy đủ đến các cơ quan và các mô
- Giảm tưới máu hoặc sốc là không cung cấp đủ oxy để đáp ứng nhu cầu oxy mô
- Sốc trước tiên xảy ra ở mức tế bào rồi tiến triển đến các mô, các cơ quan, các hệ thống cơ quan và cuối cùng toàn cơ thể

Dịch truyền vào đi đâu?

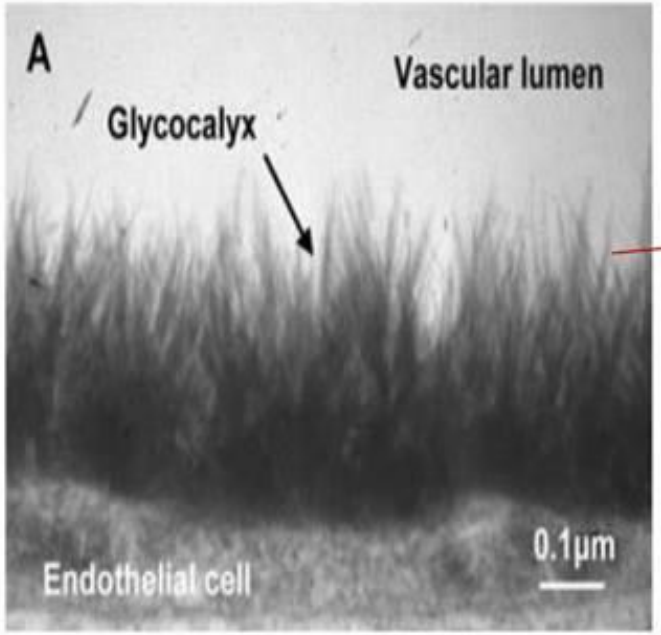
Starling equation

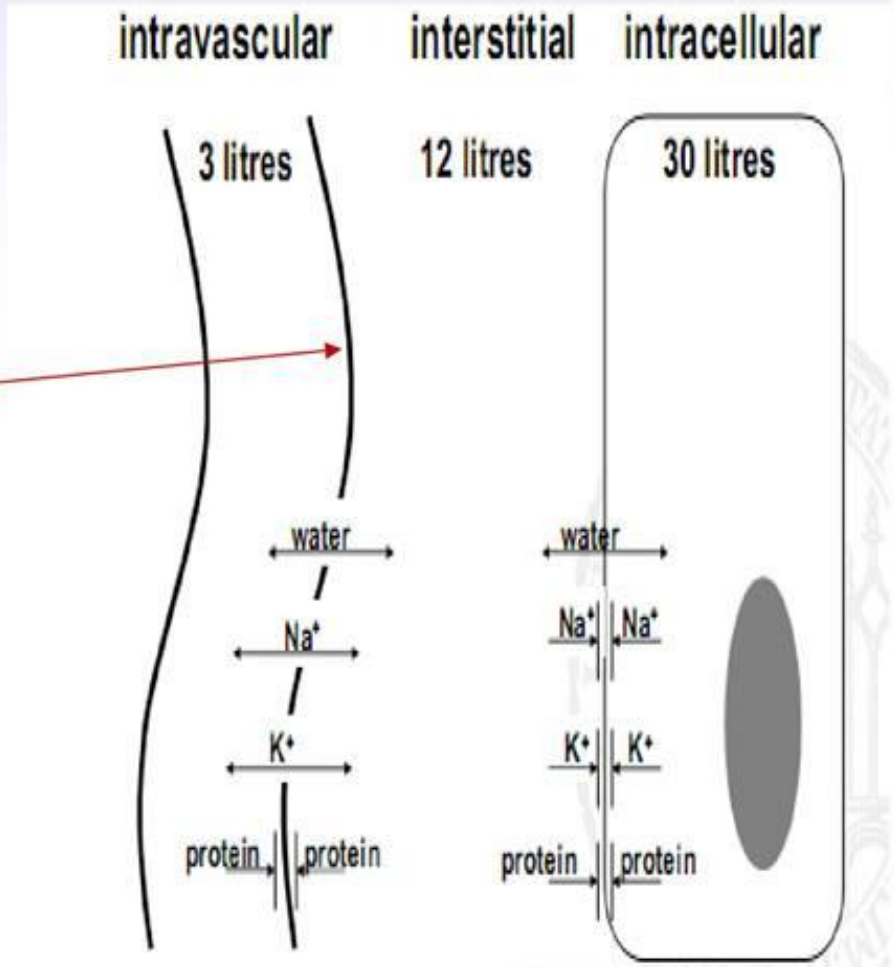


$$J_v = K_f [(P_C - P_{IS}) - \sigma(\pi_{Pl} - \pi_{IS})]$$

J_v	fluid filtration flux across the capillary wall per unit area
K_f	filtration-coefficient
P_C	microvascular hydrostatic pressure
P_{IS}	interstitial hydrostatic pressure
σ	oncotic reflection coefficient
π_{Pl}	colloidosmotic pressure in plasma
π_{IS}	interstitial colloidosmotic pressure

endothelial glycocalyx

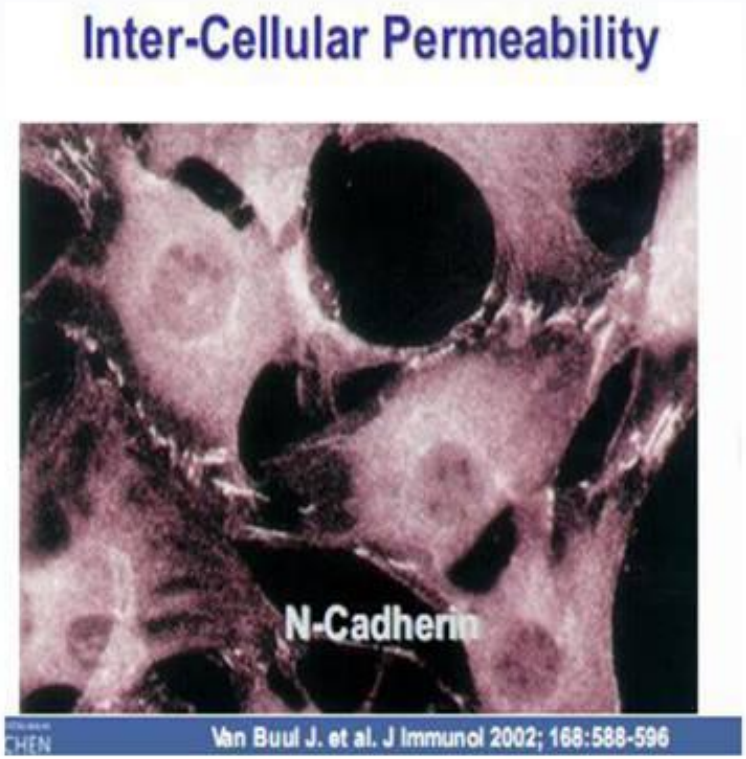




Chappell D and Jacob M et al. (2009) Circ Res 83:388-96

Jacob M et al. (2007) J Appl Physiol 102: 1235-42

Hội chứng thoát dịch mao mạch
Capillary Leakage Syndrome (CLS)



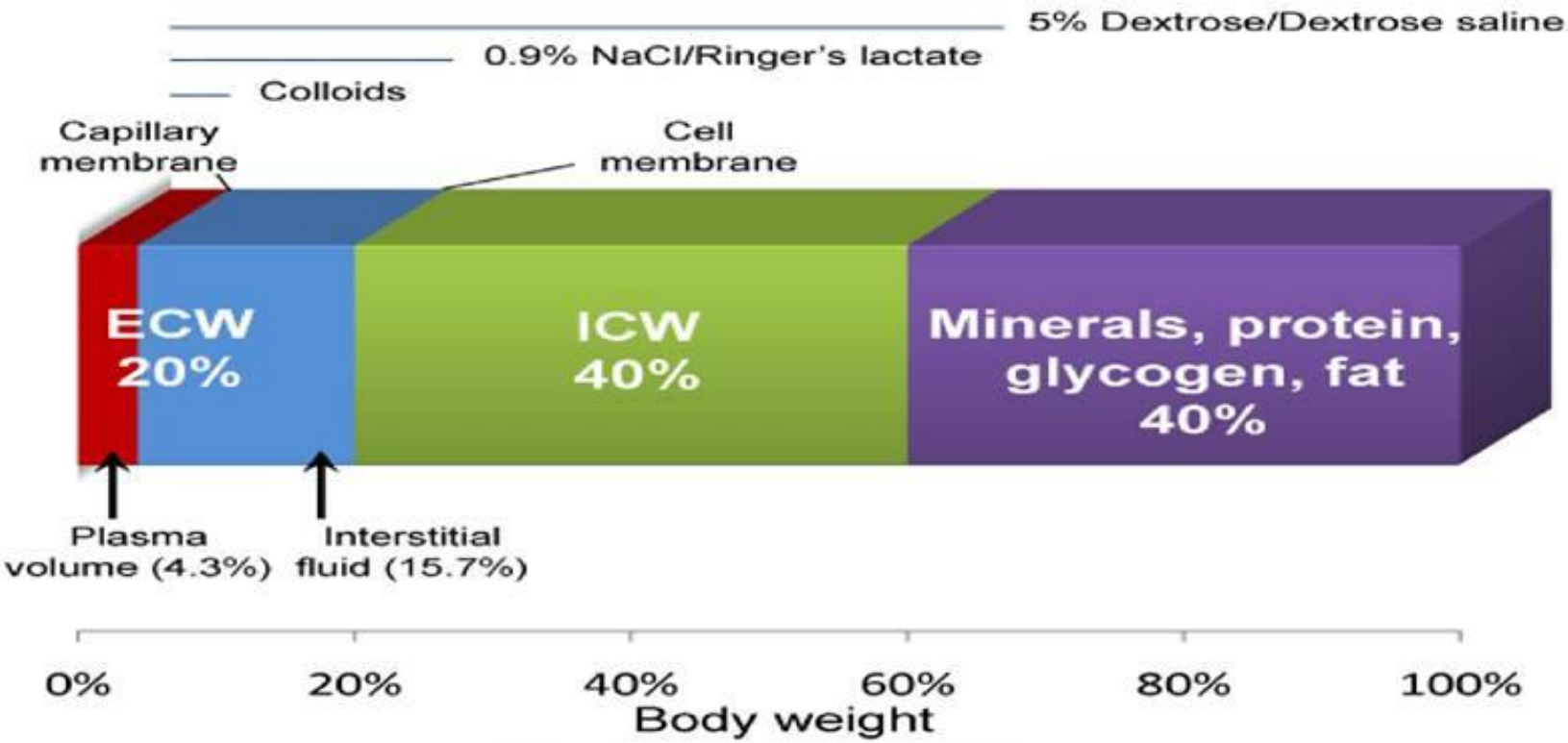
- Biến chứng thường gặp trong nhiễm trùng và viêm
- Mất dịch trong lòng mạch
- Phù toàn thể
- Huyết động không ổn định dù truyền dịch

Avoiding Intravascular Hypervolemia
Protects the Vascular Barrier

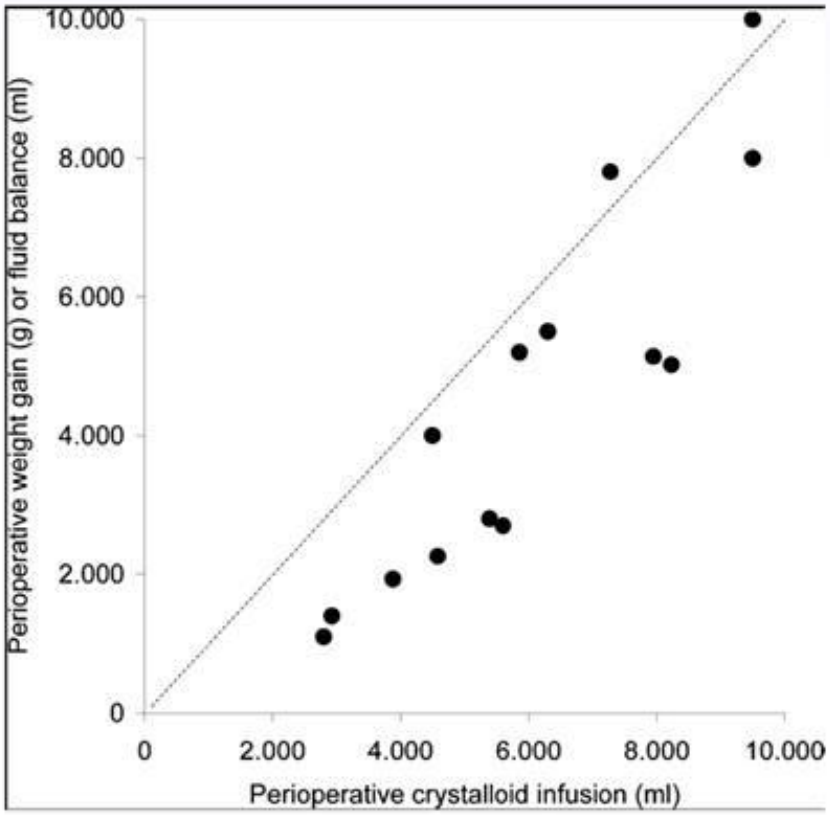
Infusion Therapy

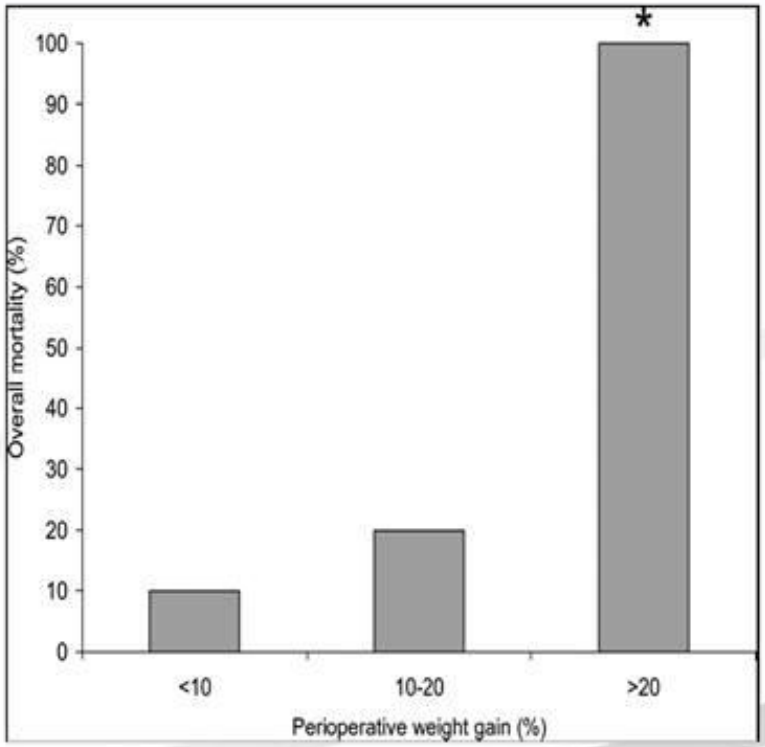
Fluid Substitution → **extracellular** → *Crystalloid*

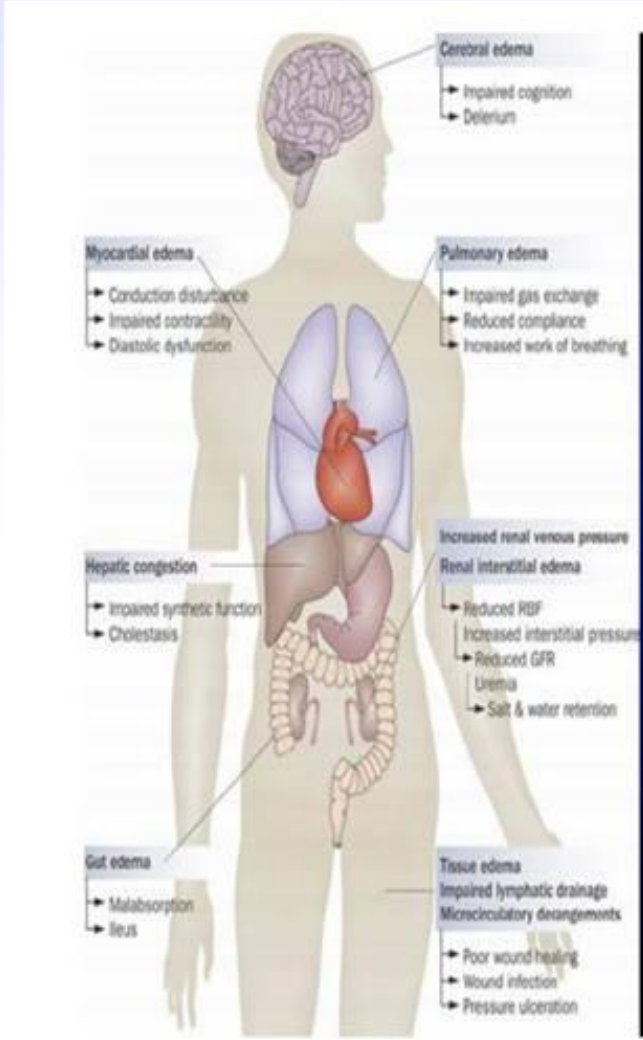
Volume Replacement → **intravascular** → *Colloid / Protein*



Tăng cân và tỷ lệ biến chứng, tử vong







Aggressive fluid strategies affect ***every*** organ system adversely

Prowle et al, Nat Rev Nephrol 2010

"wet lung" ... "shock lung" ... "Da Nang Lung"

*The deleterious effects of aggressive resuscitation again became evident during the Vietnam War, with the emergence of "**Danang Lung**", now known as acute respiratory distress syndrome (ARDS).*

Liệu pháp dịch sớm theo đích (Early goal-directed fluid therapy)

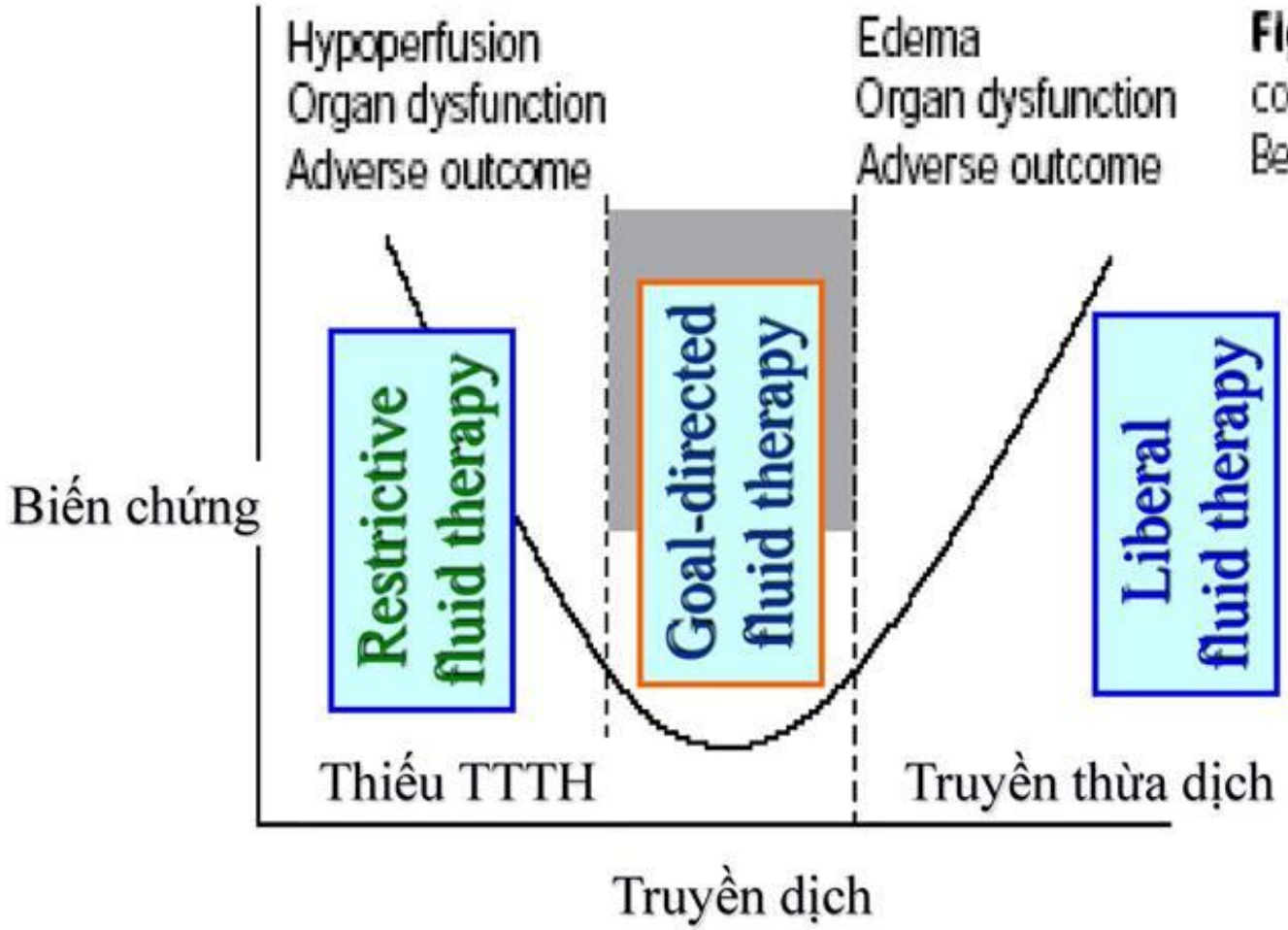


Figure 11.1. Fluid load vs. complications (modified from Bellamy) [9].

Modern goal-directed fluid therapy

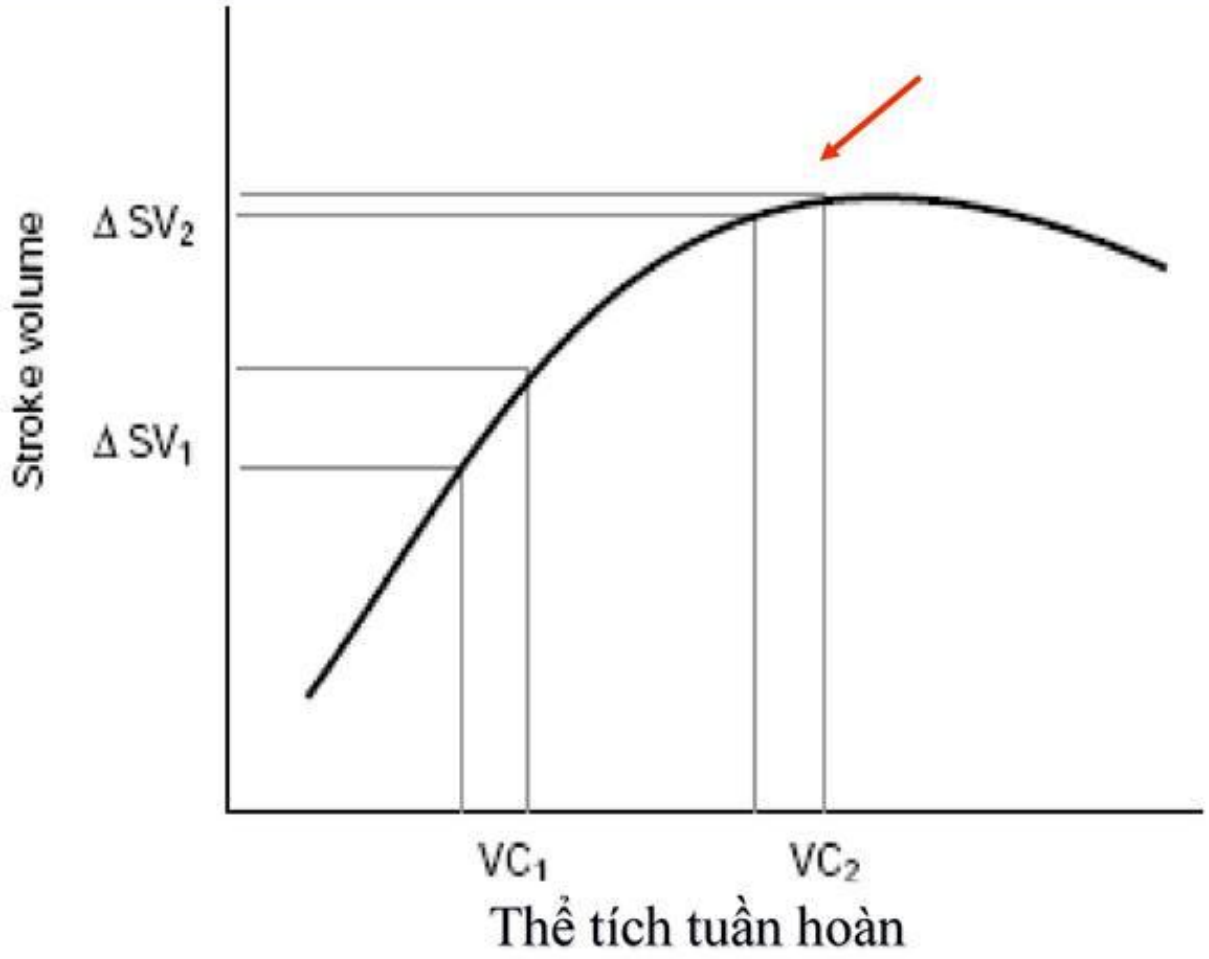


Figure 11.2. Frank–Starling-based stroke volume optimization.

Đích của hồi sức
(End-points of resuscitation)

Phát hiện và xử trí sớm

- Giảm lưu lượng (flow) máu
- Giảm tưới máu mô (tissue hypoperfusion)
- Giảm cung cấp oxy so với nhu cầu oxy mô
- Rối loạn chức năng tế bào và mô

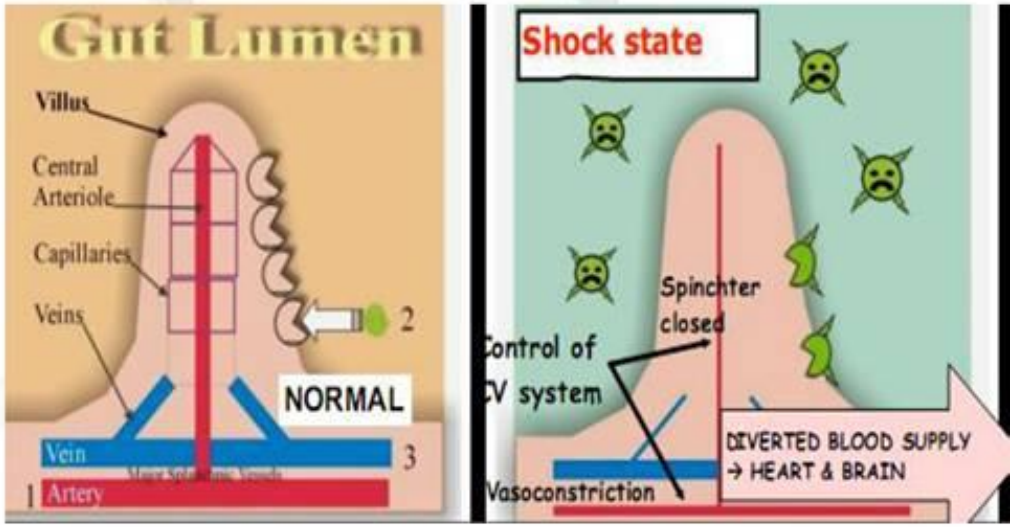
Perfusion > Flow > Pressure

End Points of Resuscitation

- Thông số truyền thống: BP, HR, CVP, UO
- CO và S_vO_2 : $S_VO_2 = ScvO_2 = S_aO_2 - VO_2 / (1{,}34 * CO \times Hb)$
- Vận chuyển oxy: $DO_2 = \{ (SaO2)(Hgb)(1.34) \} \times CO$

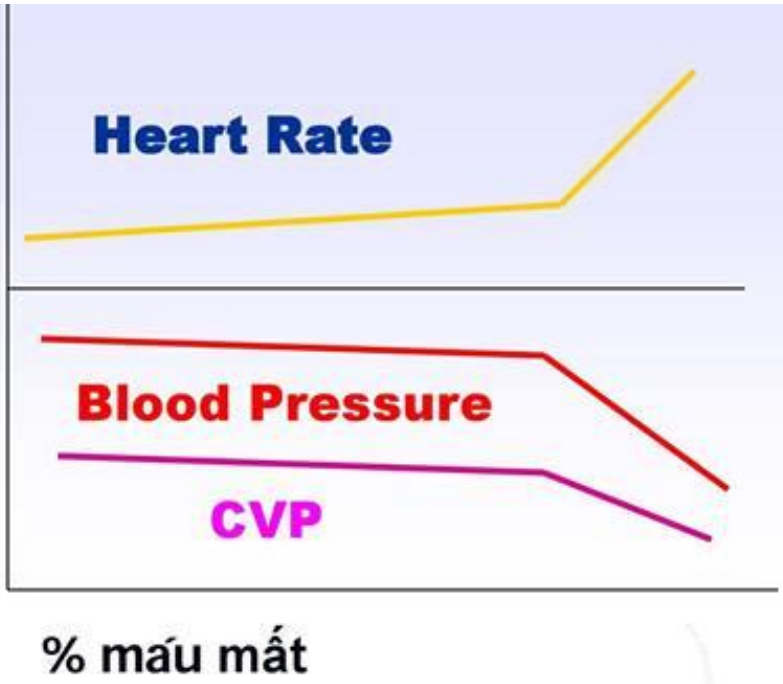
$$VO_2 = CO \times (C_aO_2 - C_vO_2)$$

- Đo chuyển hóa: BL, clearance BL, BD
- Đo pHi: hypoperfusion đầu tiên và hết sau cùng
- Đo oxy mô: SrO_2, $PtcO_2$
- Venous hypercarbia



	Class I	Class II	Class III	Class IV
Blood loss	< 750 cc 0-15%	750-1500 15-30%	1500-2000 30-40%	>2000cc >40%
HR	Normal	⇧	⇧	⇧
PP	Normal	⇩	⇩	⇩
BP	Normal	Normal	⇩	⇩
UOP	Normal	Normal	Decreased	Negligible
Mental	Normal	Anxious	Confused	Lethargic
Fluid	Crystalloid	Crystalloid	Crys+blood	Crys+blood

*ATLS; 2004. 70kg male



- Tissue hypoperfusion (SHOCK) dù HA bình thường (tái phân bố máu)
  → Tụt HA = marker muộn của hypoperfusion

- 80 - 85% BN chấn thương có dấu hiệu hồi sức kém tuy BP, HR và UO bình thường (Scalea TM, Abou-Khalil B et al. *CCM* 1994)

⇒ Đích truyền thống (BP, HR, CVP, UO): Không tin cậy
⇒ Ngừng hồi sức khi đạt được đích truyền thống có thể để lại một số bệnh nhân vẫn sốc còn bù.

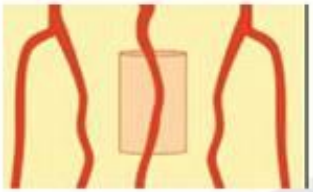
Monitoring shock

Trzeciak, Rivers, Critical Care 2005, 9(suppl 4):S20-S26

"Upstream" endpoints of resuscitation

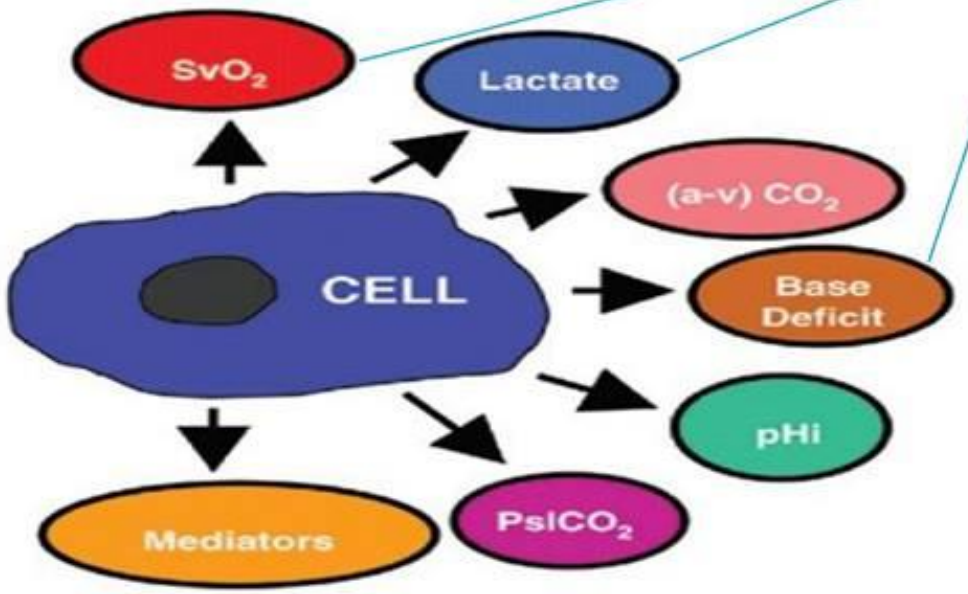
Hemodynamic parameters
- Preload (CVP, PCWP)
- Afterload (MAP, SVR)
- Contractility (SV)
- Heart rate (BPM)
- Shock index (HR/SBP)
- Coronary perfusion pressure

DO_2 parameters
- PaO_2
- Hemoglobin
- Cardiac output



goals

"Downstream" markers of the effectiveness of resuscitation

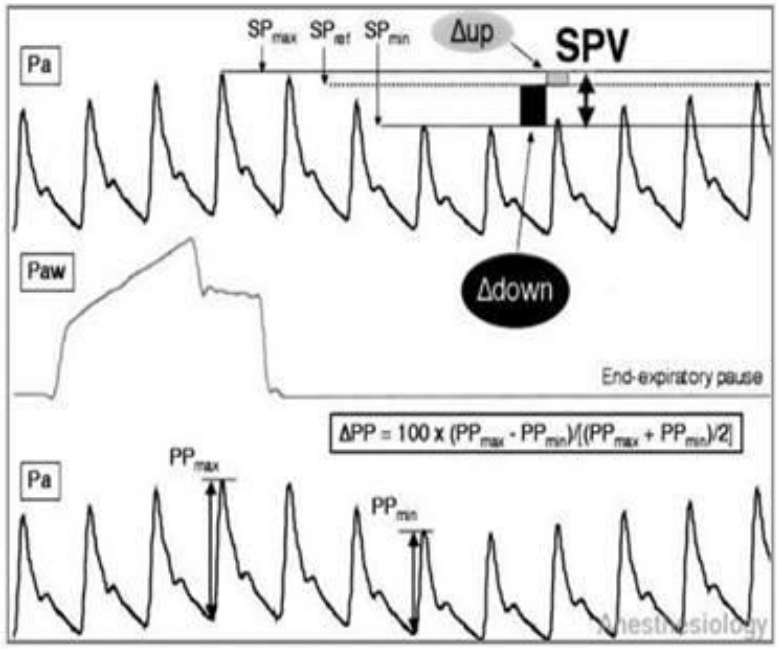


How much?
Hypovolemia = Đáp ứng với truyền dịch

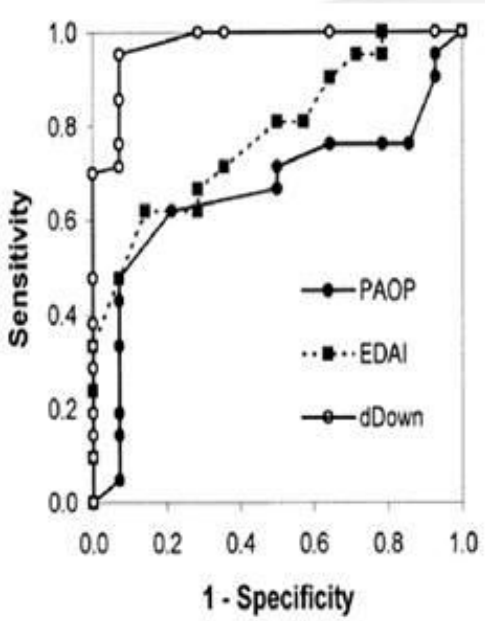
- Thông số tĩnh của áp lực làm đầy: CVP, PAP ?
- Thông số động: - SVV > 10%, SPV > 10 mmHg, PPV > 13%

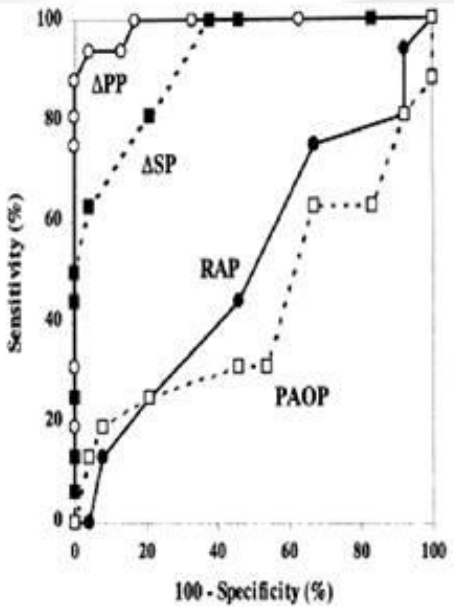
- Fluid challenge
- PLR 45^0 (passive leg raising)

≈ Trendelenburg 30^0: Se 66%, Sp 75%, PPV 91%, AUC 0,81)



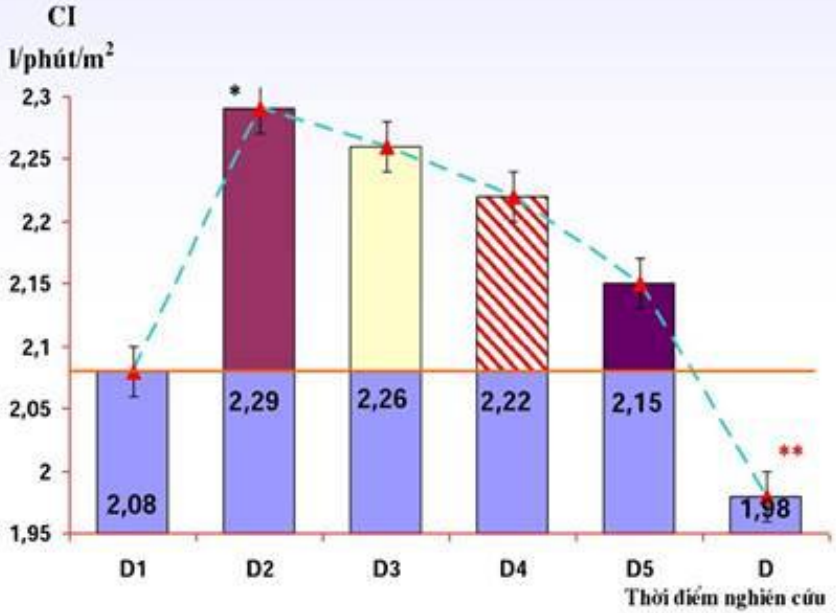
Hình 35. Biến động huyết áp theo nhịp thở máy

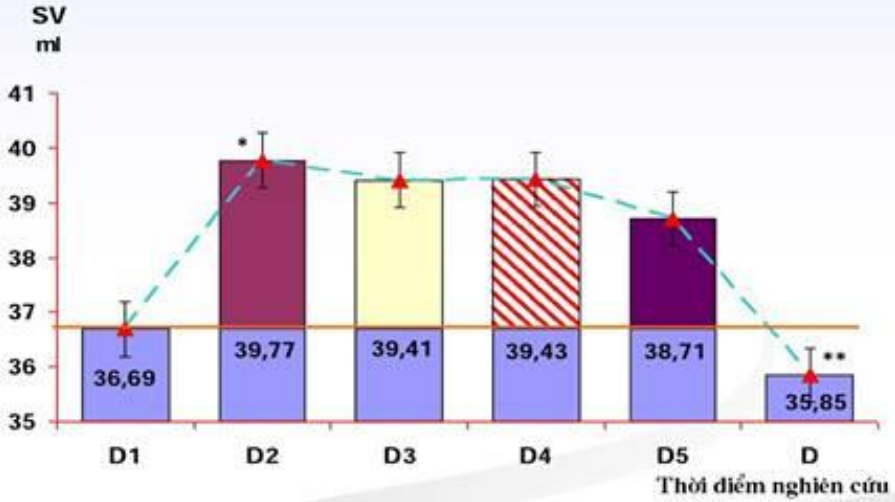


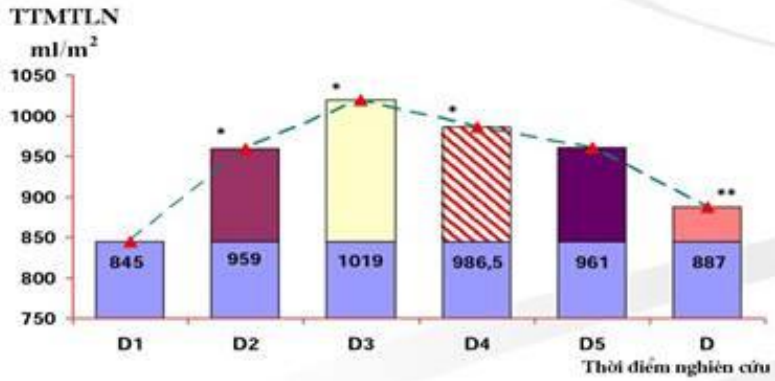


Tác dụng huyết động của Trendelenburg 30^0

(NQ Kinh, LN Van 2006)








PULSION
PiCCO2
PCCI 4.52
GEDI° 863
ELWI° 14
ScvO2 75

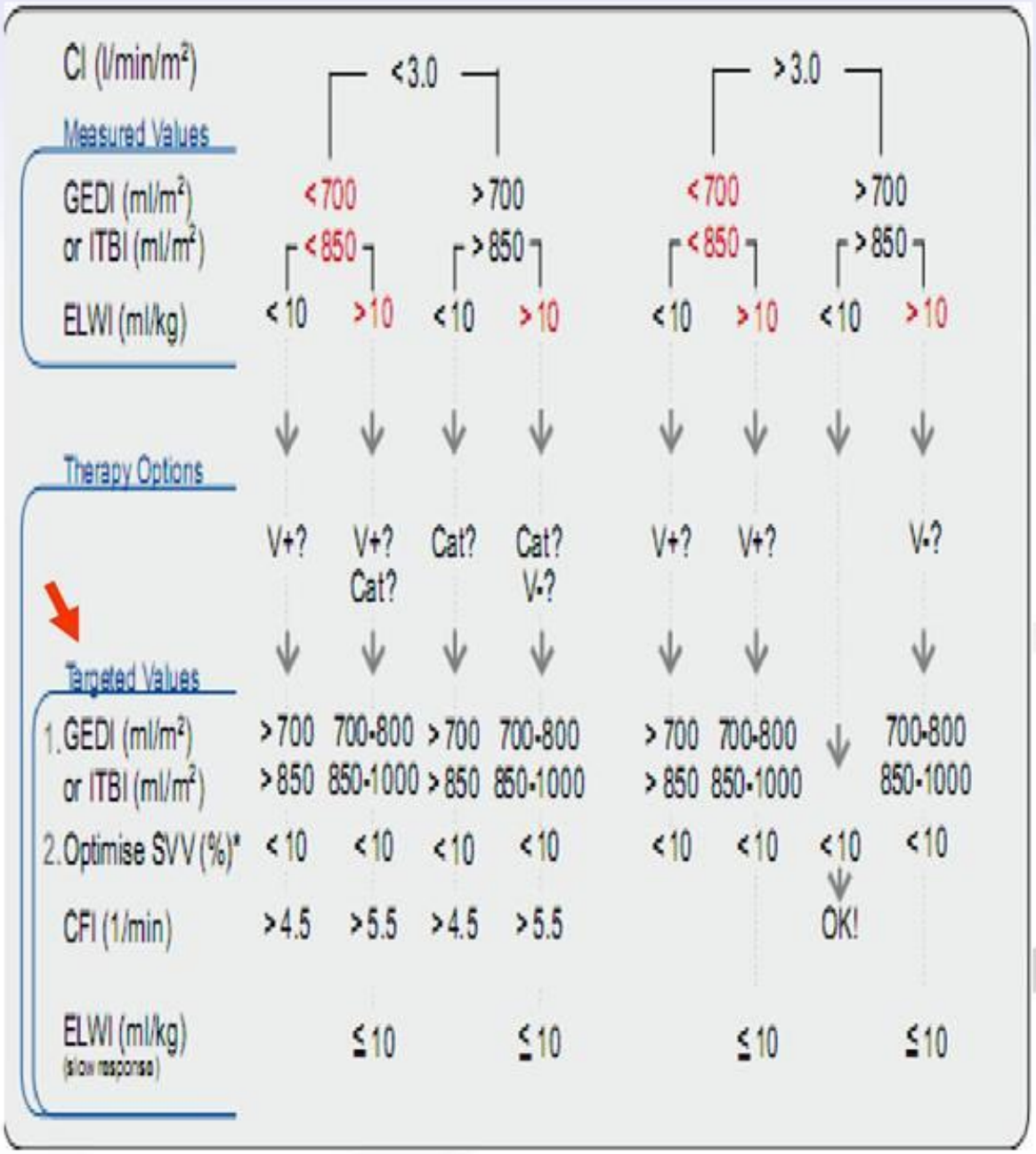

CI (l/min/m²)
< 3.0
> 3.0
Measured Values
GEDI (ml/m²)
or ITBI (ml/m²)
ELWI (ml/kg)
< 700
> 700
< 850
> 850
< 10
> 10
Therapy Options
V+?
V+? Cat?
Cat?
Cat? V-?
V-?
Targeted Values
1. GEDI (ml/m²) or ITBI (ml/m²)
> 700 > 850
700-800 850-1000
2. Optimise SVV (%)*
< 10
CFI (1/min)
> 4.5
> 5.5
OK!
ELWI (ml/kg)
(slow response)
≤ 10

Table 4.2. Perioperative methodology and outcomes of goal-directed randomized clinical trials.

GDT

Dịch

Procedure / patients (*n*)	Infusion strategy	Timing & means	Volume infused	Endpoints	Result[a]	Reference
Major bowel resection / 55	ED; SV optimization with FTc > 0.35 s	Intraoperative fluids	control vs. GDT: total: 55.2 vs. 64.6 ml/kg coll: 19.4 vs. 28.0 ml/kg	hemodynamic performance hospital stay postoperative complications	↑ SV and CO (↑) hospital stay (↓) postoperative complications ↓ critical care admissions	Conway *et al.* 2002[40]
Major bowel surgery / 128	ED; SV optimization and increase in CVP < 3 mmHg	Intraoperative fluids	control vs. GDT: cryst: same (3000 ml) coll[b]: 1500 vs. 2000 ml	hospital stay gut function	↓ hospital stay ↑ gut function recovery ↓ gastrointestinal and overall morbidity	Wakeling *et al.* 2005[42]
Colorectal resection / 108	ED; SV optimization with FTc of 0.35–0.40 s	Intraoperative fluids & inotropes	control vs. GDT[b]: cryst: 2625 vs. 2298 ml coll: 1209 vs. 1340 ml Inotrope: 50% vs. 31%	hospital stay	↓ hospital stay ↓ complications ↑ gut recovery	Noblett *et al.* 2006[43]
Major general, urologic or gynecologic surgery / 98	ED; SV optimization with FTc of 0.35–0.40 s	Intraoperative fluids	control vs. GDT[b]: coll: 282 vs. 847 ml cryst.: 4375 vs. 4405 ml blood: 118 vs. 168 ml	hospital stay GI and renal function	↓ hospital stay ↓ PONV ↑ gut recovery	Gan *et al.* 2002[41]

Table 4.2. (cont.)

GDT

Procedure / patients (n)	Infusion strategy	Timing & means	Volume infused	Endpoints	Result[a]	Reference
Upper GI surgery / 40	ITBV of 850–950 ml/m²	Intraoperative fluids	control vs. GDT[b]: cryst: 4043 vs. 4047 ml coll: 1255 vs. 1411 ml	Inflammatory response: serum PCT, CRP, TNF-α	→ PCT, CRP, TNF-α	Szakmany et al. 2005[50]
Major abdominal surgery / 80	radial artery line, PICCOplus monitor; SPV < 10%	Intraoperative fluids	control vs. GDT: cryst: 4250 vs. 4500 ml coll: 1000 vs. 1500 ml	organ function & perfusion	→ oxygen transport and organ function → ICU stay, mortality → length of mechanical ventilation	Buettner et al. 2008[48]
Elective abdominal[c] / 33	radial artery line; ΔPOP ≤ 10%	Intraoperative fluids	control vs. GDT[b]: cryst: 1,565 vs. 2,176 ml coll[d]: 0 vs. 2247 ml	hospital stay	↓ hospital stay ↓ ICU stay ↓ complications ↓ length of mechanical ventilation	Lopes et al. 2007[47]
Major abdominal surgery[e] / 60	radial artery line; FloTrac/Vigileo device; CI ≥ 2.5 l/(min/m²)	Intraoperative fluids & inotropes	control vs. GDT[b]: cryst[d]: 3153 vs. 2489 ml coll[d]: 817 vs. 1188 ml dobu[f]: 30.4 vs. 4.1 µg kg⁻¹ h⁻²	hospital stay postoperative complications	↓ hospital stay ↓ complications	Mayer et al. 2010[49]

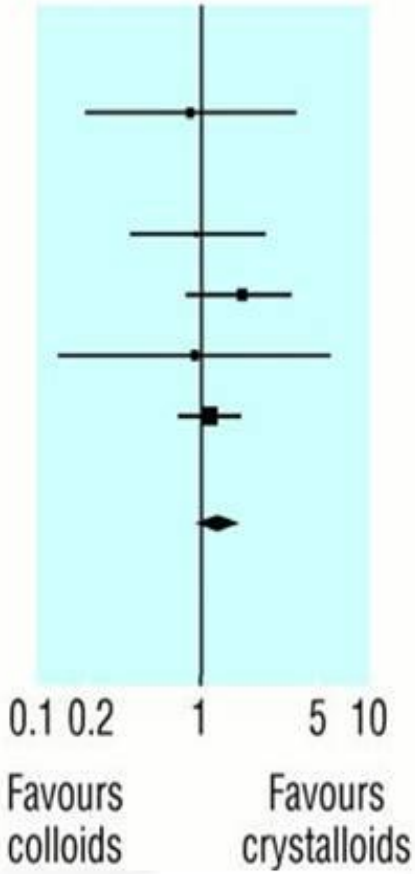
Đích

Kết cục tốt

Which fluid?
Dịch keo hay dịch tinh thể?

Dịch tinh thể và dịch keo

Type of injury	No of deaths: Colloids	No of deaths: Crystalloids	Relative risk (95% CI)	Weight (%)	Relative risk (95% CI)
Trauma					
Lowe et al[w1-w3]	3/77	4/94		2.8	0.92 (0.21 to 3.97)
Modig[w4 w5]	0/14	0/17		0.0	
Younes et al[w7]	7/35	7/35		5.5	1.00 (0.39 to 2.55)
Vassar et al[w8]	21/89	11/85		8.9	1.82 (0.94 to 3.55)
Nagy et al[w6]	2/21	2/20		1.6	0.95 (0.15 to 6.13)
Vassar et al[w9]	49/99	20/50		20.9	1.24 (0.83 to 1.83)
Subtotal	82/335	44/301		39.8	1.30 (0.95 to 1.77)
$\chi^2 = 1.68$ (df = 4)					



	Khả năng bù thể tích (% thể tích được truyền)	Thời gian tồn tại (thể tích được bù: h)
SSI	20 à 30	0,5
Ringer lactate	20 à 30	0,5
SSH	70	0,5
Dextran 40	100 à 180	4 à 6
Gélatines fluides	60 à 80	3 à 4
Albumine 4 / 20%	90 à 400	6 à 12
HEA	100 à 150	6 à 8
SSH/dextran	200 à 300	6 à 8

The Volume Effects of an Isotonic Crystalloid is Much Smaller than that of an Isooncotic Colloid

Trên thực tế lâm sàng?

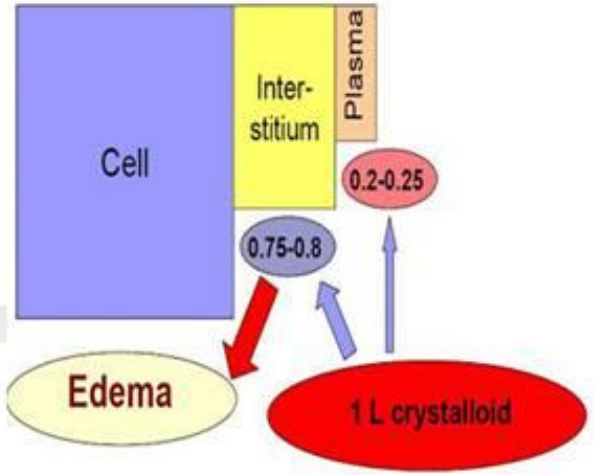
Dịch keo vs dịch tinh thể:

Cải thiện huyết động hơn

Hạn chế tăng cân ứ dịch hơn

Cung cấp oxy mô tốt hơn

Ít bục miệng nối tiêu hóa hơn



<u>Chú ý</u>: NaCl 0.9% (normal , physiologic saline)
= abnormal (non-physiologic) solution →
Cần truyền dịch tinh thể cân bằng (buffer, ↓[Cl^-])

Colloids are more effective than 0.9% NaCl

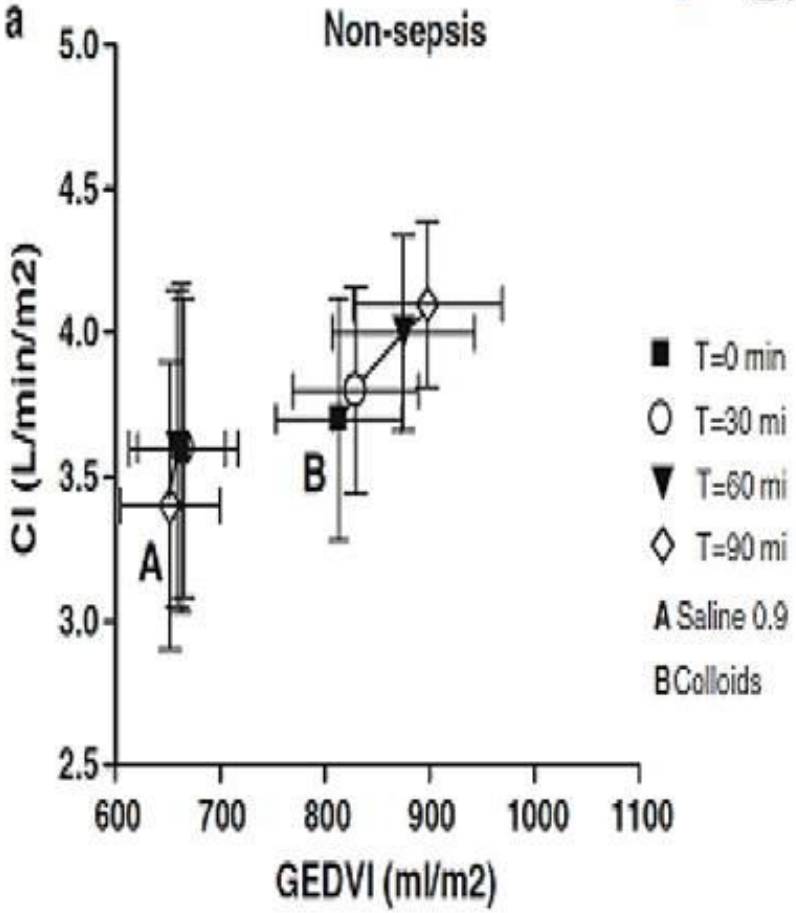
Intensive Care Med (2010) 36:697–701
DOI 10.1007/s00134-010-1776-x

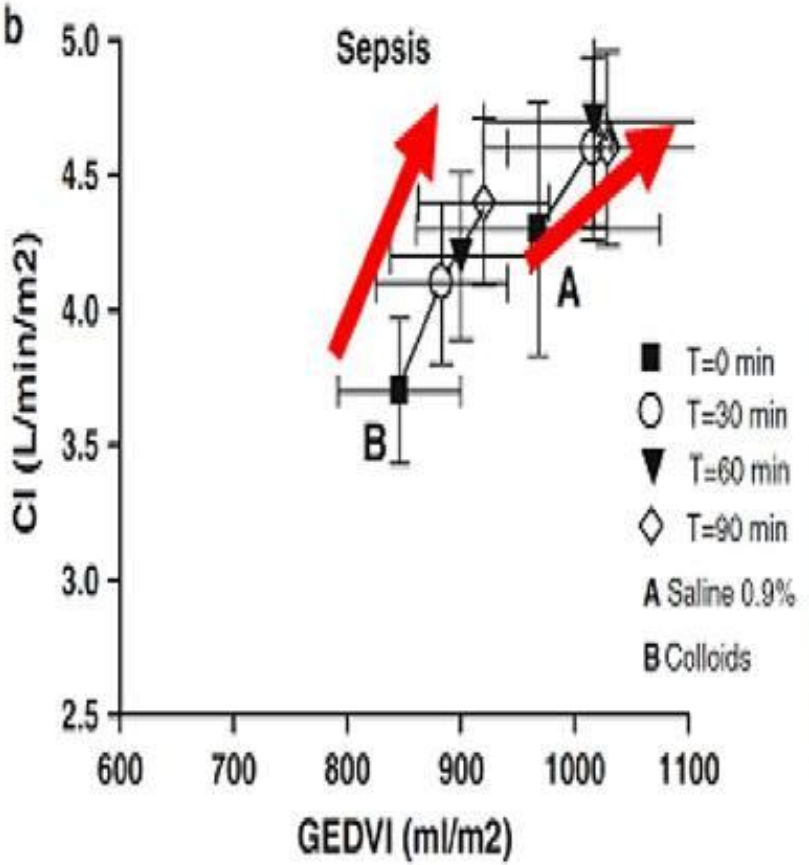
BRIEF REPORT

Ronald J. Trof
Sharwan P. Sukul
Jos W. R. Twisk
Armand R. J. Girbes
A. B. Johan Groeneveld

Greater cardiac response of colloid than saline fluid loading in septic and non-septic critically ill patients with clinical hypovolaemia

- Dutch single center study
- 24 Sepsis vs 24 non-Sepsis patients
- 0,9% NaCl versus Colloids (HES/5% HA)
- Delta CVP over 90 minutes
- CI & GEDVI



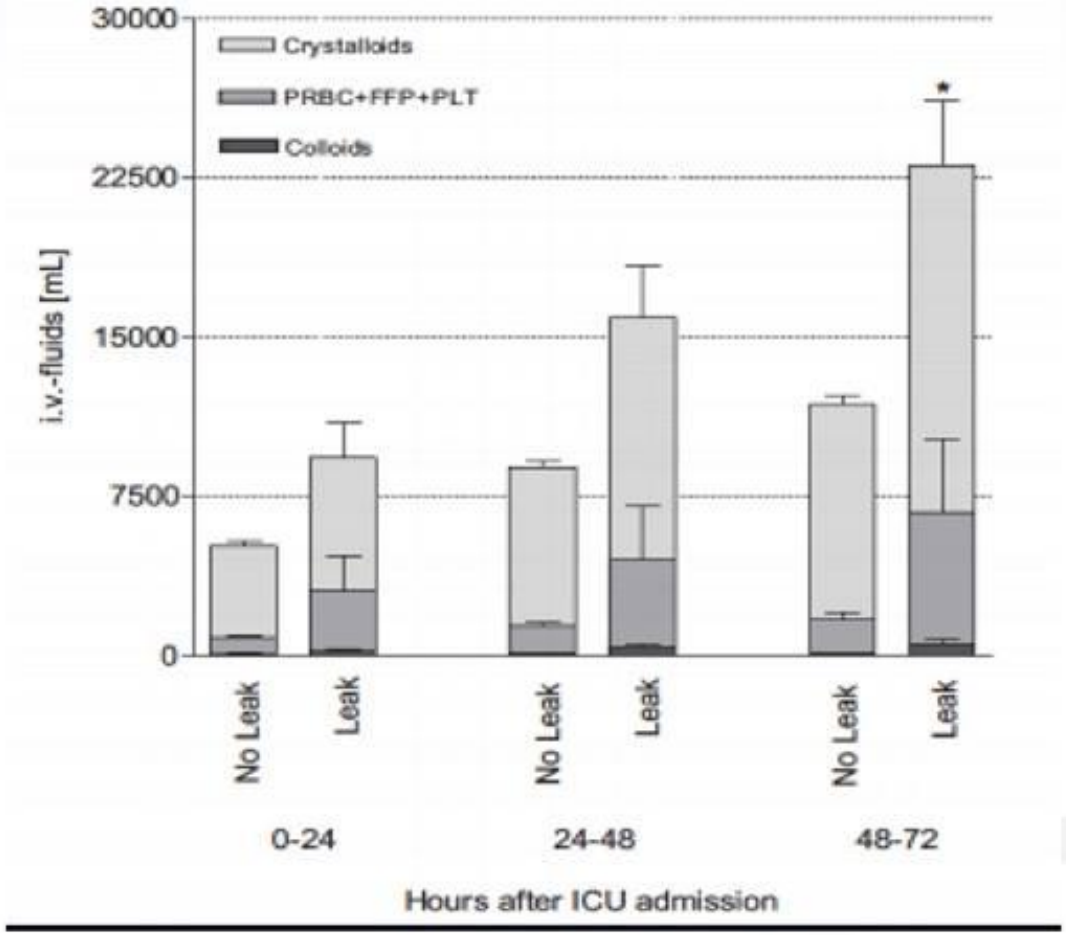


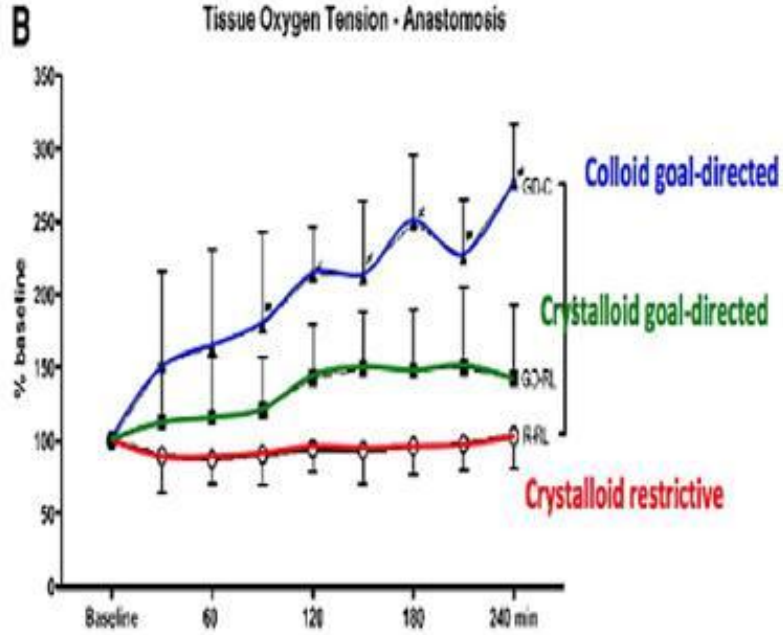
ORIGINAL ARTICLE

Crystalloids After Primary Colon Resection and Anastomosis at Initial Trauma Laparotomy: Excessive Volumes Are Associated With Anastomotic Leakage

Beat Schnüriger, MD, Kenji Inaba, MD, Tiffany Wu, MS, Barbara M. Eberle, MD, Howard Belzberg, MD, and Demetrios Demetriades, MD

The Journal of **TRAUMA**® *Injury, Infection, and Critical Care* • Volume 70, Number 3, March 2011

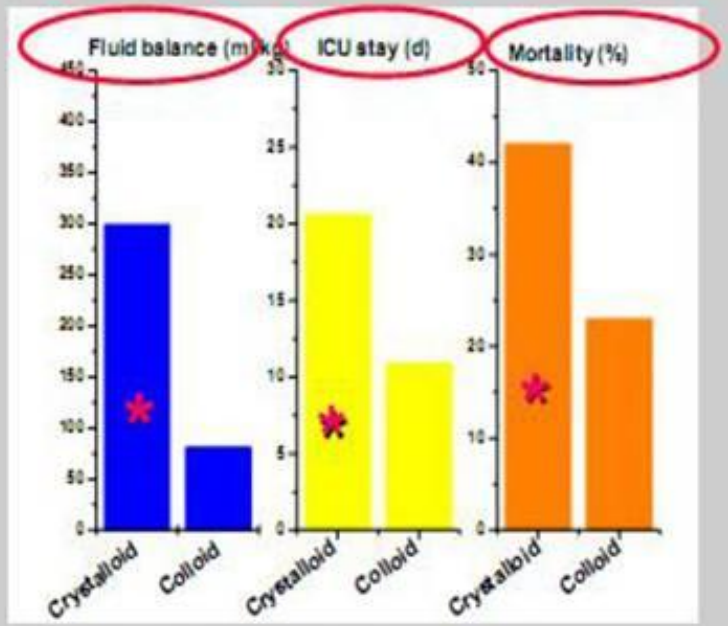




Kimberger O, et al. Anesthesiology 2009

Vi tuần hoàn ở ruột

The importance of colloid oncotic pressure during open heart surgery in infants



Haneda K, Sato S, Ishizawa E, Horiuchi T. Tohoku J Exp Med (1985) 147: 65-71

Gelatin

3 loại dịch Gelatin

- Oxypolygelatins (e.g., Gelifundol): đã bỏ
- Polygeline = Liên kết chéo urê (Haemaccel, Hoechst)
- Succinylated gelatin (Gelofusine/Gelaspan, Plasmion, Plasmagel). Có ích khi toan máu tăng Cl^-.

Succinylated gelatin vs. urea-cross linked gelatin

Characteristics	Gelofusine	Gelofusin Iso/Gelaspan	Haemaccel
Type of gelatin	Succinylated	Succinylated	Urea-linked
Gelatin concentration	4%	4%	3.5%
Osmolarity [mOsm/l]	274	284	293
Mean Mw	30 Kd	30 Kd	35 Kd
Volume Effect	100%, 3-4 h	100%, 3-4 h	~70%, 1-2 h
Na^+ [mmol/l]	154	151	145
Cl^- [mmol/l]	120	103	145
K^+ [mmol/l]	0	4	5.1
Ca^{2+} [mmol/l]	0	1	6.25
Mg^{2+} [mmol/l]	0	1	0
Acetate [mmol/l]	0	24	0

Albumin versus Gelatine

	Gelatin	5% Albumin
Volume Effect	80-100 %	100%
Effect	2-4 hours	up to 14 hours
Elemination/Extravasation	Kidney, Unspec. Peptidase	Extravasation of 60-75%
Accumulation	No	Yes, mean half life of exogenous Albumin: 19 days!
Anaphylaxia	++	(+)
Coagulation effects	+	(+)

HES versus Gelatine

	Gelatin	HES 130/0.4 Voluven®
Volume Effect	80-100 %	100%
Effect	2-4 hours	4-6 hours
Dose limit	no	50 ml/kg
Elemination	Kidney, Unspec. Peptidase	Amylase, kidney
Accumulation	No	Yes (kidney dysfunction)
Anaphylaxia	++	(+)
Coagulation effects	+	++

... different volume effects?

ICU patients/septic patients: no difference

Ernest D et al. Crit Care Med 1999

Feng X et al. Anesth&Analg 2007

Marx G et al. Intensive Care Med 2002

Marx G et al. Crit Care Med 2007

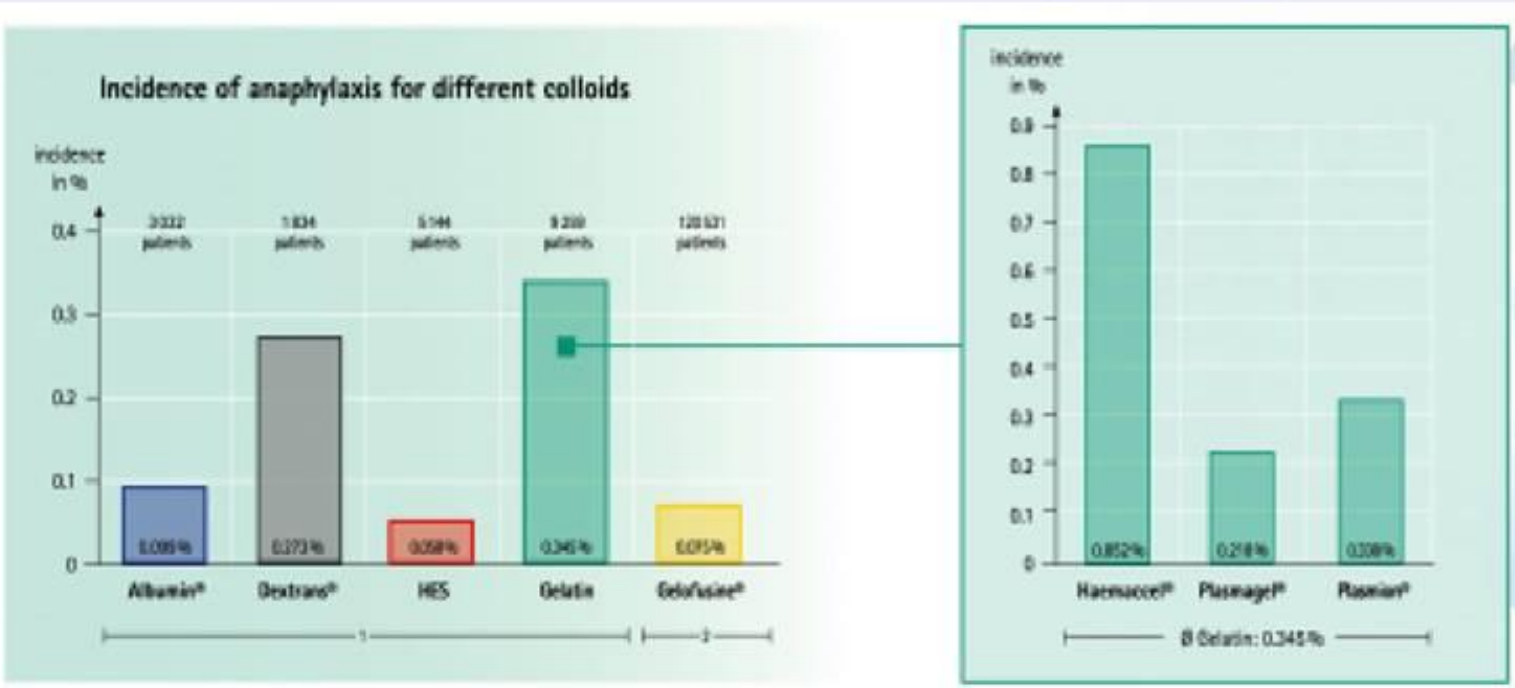
Perioperative patients: no difference

Beyer R et al. Br J Anaaesthesia 1997

Haisch G et al. Anesth&Analg 2001

Kumle B et al. Anesth&Analg 1999

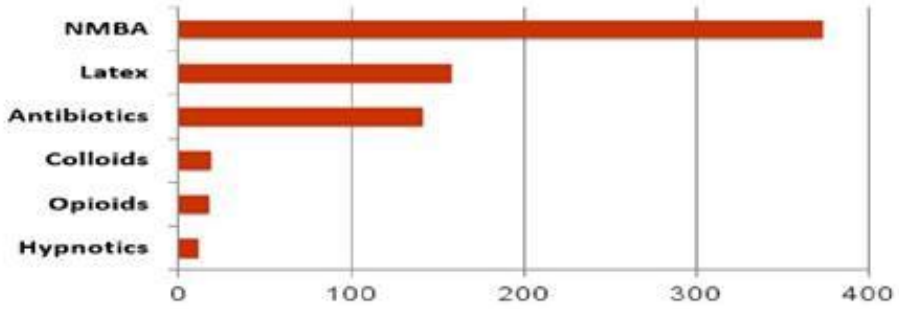
Gelatin cải tiến và dị ứng



Results in terms of frequency of anaphylactic reaction by:

identified trigger

786 cases (63%) IgE-mediated



Dong S.W. et al, Minerva Anestesiol, 2012 Aug;78(8):868-78. Epub 2012 Mar 22.

1)Laxenaire, M C. et al. Ann Fr Anesth Réanim 13 (1994) 301-310
2)Lundagaard-Hansen P et al. Dev Biol Stand 48(1980) 251-256

Gelatin trong sốc nhiễm trùng

Intensive Care Med (2004) 30:1356–1360
DOI 10.1007/s00134-004-2278-8

ORIGINAL

Zsolt Molnár
András Mikor
Tamás Leiner
Tamás Szakmány

Fluid resuscitation with colloids of different molecular weight in septic shock

- Prospective randomisid study
- Early septic shock patients with ALI
- N=30
- Gelatine 4% versus 6% HES 200
- Primary Objective: Effects of colloids

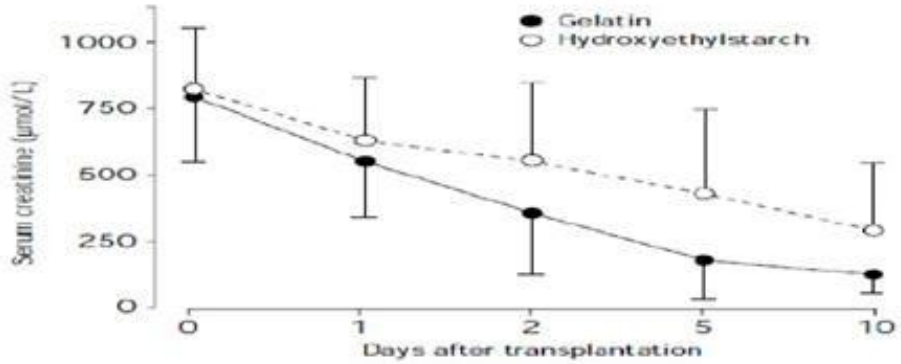
Gelatine versus HES in Sepsis

	t_b	t_{ep}	t_{30}	t_{60}
$ITBVI_{HES}$ (ml/m^2)	798±37	956±53*	904±70*	854±116*
$ITBVI_{GEL}$	791±52	967±71*	897±96*	905±92*
CI_{HES} (l·min·m^{-2})	3.84±0.96	5.06±1.19*	4.69±1.14*	4.04±1.09
CI_{GEL}	3.82±0.88	4.88±0.85*	4.69±0.77*	4.58±1.25
Hb_{HES} (g/l)	99±14	97±15	97±18	96±16
Hb_{GEL}	95±21	95±22	93±22	94±22
DO_2I_{HES} (ml·min·m^2)	477±99	630±183*	598±126*	527±109
DO_2I_{GEL}	457±101	615±186*	560±163*	550±178
$EVLW_{HES}$ (ml/kg)	8±6	8±6	9±7	8±6
$EVLW_{GEL}$	8±3	8±3	8±3	8±3

THE LANCET

Effect of hydroxyethylstarch in brain-dead kidney donors on renal function in kidney-transplant recipients

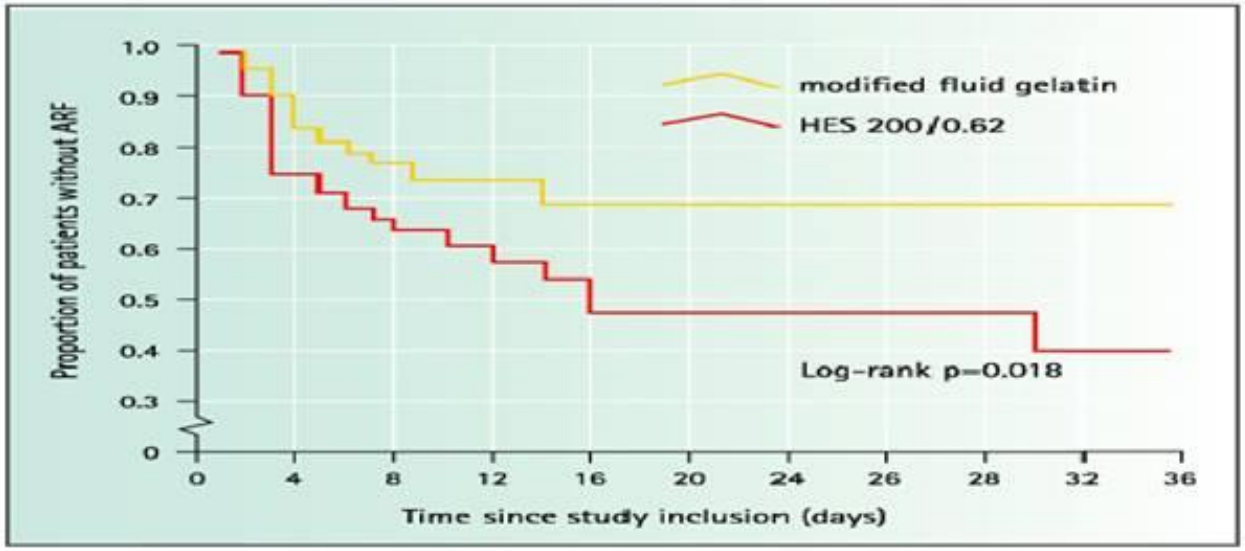
M L Cittanova, I Leblanc, Ch Legendre, C Mouquet, B Riou, P Coriat



Effects of hydroxyethylstarch and gelatin on renal function in severe sepsis: a multicentre randomised study

Lancet 2001; 357: 911–16

Frédérique Schortgen, Jean-Claude Lacherade, Fabrice Bruneel, Isabelle Cattaneo, François Hemery, François Lemaire, Laurent Brochard

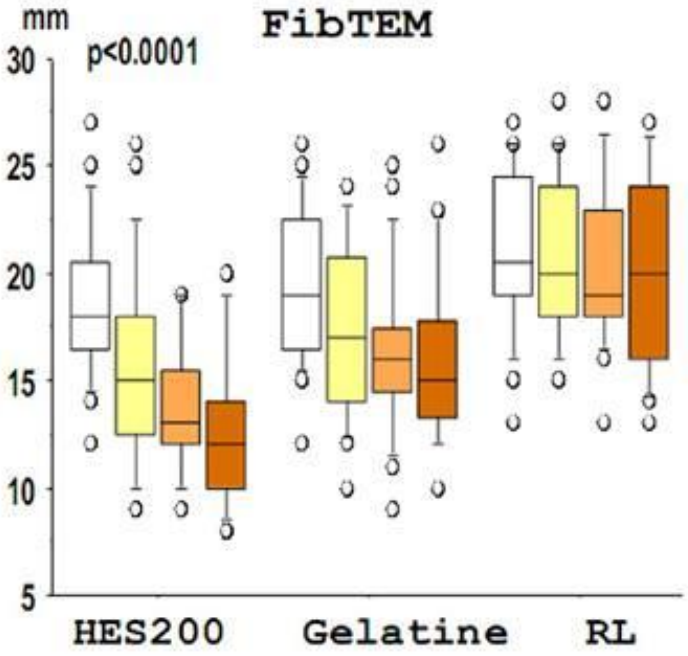


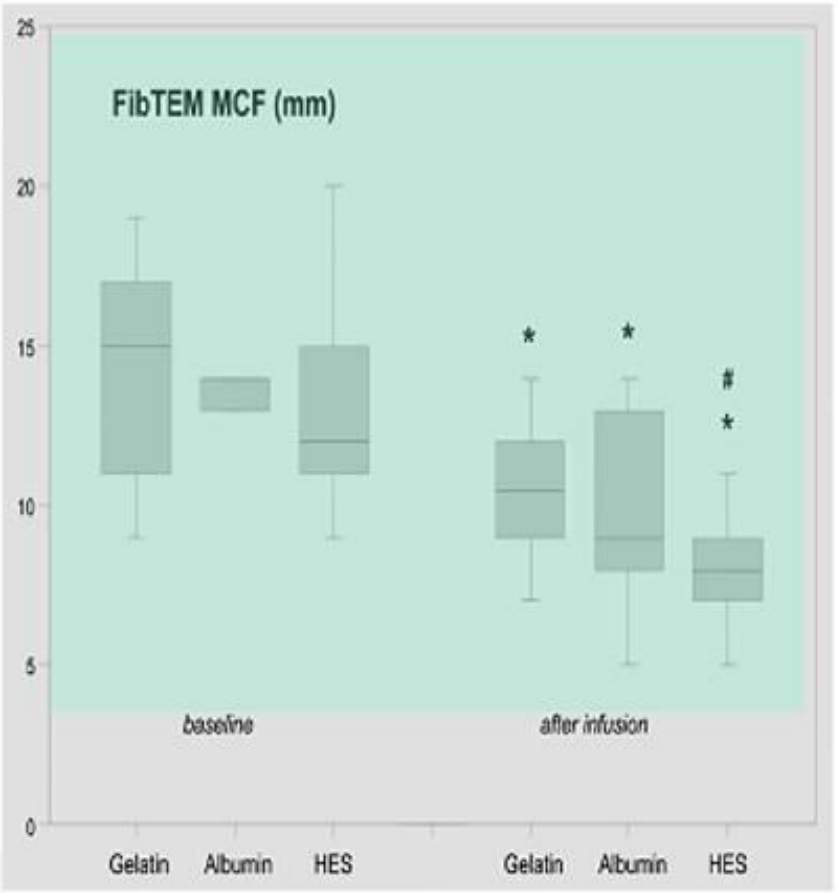
Fluid therapy in the critically ill

- Crystalloid/colloid: 3:1
- Monitoring
  - Lactate clearence/ScvO2
  - SV/GEDV
- Type of crystalloid:
  balanced electrolyte solution
- Type of colloid (Indication: Shock)
  - ICU/sepsis: modified fluid gelatine

Gelatin và đông máu

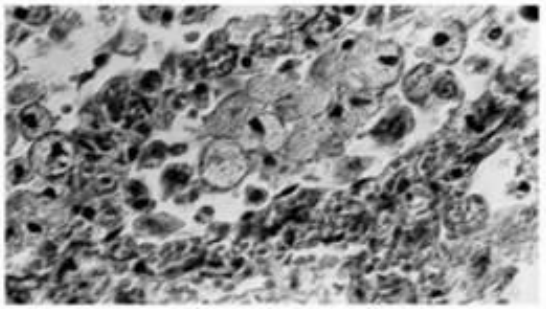
ROTEM®-measurements:
Maximum Clot Firmness (MCF) FibTEM:



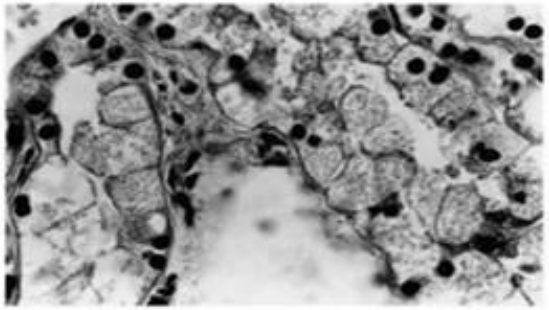


Elemination - storage

Storage of starch in alveolar macrophages



Storage of starch in the kidney (Vacuoloisation of tubulus epithelium)



Ginz et al. Der Anasthesist 1998

Gelatin vs HES:

Volume effect như nhau,
Ít tích lũy ở mô hơn nên không giới hạn lượng truyền
Ít ảnh hưởng lên đông máu hơn

Kết luận

Dịch là thuốc →

Give the *right* amount of the *right* fluid at the *right* time

Cám ơn sự chú ý của quí vị!