Choc

Définition

Le choc est une altération de la circulation (déficit hémodynamique) où la perfusion tissulaire est insuffisante pour assurer le métabolisme cellulaire

Sémiologie

- hypotension artérielle
- tachycardie (pouls filant)
- lipothymie, apathie, agitation
- pâleur, froideur, moiteur
- marbrures cutanées, cyanose
- oligurie, anurie
- hyperventilation (acidose métabolique)
- « choc chaud »: extrémités vasodilatées, rouges, chaudes, sèches

Evaluation des signes vitaux (paramètres cliniques)

- Respiration : FR, VT, couleur peau
- Cerveau : pupilles (taille, L+), sensibilité, conscience
- Reins : diurèse normale = 6-15 ml/ 10 min
- Température
- Cardiovasculaire : TA, pouls, FC, RC, turgescence jugulaire, pouls capillaire (front: N < 1,5 sec), sudations, vasoconstriction, marbrures, monitoring cardiaque et hémodynamique

Signification

TABLEAU 1

Signes cliniques et biologiques simples de l'état de choc

Fonction	Signes simples
Macrocirculation	Hypotension artérielle systémique (définie par une pression artérielle moyenne < 65 mmHg ou une pression artérielle systolique < 90 mmHg ou baissant de plus de 40 mmHg par rapport au chiffre habituel du patient) ou nécessité de perfuser des catécholamines pour maintenir une pression artérielle adéquate
Microcirculation	Allongement du temps de recoloration cutanée > 3 s, pâleur, froideur, cyanose, ou marbrures cutanées
Perfusion d'organes	Troubles des fonctions supérieures, oligurie
Métabolisme cellulaire	Hyperlactatémie (> 2 mmol.L)

TABLEAU 3

Principales causes d'hyperlactatémie en dehors de l'état de choc

Fonction	Signes simples
Baisse d'apport en oxygène sans état de choc	▮ Hypoxémie profonde ▮ Anémie profonde ▮ Intoxication au monoxyde de carbone
Augmentation brutale de la demande en oxygène	▮ Convulsion ▮ Exercice physique intense
Stimulation de la glycolyse aérobie	▮ β2-mimétiques ▮ Intoxication à la cocaïne ▮ Phéochromocytome
Augmentation de l'activité glycolytique de la tumeur et hypoxie tissulaire tumorale	▮ Cancer/hémopathie
Interférence avec la phosphorylation oxydative	▮ Intoxications : metformine, salicylates (ex : aspirine), alcool, méthanol, éthylène glycol, cyanure ▮ Syndrome de perfusion du propofol
Baisse de la clairance du lactate	▮ Hépatopathies

Classification

- choc hypovolémique
- choc cardiogénique
- choc obstructif
- choc distributif

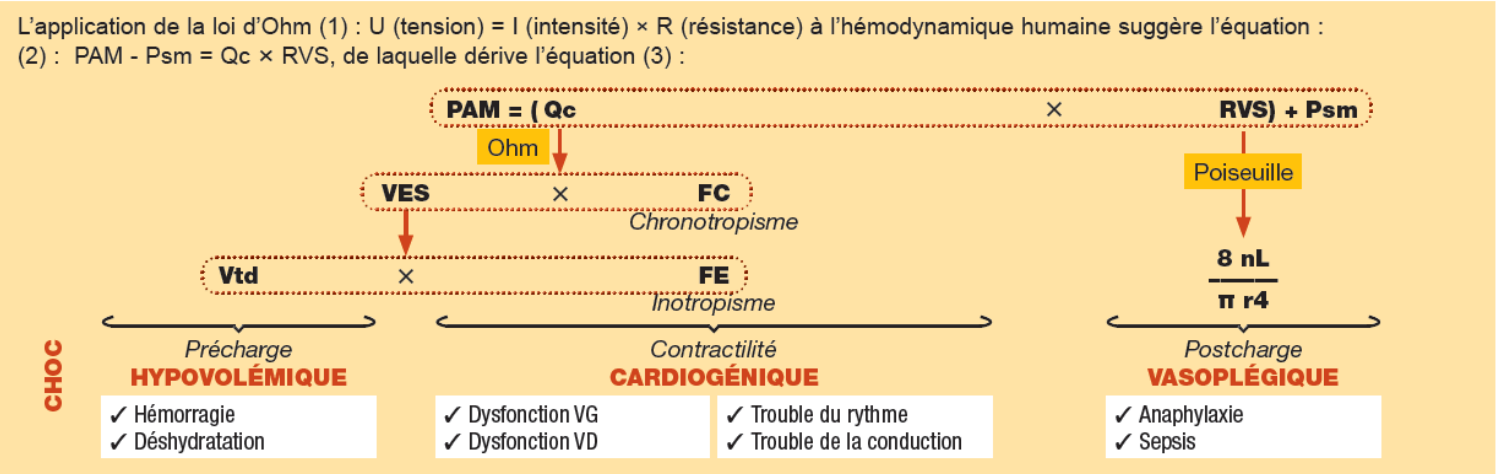


FIGURE **Déterminants de la pression artérielle et différents types de choc.** PAM : pression artérielle moyenne ; Qc : débit cardiaque ; RVS : résistances vasculaires systémiques ; Psm : pression systémique moyenne ; VES : volume d'éjection systolique du ventricule gauche ; FC : fréquence cardiaque ; Vtd : volume télédiastolique du ventricule gauche ; FE : fraction d'éjection du ventricule gauche ; n : viscosité sanguine; L : longueur des vaisseaux; r : rayon des vaisseaux.

Choc hypovolémique

= le volume contenu dans le compartiment intravasculaire n'assure pas une perfusion tissulaire adéquate

- par pertes externes de liquide: sang (choc hémorragique), plasma, hydroélectrolytiques, digestives, cutanées, rénales
- par séquestration interne de liquide: hémorragies internes, 3è espace, choc anaphylactique*, phéochromocytome*

* Classés parfois comme vasoplégiques

Principales étiologies

A. Par pertes externes de liquide

- pertes de sang : hémorragies externes
- pertes de plasma : brûlures, lésions exsudatives
- pertes hydro-électrolytiques:

- pertes digestives : vomissements, diarrhées
- pertes cutanées : déshydratation (fièvre)
- pertes rénales : diabète sucré, diabète insipide, diurétiques, crise addisonienne, hypercalcémie

B. Par séquestration interne du liquide

- hémorragies internes :
  - fractures
  - digestives (ulcus, varices œsophagiennes,...)
  - hémothorax
  - hémopéritoine
  - hématome retropéritonéal
  - anévrisme disséquant de l'aorte
  - pancréatite hémorragique
  - infarctus intestinal,...
- 3e espace :
  - ascite
  - obstruction intestinale
  - épanchement pleural
- choc anaphylactique
- phéochromocytome

Choc cardiogénique

= la pompe cardiaque est incapable d'assurer un volume circulant suffisant

- altérations myocardiques: infarctus, cardiomyopathies
- lésions valvulaires et septales
- tachycardies (remplissage diastolique inadéquat)

Principales étiologies

1. **Altérations myocardiques**
- infarctus du myocarde
- myocardite aiguë
- cardiomyopathies au stade terminal

2. **Lésions valvulaires et septales**
- rupture de pilier ou de cordage tendineux
- rupture ou perforation valvulaire
- perforation du septum interventriculaire

3. **Tachycardies** (remplissage diastolique inadéquat)

Choc obstructif

= obstruction à la circulation du sang au niveau des grosses veines, du cœur, des artères pulmonaires, de l'aorte

Principales étiologies

- compression des veines caves
- tamponnade péricardique
- ball-valve thrombus, myxome de l'oreillette
- embolie pulmonaire
- anévrysme disséquant de l'aorte
- pneumothorax
- épanchements pleuraux massifs
- VA à pression positive élevée

Choc distributif

= déficit majeur de la résistance artérielle et/ou de la capacité veineuse responsable d'une perturbation de la distribution de la masse sanguine

- choc septique
- intoxication barbiturique
- blocage ganglionnaire (anesthésie)
- choc spinal (section cervicale moelle épinière)
- choc anaphylactique
- phéochromocytome

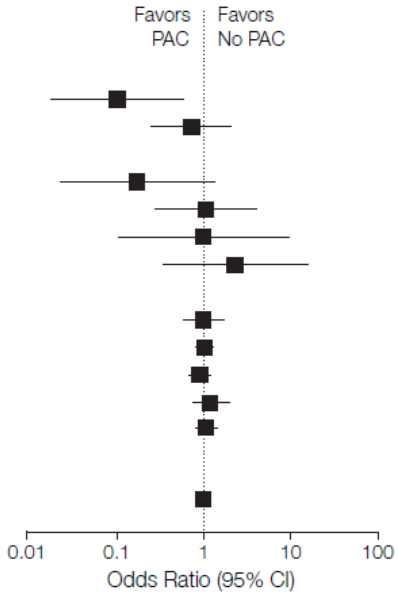
Bilan paraclinique

- Biologie : EHC, urée, créatinine, glycémie, iono, Ca, coagulation, gazométrie, groupe + compat, enzymes, CRP
- RX thorax
- ECG
- Échocardiographie
- Centre antipoison
- Aspiration gastrique (hématest)
- Gastroscopie
- Abdomen : RX à blanc, échographie, TDM
- Bactériologie : HC, EMU + culture, expectorations, PL, FG, FV

Sonde de Swan-Ganz : erreur non intentionnelle

Figure 2. Odds Ratio (PAC vs No PAC) for Mortality of RCTs Evaluating the Safety and Efficacy of the PAC

Source	No. of Deaths/ Total No. of Patients: PAC	No. of Deaths/ Total No. of Patients: No PAC	Odds Ratio (95% CI)
Schultz et al,[15] 1985	1/35	10/35	0.11 (0.02-0.63)
Shoemaker et al,[16] 1988	11/58	7/30	0.76 (0.27-2.15)
Isaacson et al,[17] 1990	1/49	0/53	NA
Berlauk et al,[18] 1991	1/66	2/21	0.18 (0.02-1.42)
Guyatt,[19] 1991	10/16	9/17	1.10 (0.29-4.22)
Bender et al,[20] 1997	1/51	1/53	1.04 (0.11-9.95)
Valentine et al,[21] 1998	3/60	1/60	2.38 (0.35-16.29)
Bonazzi et al,[22] 2002	0/50	0/50	NA
Rhodes et al,[23] 2002	46/95	50/106	1.01 (0.58-1.76)
Sandham et al,[24] 2003	163/997	155/997	1.06 (0.83-1.35)
Richard et al,[25] 2003	199/338	208/343	0.93 (0.68-1.26)
ESCAPE,[10] 2005	45/215	38/218	1.25 (0.78-2.02)
Harvey et al,[14] 2005 (PAC-Man)	346/506	333/507	1.13 (0.87-1.47)
Combined			1.04 (0.90-1.20)



CI indicates confidence interval; NA, not available; PAC, pulmonary artery catheter; RCT, randomized clinical trial. *P* for heterogeneity = .36.

JAMA. 2005;294:1664-1670

TABLEAU 4

Profil hémodynamique habituel des états de choc

	Paramètres physiologiques				
Choc	Débit cardiaque	Extraction périphérique de l'O2	Précharge	Contractilité	Postcharge
Hypovolémique	↓	↑	↓	↑	↑
Cardiogénique	↓	↑	↑	↓	↑
Vasoplégique	↑	↓	–	↑	↓

Complication : syndrome de défaillance multiviscérale

= SDMV ou MOF (multiple organ failure)

- Syndrome caractérisé par la défaillance d'au moins 2 organes, avec un pronostic d'autant plus sombre que le nombre d'organes atteints est élevé.
- Il n'y a pas à ce sujet consensus sur un système de score unique en réanimation.

Traitement du choc

Principes

- Traitement étiologique
- Augmenter le transport de l'oxygène

  $DO_2 = Ca\ O_2 \times DC$
- Diminuer la demande en oxygène

  $VO_2 = Ca\text{-}v\ O_2 \times DC$
- Divers: combattre l'acidose

  combattre l'anurie

Augmenter le transport en oxygène

A. le débit cardiaque

- expanseurs: sang, colloïdes, cristalloïdes
- sympathomimétiques: dopamine, dobutamine, isoprotérénol, noradrénaline

B. la concentration en hémoglobine (!anémie)

C. Fi O_2 (oxygénothérapie)

Les expanseurs

Bénéfices attendus du remplissage

régression des signes cliniques d'hypovolémie

- augmentation de la délivrance en oxygène aux tissus: correction acidose lactique et hypotension artérielle
- redistribution favorable des débits régionaux : reprise de la diurèse et réduction de la fréquence cardiaque

Table 1. Types and Compositions of Resuscitation Fluids.*

Variable	Human Plasma	Colloids									Crystalloids		
		4% Albumin	Hydroxyethyl Starch						4% Succinylated Modified Fluid Gelatin	3.5% Urea-Linked Gelatin	0.9% Saline	Compounded Sodium Lactate	Balanced Salt Solution
			10% (200/0.5)	6% (450/0.7)	6% (130/0.4)		6% (130/0.42)						
Trade name		Albumex	Hemohes	Hextend	Voluven	Volulyte	Venofundin	Tetraspan	Gelofusine	Haemaccel	Normal saline	Hartmann's or Ringer's lactate	PlasmaLyte
Colloid source		Human donor	Potato starch	Maize starch	Maize starch	Maize starch	Potato starch	Potato starch	Bovine gelatin	Bovine gelatin			
Osmolarity (mOsm/liter)	291	250	308	304	308	286	308	296	274	301	308	280.6	294
Sodium (mmol/liter)	135–145	148	154	143	154	137	154	140	154	145	154	131	140
Potassium (mmol/liter)	4.5–5.0			3.0		4.0		4.0		5.1		5.4	5.0
Calcium (mmol/liter)	2.2–2.6			5.0				2.5		6.25		2.0	
Magnesium (mmol/liter)	0.8–1.0			0.9		1.5		1.0					3.0
Chloride (mmol/liter)	94–111	128	154	124	154	110	154	118	120	145	154	111	98
Acetate (mmol/liter)						34		24					27
Lactate (mmol/liter)	1–2			28								29	
Malate (mmol/liter)								5					
Gluconate (mmol/liter)													23
Bicarbonate (mmol/liter)	23–27												
Octanoate (mmol/liter)		6.4											

* To convert the values for potassium to milligrams per deciliter, divide by 0.2558. To convert the values for calcium to milligrams per deciliter, divide by 0.250. To convert the values for magnesium to milligrams per deciliter, divide by 0.4114.

Cristalloïdes

Sérum physiologique

- 9 g de NaCl/L d'eau
- 154 mmol/L sodium
- 154 mmol/L chlorure
- Osmolalité = 308 mosm/L
- pH = 5,0

Solution de Ringer

- Sodium: 147 mmol/l
- Potassium: 4 mmol/l
- Calcium: 2,25 mmol
- Chlorures: 155,5 mmol/l
- Osmolarité approximative: 309 mOsm/L
- pH: 5 – 7,5

Solution de Lactate Ringer

Un litre de liquide de Ringer contient :

- 130 mEq d'ion sodium = 130 mmol/l
- 109 mEq d'ion chlorure = 109 mmol/l
- 28 mEq de lactate = 28 mmol/l
- 4 mEq d'ion potassium = 4 mmol/l
- 3 mEq d'ion calcium = 1,5 mmol/l
- pH = 5,0

Solution de Hartmann

- Un litre de liquide de Hartmann contient:
- 131 mEq d'ion sodium = 131 mmol/L.
- 111 mEq d'ion chlorure = 111 mmol/L.
- 29 mEq de lactate = 29 mmol/L.
- 5 mEq d'ion potassium = 5 mmol/L.
- 4 mEq d'ion calcium = 2 mmol/L.
- pH = 6,5
- Osmolarité = 279 mosm/L

Plasmalyte A

- Composition (en mmole/l) :
  - sodium 140
  - chlore 98
  - lactate 28
  - potassium 5
  - magnésium 1,5
  - acétate 27
  - gluconate 23
- pH 7,4

NaCl 0,9 % versus Lactate Ringer ou Plasmalyte A

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Balanced Crystalloids versus Saline in Critically Ill Adults

Matthew W. Semler, M.D., Wesley H. Self, M.D., M.P.H., Jonathan P. Wanderer, M.D., Jesse M. Ehrenfeld, M.D., M.P.H., Li Wang, M.S., Daniel W. Byrne, M.S., Joanna L. Stollings, Pharm.D., Avinash B. Kumar, M.D., Christopher G. Hughes, M.D., Antonio Hernandez, M.D., Oscar D. Guillamondegui, M.D., M.P.H., Addison K. May, M.D., Liza Weavind, M.B., B.Ch., Jonathan D. Casey, M.D., Edward D. Siew, M.D., Andrew D. Shaw, M.B., Gordon R. Bernard, M.D., and Todd W. Rice, M.D., for the SMART Investigators and the Pragmatic Critical Care Research Group*

N Engl J Med 2018;378:829-39.
DOI: 10.1056/NEJMoa1711584

Table 2. Clinical Outcomes.*

Outcome	Balanced Crystalloids (N=7942)	Saline (N=7860)	Adjusted Odds Ratio (95% CI)†	P Value†
Primary outcome				
Major adverse kidney event within 30 days — no. (%)‡	1139 (14.3)	1211 (15.4)	0.90 (0.82 to 0.99)	0.04
Components of primary outcome				
In-hospital death before 30 days — no. (%)	818 (10.3)	875 (11.1)	0.90 (0.80 to 1.01)	0.06
Receipt of new renal-replacement therapy — no./total no. (%)§	189/7558 (2.5)	220/7458 (2.9)	0.84 (0.68 to 1.02)	0.08
Among survivors	106/6787 (1.6)	117/6657 (1.8)		
Final creatinine level ≥200% of baseline — no./total no. (%)§	487/7558 (6.4)	494/7458 (6.6)	0.96 (0.84 to 1.11)	0.60
Among survivors	259/6787 (3.8)	273/6657 (4.1)		
Among survivors without new renal-replacement therapy	215/6681 (3.2)	219/6540 (3.3)		
Secondary outcomes				
In-hospital death — no. (%)				
Before ICU discharge	528 (6.6)	572 (7.3)	0.89 (0.78 to 1.02)	0.08
Before 60 days	928 (11.7)	975 (12.4)	0.92 (0.83 to 1.02)	0.13

JAMA | Original Investigation

Effect of Intravenous Fluid Treatment With a Balanced Solution vs 0.9% Saline Solution on Mortality in Critically Ill Patients

The BaSICS Randomized Clinical Trial

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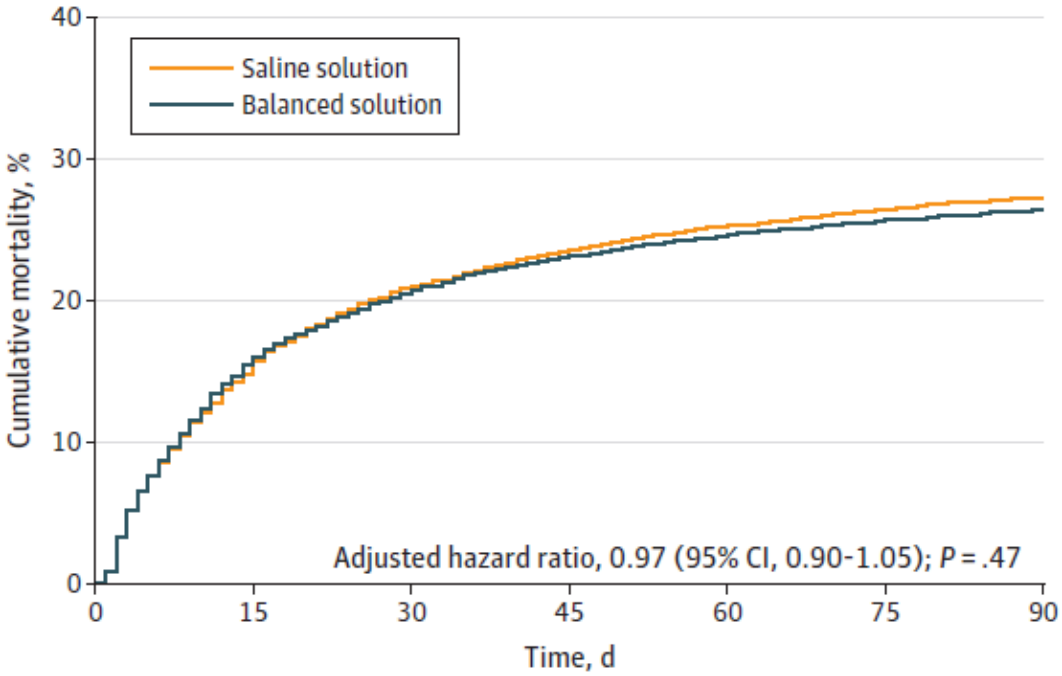
JAMA. 2021;326(9):818-829. doi:10.1001/jama.2021.11684

Figure 3. Cumulative Incidence of the Primary Outcome of 90-Day Survival for a Balanced Solution vs Saline Solution (0.9% Sodium Chloride)



No. at risk							
Saline solution	5290	4492	4172	4034	3937	3875	3829
Balanced solution	5230	4407	4139	4004	3922	3863	3821

The NEW ENGLAND JOURNAL of MEDICINE

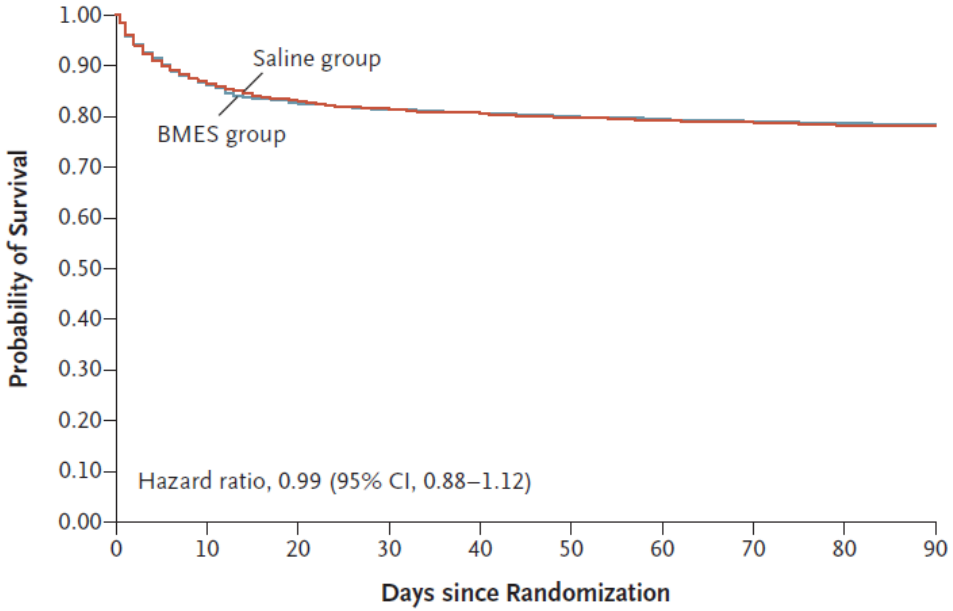
ORIGINAL ARTICLE

Balanced Multielectrolyte Solution versus Saline in Critically Ill Adults

Simon Finfer, M.D., Sharon Micallef, B.N., Naomi Hammond, Ph.D., Leanlove Navarra, B.S.N., Rinaldo Bellomo, M.D., Ph.D., Laurent Billot, M.Res., Anthony Delaney, M.D., Ph.D., Martin Gallagher, M.D., Ph.D., David Gattas, M.D., Qiang Li, M.Biostat., Diane Mackle, M.N., Jayanthi Mysore, M.S., Manoj Saxena, M.D., Ph.D., Colman Taylor, Ph.D., Paul Young, M.D., Ph.D., and John Myburgh, M.D., D.Sc., for the PLUS Study Investigators and the Australian and New Zealand Intensive Care Society Clinical Trials Group*

DOI: 10.1056/NEJMoa2114464

A Kaplan–Meier Estimates of the Probability of Survival



No. of Patients										
BMES group	2446	2119	2019	1983	1964	1949	1937	1922	1916	1906
Saline group	2430	2109	2015	1973	1952	1929	1913	1904	1890	1884

Conclusion

Le NaCl 0,9 % peut être considéré comme l'expanseur de choix

Colloïdes

- Gélatines
- Amidons

Gélatines

- Gélofusine^{R} : flacon de 500 ml à 4 %, contenant 154 mEq Na/l et de PM moyen de 30000
- autre spécialité : Geloplasma^{R}, Plasmion^{R}
- expansion volémique = volume perfusé
- effets secondaires : rarement réaction allergique

Hydroxyéthylamidons (HEA)

- Haes-steril^{R}, Plasmasteril^{R}, Voluven^{R}: solution à 6 % en NaCl isotonique
- expansion volémique supérieure au volume perfusé (550 à 750 ml pour 500 ml perfusé)
- effets secondaires : rarement réaction allergique et surtout troubles de l'hémostase à doses totales élevées ou si forme à longue durée d'action (Elohès); risque accru d'insuffisance rénale; prurit au long terme

Dérivés plasmatiques

- *Plasma frais congelé*
  risque de transmission de maladies virales (hépatite, SIDA) : à ne plus utiliser comme expanseur
- *SSPP* (solution stable de protéines plasmatiques): Albumine à 4%
  - 40 g protéines/l en solution isotonique et avec > 95 % d'albumine (correspond en fait à de l'albumine à 4%); flacon de 400 ml
  - volume injecté = expansion volumique
  - très peu de risque
  - *! critères restreints de remboursement en Belgique !* prescription limitée au choc distributif et anaphylactique et au choc associé à pancréatite; ascite réfractaire du cirrhotique avec hypoprotéinémie et ponctions itératives; syndrome néphrotique avec hypoprotéinémie; plasmaphérèse itérative; cirrhose décompensée avec ponction d'ascite de > 5l ou péritonite bactérienne spontanée
- *Albumine humaine à 20%*
  - flacon de 100 ml à 20 % (=20 g d'albumine)
  - expansion volumique importante (400 ml pour un flacon)
  - intérêt : œdème interstitiel important (notamment pulmonaire)

Que prescrire?

Fraudes aux données

The role of albumin as a resuscitation fluid for patients with sepsis: A systematic review and meta-analysis*

Anthony P. Delaney, MD, FCICM; Arina Dan, MD, FCICM; John McCaffrey, MD, FCICM; Simon Finfer, MD, FCICM

(Crit Care Med 2011; 39:386–391)

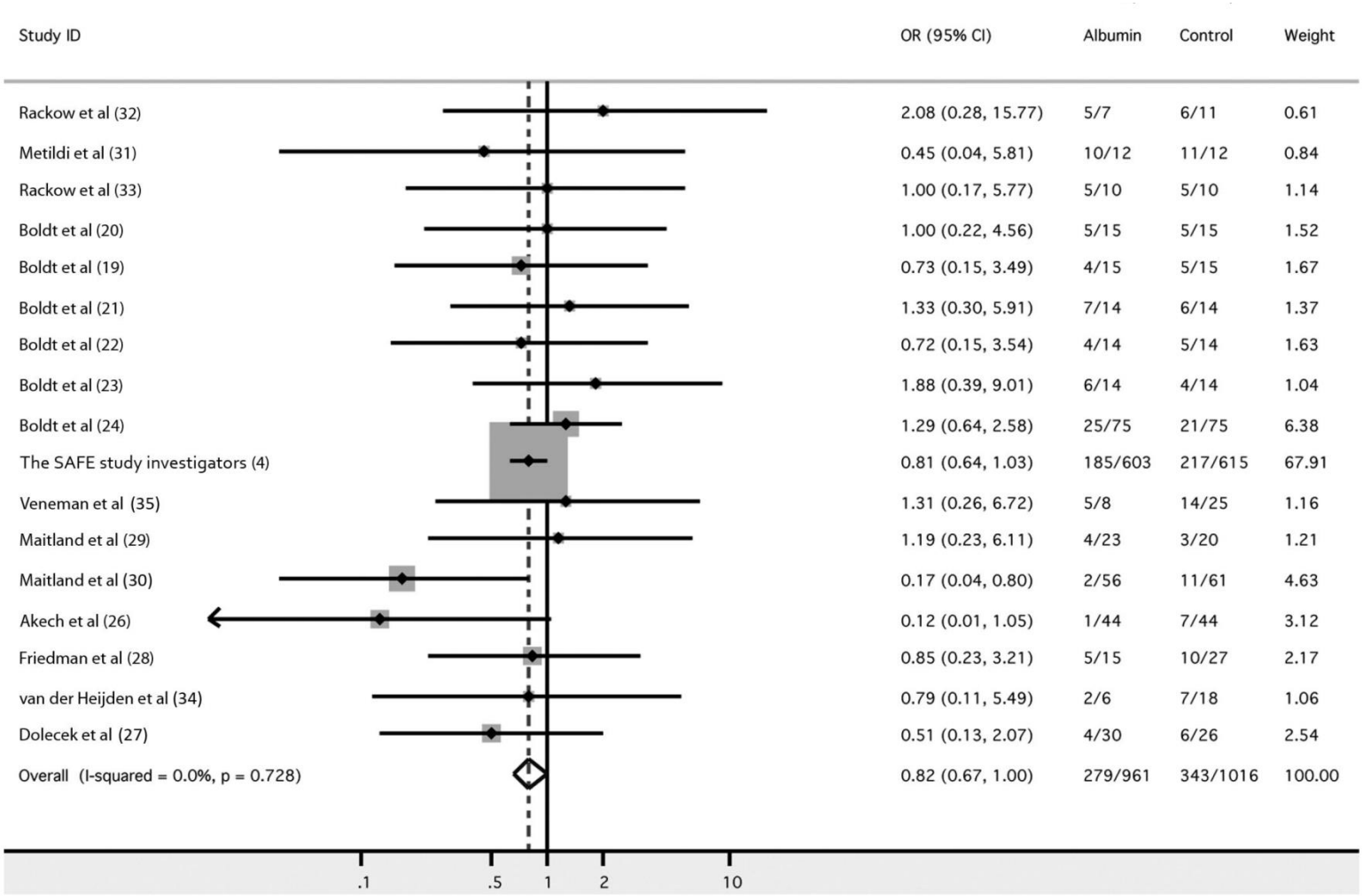


Figure 2. Forrest plot showing the pooled estimate of the effect of resuscitation with albumin-containing solutions on mortality for patients with sepsis. *OR*, odds ratio; *CI*, confidence limit.

Cardiopulmonary Bypass Priming Using a High Dose of a Balanced Hydroxyethyl Starch Versus an Albumin-Based Priming Strategy

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BACKGROUND: The optimal priming solution for cardiopulmonary bypass (CPB) is unclear. In this study, we evaluated the influence of high-volume priming with a modern balanced hydroxyethyl starch (HES) preparation on coagulation, inflammation, and organ function compared with an albumin-based CPB priming regimen.

METHODS: In 50 patients undergoing coronary artery bypass grafting, the CPB circuit was prospectively and randomly primed with either 1500 mL of 6% HES 130/0.42 in a balanced electrolyte solution (Na^+ 140 mmol/L, Cl^- 118 mmol/L, K^+ 4 mmol/L, Ca^{2+} 2.5 mmol/L, Mg^{++} 1 mmol/L, $acetate^-$ 24 mmol/L, $malate^-$ 5 mmol/L) (n = 25) or with 500 mL of 5% human albumin plus 1000 mL 0.9% saline solution (n = 25). Inflammation (interleukins [IL]-6, -10), endothelial damage (soluble intercellular adhesion molecule-1), kidney function (kidney-specific proteins α-glutathione *S*-transferase, neutrophil gelatinase-associated lipocalin), coagulation (measured by thrombelastometry [ROTEM®, Pentapharm, Munich, Germany]), and platelet function (measured by whole blood aggregometry [Multiplate® analyzer, Dynabyte Medical, Munich, Germany]) were assessed after induction of anesthesia, immediately after surgery, 5 h after surgery, and on the morning of first and second postoperative days.

RESULTS: Total volume given during and after CPB was 3090 ± 540 mL of balanced HES and 3110 ± 450 mL of albumin. Base excess after surgery was lower in the albumin-based priming group than in the balanced HES priming group (−5.9 ± 1.2 mmol/L vs +0.2 ± 0.2 mmol/L, P = 0.0003). Plasma levels of IL-6, IL-10, and intercellular adhesion molecule-1 were higher after CPB in the albumin-based priming group compared with the HES priming group at all time periods (P = 0.0002). Urinary concentrations of α-glutathione *S*-transferase and neutrophil gelatinase-associated lipocalin were higher after CPB through the end of the study in the albumin group compared with the balanced HES group (P = 0.00004). After surgery through the first postoperative day, thrombelastometry data (clotting time and clot formation time) revealed more impaired coagulation in the albumin-based priming group compared with the HES priming group (P = 0.004). Compared with baseline, platelet function was unchanged in the high-dose balanced HES priming group after CPB and 5 h after surgery, but it was significantly reduced in the albumin-based priming group.

CONCLUSION: High-volume priming of the CPB circuit with a modern balanced HES solution resulted in reduced inflammation, less endothelial damage, and fewer alterations in renal tubular integrity compared with an albumin-based priming. Coagulation including platelet function was better preserved with high-dose balanced HES CPB priming compared with albumin-based CPB priming.

(Anesth Analg 2009;109:1752–62)

Association of Hydroxyethyl Starch Administration With Mortality and Acute Kidney Injury in Critically Ill Patients Requiring Volume Resuscitation

A Systematic Review and Meta-analysis

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Importance Hydroxyethyl starch is commonly used for volume resuscitation yet has been associated with serious adverse events, including acute kidney injury and death. Clinical trials of hydroxyethyl starch are conflicting. Moreover, multiple trials from one investigator have been retracted because of scientific misconduct.

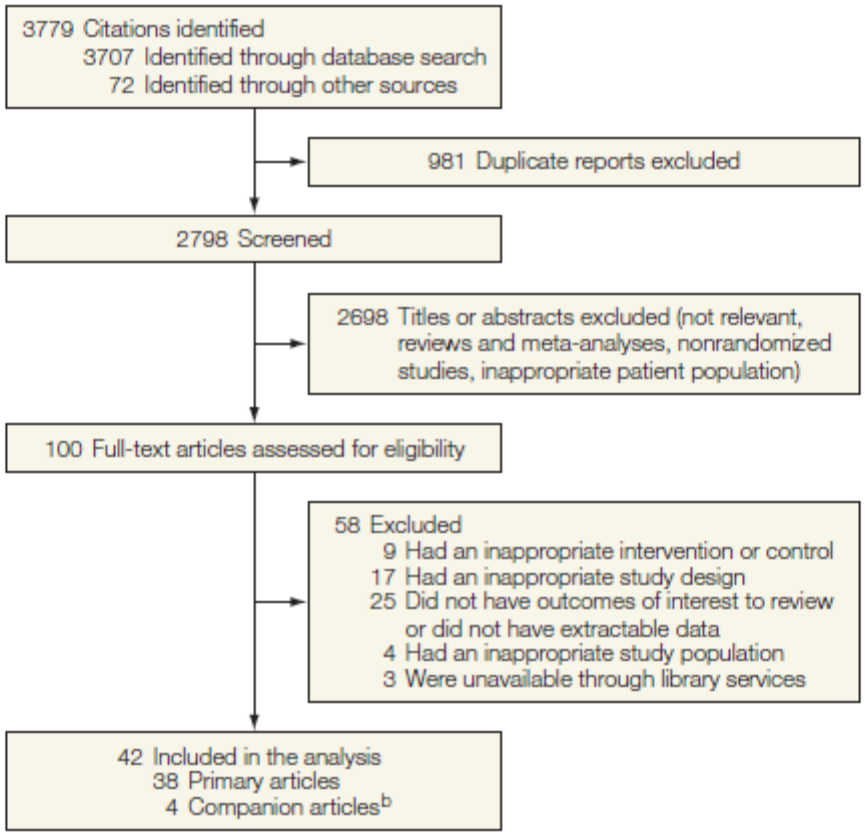
Objectives To evaluate the association of hydroxyethyl starch use with mortality and acute kidney injury.

Data Sources Randomized controlled trials from MEDLINE, EMBASE, CENTRAL, Global Health, HealthStar, Scopus, Web of Science, the International Clinical Trials Registry Platform (inception to October 2012), reference lists of relevant articles, and gray literature.

FLUIDS ARE A CORE ELEMENT IN

JAMA. 2013;309(7):678-688

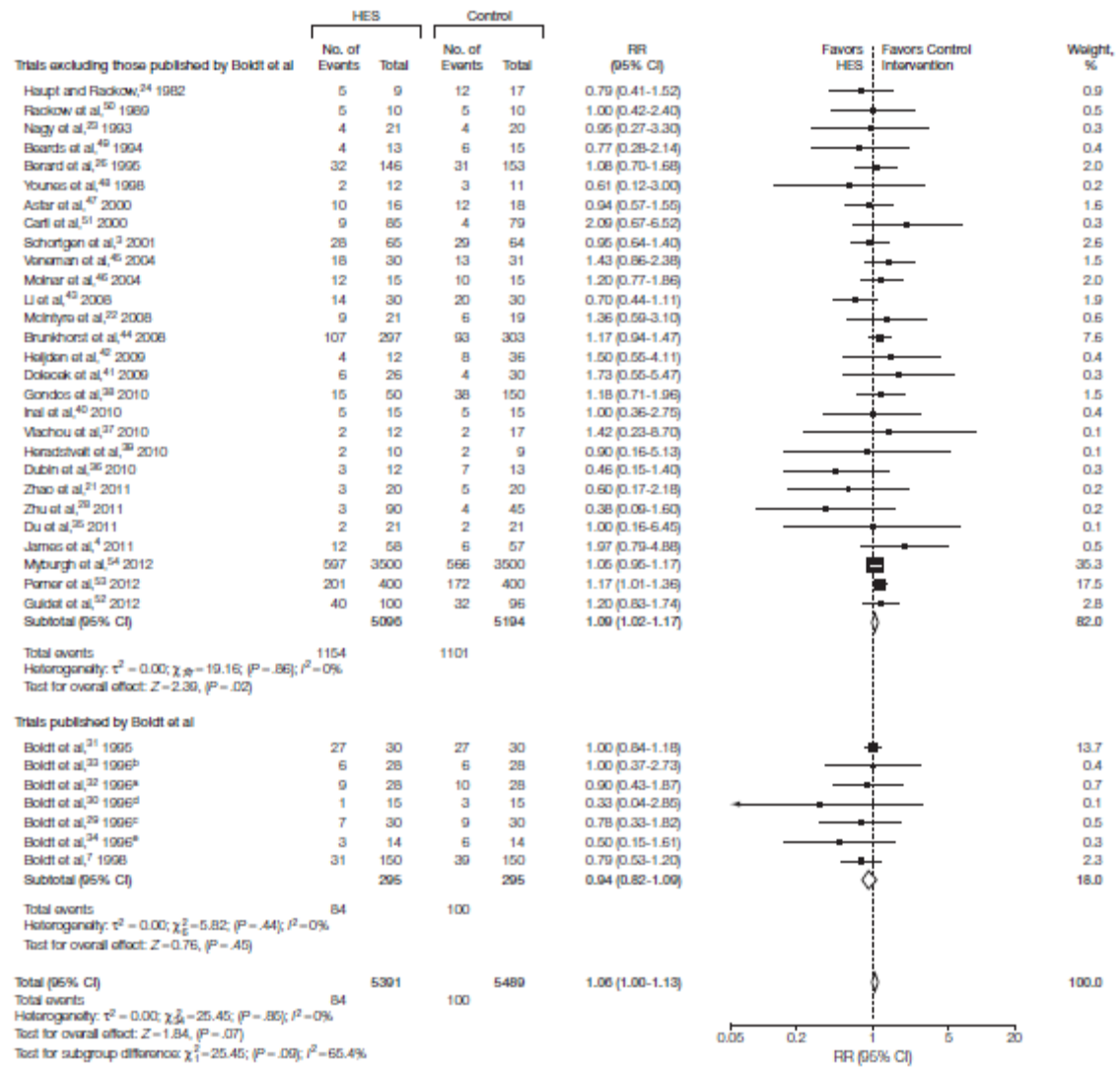
Figure 1. Study Flow Diagram[a]



[a] This flow diagram follows the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA)[14] with modifications.

[b] Companion articles represent reports of previously published analyses involving the same study population.

Figure 2. Mortality and Hydroxyethyl Starch



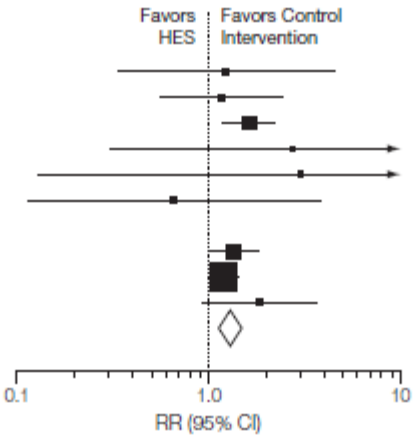
The varying sizes of the boxes represent the weight in the analysis. HES indicates hydroxyethyl starch. Risk ratios (RRs) are derived by a random-effects model using Mantel-Haenszel tests.

Figure 3. Renal Replacement Therapy and Hydroxyethyl Starch

Source	HES No. of Events	HES Total	Control No. of Events	Control Total	RR (95% CI)	Weight, %
Berard et al,[26] 1995	5	155	4	152	1.23 (0.34-4.48)	1.0
Schortgen et al,[3] 2001	13	65	11	64	1.16 (0.56-2.40)	3.3
Brunkhorst et al,[44] 2008	81	297	51	303	1.62 (1.19-2.21)	18.0
McIntyre et al,[22] 2008	3	21	1	19	2.71 (0.31-23.93)	0.4
Du et al,[35] 2011	1	21	0	21	3.00 (0.13-69.70)	0.2
James et al,[4] 2011	2	58	3	57	0.66 (0.11-3.78)	0.6
Viachou et al,[37] 2010	0	12	0	17	Not estimable	
Perner al,[53] 2012	87	400	65	400	1.34 (1.00-1.79)	20.8
Myburgh et al,[54] 2012	235	3500	196	3500	1.20 (1.00-1.44)	51.8
Guidet et al,[52] 2012	21	100	11	96	1.83 (0.93-3.59)	3.9
Total (95% CI)		**4629**		**4629**	**1.32 (1.15-1.50)**	**100.00**
Total events	448		342			

Heterogeneity: $\tau^2 = 0.00$; $\chi^2_8 = 5.07$; ($P = .75$); $I^2 = 0\%$

Test for overall effect: $Z = 4.08$, ($P < .001$)



The varying sizes of the boxes represent the weight in the analysis. HES indicates hydroxyethyl starch. Risk ratios (RRs) are derived by a random-effects model using Mantel-Haenszel tests.

EDITORIAL

Hydroxyethyl Starch for Intravenous Volume Replacement

More Harm Than Benefit

Massimo Antonelli, MD

Claudio Sandroni, MD

In addition, this meta-analysis[4] included 3 additional randomized trials published in 2012—the Crystalloid Versus Hydroxyethyl Starch Trials (CHEST),[2] the Scandinavian

ORIGINAL ARTICLE

Albumin Replacement in Patients with Severe Sepsis or Septic Shock

Pietro Caironi, M.D., Gianni Tognoni, M.D., Serge Masson, Ph.D., Roberto Fumagalli, M.D., Antonio Pesenti, M.D., Marilena Romero, Ph.D., Caterina Fanizza, M.Stat., Luisa Caspani, M.D., Stefano Faenza, M.D., Giacomo Grasselli, M.D., Gaetano Iapichino, M.D., Massimo Antonelli, M.D., Vieri Parrini, M.D., Gilberto Fiore, M.D., Roberto Latini, M.D., and Luciano Gattinoni, M.D., for the ALBIOS Study Investigators*

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ABSTRACT

BACKGROUND

Although previous studies have suggested the potential advantages of albumin administration in patients with severe sepsis, its efficacy has not been fully established.

N Engl J Med 2014;370:1412-21.
DOI: 10.1056/NEJMoa1305727

Table 1. Characteristics of the Patients at Baseline.*

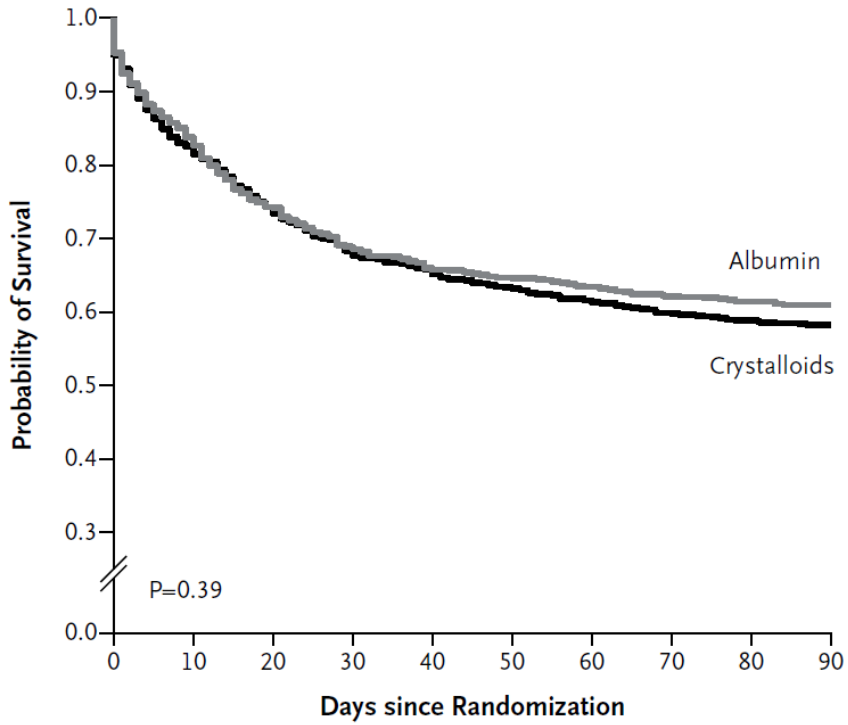
Characteristic	Albumin Group (N = 903)	Crystalloid Group (N = 907)
Age — yr		
Median	70	69
Interquartile range	57–77	59–77
Female sex — no. (%)	360 (39.9)	357 (39.4)
Body-mass index†	27±6	27±6
Reason for ICU admission — no. (%)		
Medical	511 (56.6)	518 (57.1)
Elective surgery	69 (7.6)	58 (6.4)
Emergency surgery	323 (35.8)	331 (36.5)
Preexisting condition — no. (%)‡		
Liver disease	13 (1.4)	14 (1.5)
COPD	113 (12.5)	108 (11.9)
Chronic renal failure	44 (4.9)	32 (3.5)
Immunodeficiency	115 (12.7)	128 (14.1)
Congestive or ischemic heart disease	149 (16.5)	165 (18.2)
SAPS II score§		
Median	48	48
Interquartile range	37–59	37–60

Table 2. Outcomes.

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)		
SOFA score†			—	0.23
Median	6.00	5.62		
Interquartile range	4.00–8.50	3.92–8.28		
SOFA subscore†				
Cardiovascular			—	0.03
Median	1.20	1.42		
Interquartile range	0.46–2.31	0.60–2.50		
Respiratory			—	0.63
Median	2.00	2.00		
Interquartile range	1.56–2.48	1.57–2.50		
Renal			—	0.15
Median	0.83	0.75		
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	4–17		
In hospital‡			—	0.65
Median	20	20		
Interquartile range	10–36	9–38		

Table 2. (Continued.)

Outcome	Albumin Group	Crystalloid Group	Relative Risk (95% CI)	P Value
Tertiary outcomes§				
Renal-replacement therapy — no./total no. (%)¶	222/903 (24.6)	194/907 (21.4)		0.11
Acute kidney injury — no./total no. (%)‖	183/834 (21.9)	190/837 (22.7)		0.71
Duration of mechanical ventilation — days**			—	0.50
Median	6	6		
Interquartile range	2–14	2–13		
Time to suspension of vasopressor or inotropic agents — days††			—	0.007
Median	3	4		
Interquartile range	1–6	2–7		



No. at Risk

Albumin	903	733	647	597	567	556	545	535	529	523
Crystalloids	907	729	652	598	676	551	538	521	511	504

Figure 2. Probability of Survival from Randomization through Day 90.

The graph shows the Kaplan–Meier estimates for the probability of survival among patients receiving albumin and crystalloids and among those receiving crystalloids alone. The P value was calculated with the use of the log-rank test.

Conclusions

Les solutions recommandées sont:

- Cristalloïdes
- Gélatines (à éviter en cas de risque ou présence d'insuffisance rénale)

Les amidons ne doivent plus être utilisés.

Les catécholamines

TABLEAU 5

Principales catécholamines adrénergiques actuellement utilisées au cours du choc

Récepteur adrénergique	Site anatomique principal	Effet physiologique de la stimulation	Effets cliniques favorables (bénéfices)	Effets cliniques péjoratifs (risques)	Catécholamine agoniste
Alpha	▮ Vaisseaux	▮ Vasoconstriction	▮ ↗ RVS et PA	▮ Ischémie viscérale ou périphérique	▮ Noradrénaline ▮ Adrénaline
Bêta	▮ Cœur	▮ Inotrope (contractilité) ▮ Chronotrope (fréquence) ▮ Dromotrope (conduction) ▮ Bathmotrope (excitabilité) ▮ Lusitrope (relaxation)	▮ ↗ DC ± PA	▮ Ischémie myocardique	▮ Dobutamine ▮ Adrénaline

RVS : résistances vasculaires systémiques ; PA : pression artérielle ; DC : débit cardiaque.

Les agents sympathomimétiques

récepteur	***α***	***β1***	***β2***	***δ***
effet	vasoconstricteur	inotrope	vasodilatateur	splanchnique
dopamine ***µg/kg/min***	++ (>15)	+++ (2,5 à 10)	++ (id)	+++ (< 5)
dobutamine ***µg/kg/min***	+/-	+++ (5 à 10)	+	-
adrénaline ***µg/min***	++ (>20)	++ (1-4)	++ (id)	
noradrénaline ***µg/kg/min***	+++ (0,02 à 0,1)	+		

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MARCH 4, 2010 VOL. 362 NO. 9

Comparison of Dopamine and Norepinephrine in the Treatment of Shock

Daniel De Backer, M.D., Ph.D., Patrick Biston, M.D., Jacques Devriendt, M.D., Christian Madl, M.D., Didier Chochrad, M.D., Cesar Aldecoa, M.D., Alexandre Brasseur, M.D., Pierre Defrance, M.D., Philippe Gottignies, M.D., and Jean-Louis Vincent, M.D., Ph.D., for the SOAP II Investigators*

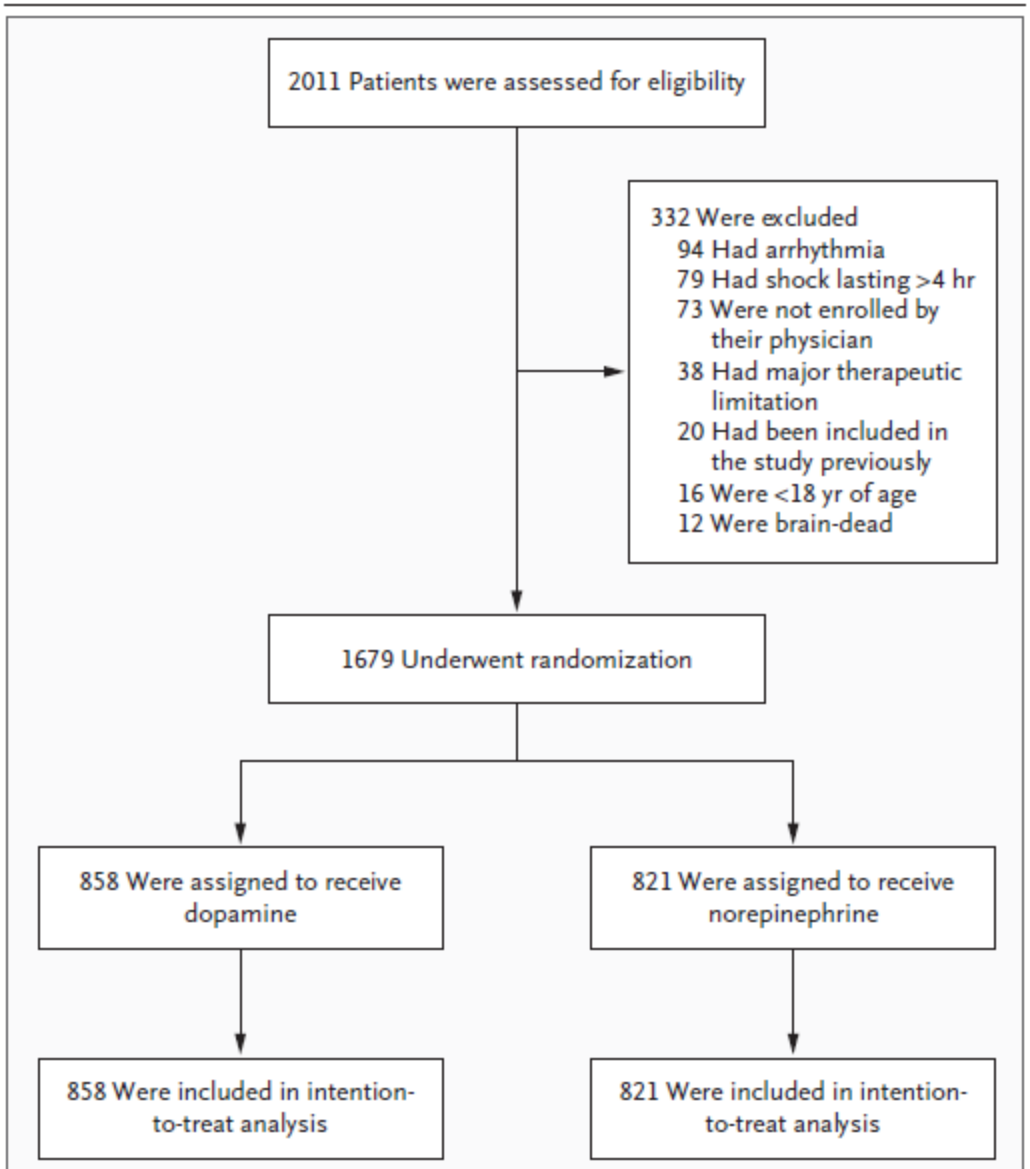
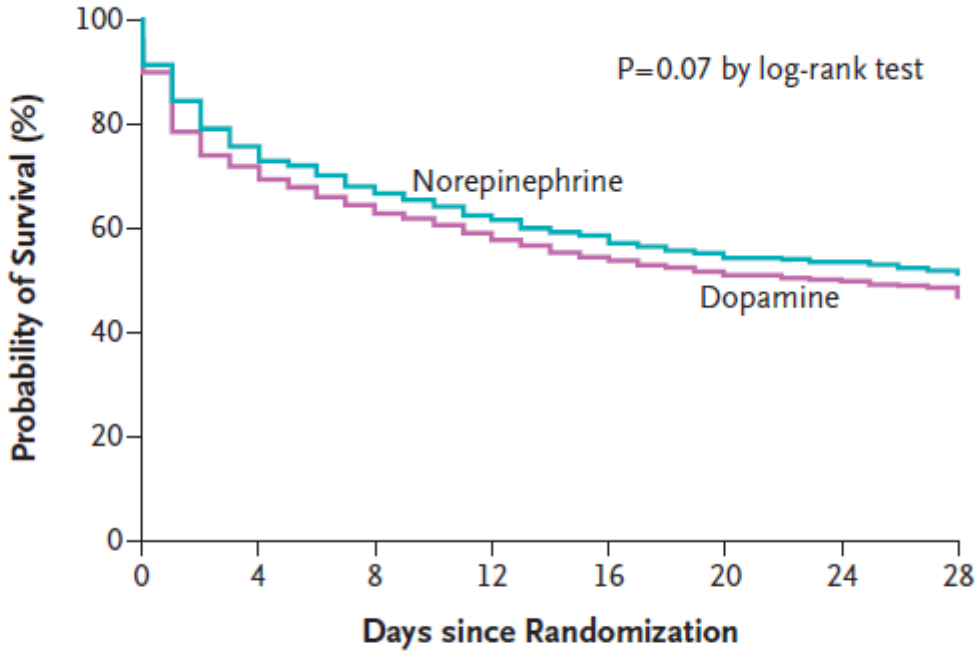


Figure 1. Screening and Enrollment.

Table 2. Mortality Rates.*

Time Period	Dopamine	Norepinephrine	Odds Ratio (95% CI)†	P Value
	percent mortality			
During stay in intensive care unit	50.2	45.9	1.19 (0.98–1.44)	0.07
During hospital stay	59.4	56.6	1.12 (0.92–1.37)	0.24
At 28 days	52.5	48.5	1.17 (0.97–1.42)	0.10
At 6 mo	63.8	62.9	1.06 (0.86–1.31)	0.71
At 12 mo	65.9	63.0	1.15 (0.91–1.46)	0.34

* Data were available for 1656 patients in the intensive care unit, in the hospital, and at 28 days; for 1443 patients at 6 months; and for 1036 patients at 12 months.
† Odds ratios for death are for the comparison of the dopamine group with the norepinephrine group.



No. at Risk								
Norepinephrine	821	617	553	504	467	432	412	394
Dopamine	858	611	546	494	452	426	407	386

Figure 2. Kaplan–Meier Curves for 28-Day Survival in the Intention-to-Treat Population.

Table 1. Baseline Characteristics of the Patients and Major Therapeutic Interventions at Baseline.*

Variable	Dopamine (N = 858)	Norepinephrine (N = 821)
Age — yr		
Median	68	67
Interquartile range	55–76	56–76
Male sex — no. (%)	507 (59.1)	449 (54.7)
APACHE II score†		
Median	20	20
Interquartile range	15–28	14–27
SOFA score‡		
Median	9	9
Interquartile range	7–12	6–12
Reason for admission — no. (%)		
Medical	565 (65.9)	532 (64.8)
Scheduled surgery	168 (19.6)	161 (19.6)
Emergency surgery	125 (14.6)	128 (15.6)
Cause of shock — no. (%)		
Sepsis	542 (63.2)	502 (61.1)
Lungs	278 (32.4)	246 (30.0)
Abdomen	138 (16.1)	135 (16.4)
Urine	51 (5.9)	42 (5.1)
Catheter	14 (1.6)	10 (1.2)
Endocardium	9 (1.0)	11 (1.3)
Mediastinum	10 (1.2)	15 (1.8)
Soft tissues	11 (1.3)	13 (1.6)
Other	15 (1.7)	20 (2.4)
Cardiogenic source	135 (15.7)	145 (17.6)
Myocardial infarction	75 (8.7)	86 (10.5)
Dilated cardiomyopathy	25 (2.9)	19 (2.3)
Tamponade	2 (0.2)	7 (0.9)
Pulmonary embolism	10 (1.2)	8 (1.0)
Valvular disease	4 (0.5)	5 (0.6)
After cardiopulmonary bypass	19 (2.2)	20 (2.4)
Other		
Hypovolemia	138 (16.1)	125 (15.2)
Hemorrhage	130 (15.2)	116 (14.1)
Trauma	17 (2.0)	23 (2.8)
Gastrointestinal bleeding	31 (3.6)	22 (2.7)
Bleeding at surgical site	64 (7.5)	57 (6.9)
Other	18 (2.1)	14 (1.7)
Dehydration	8 (0.9)	9 (1.1)
Other	48 (5.9)	44 (5.0)
Spinal	6 (0.7)	8 (1.0)
Peridural§	13 (1.5)	4 (0.5)
Intoxication-related¶	7 (0.8)	4 (0.5)
Anaphylactic	3 (0.3)	4 (0.5)
Miscellaneous	13 (1.5)	29 (3.5)
Hemodynamic, respiratory, and biologic variables		

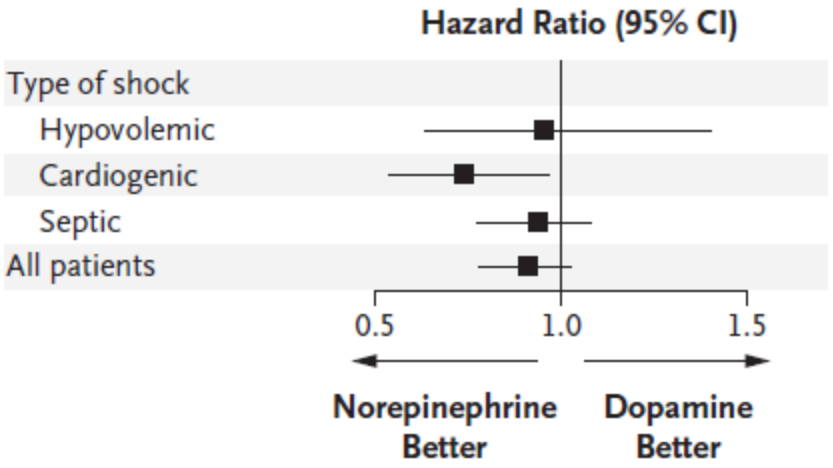


Figure 3. Forest Plot for Predefined Subgroup Analysis According to Type of Shock.

A total of 1044 patients were in septic shock (542 in the dopamine group and 502 in the norepinephrine group), 280 were in cardiogenic shock (135 in the dopamine group and 145 in the norepinephrine group), and 263 were in hypovolemic shock (138 in the dopamine group and 125 in the norepinephrine group). The P value for interaction was 0.87.

Dopamine versus norepinephrine in the treatment of septic shock: A meta-analysis*

Daniel De Backer, MD, PhD; Cesar Aldecoa, MD; Hassane Njimi, MSc, PhD; Jean-Louis Vincent, MD, PhD, FCCM

Objectives: There has long-been controversy about the possible superiority of norepinephrine compared to dopamine in the treatment of shock. The objective was to evaluate the effects of norepinephrine and dopamine on outcome and adverse events in patients with septic shock.

Data Sources: A systematic search of the MEDLINE, Embase, Scopus, and CENTRAL databases, and of Google Scholar, up to June 30, 2011.

Study Selection and Data Extraction: All studies providing information on the outcome of patients with septic shock treated with dopamine compared to norepinephrine were included. Observational and randomized trials were analyzed separately. Because time of outcome assessment varied among trials, we evaluated 28-day mortality or closest estimate. Heterogeneity among trials was assessed using the Cochrane Q homogeneity test. A Forest plot was constructed and the aggregate relative risk of death was computed. Potential publication bias was evaluated using funnel plots.

Methods and Main Results: We retrieved five observational (1,360 patients) and six randomized (1,408 patients) trials, totaling 2,768 patients (1,474 who received norepinephrine and 1,294 who received dopamine). In observational studies, among which there was significant heterogeneity ($p < .001$), there was no difference in mortality (relative risk, 1.09; confidence interval, 0.84–1.41; $p = .72$). A sensitivity analysis identified one trial as being responsible for the heterogeneity; after exclusion of that trial, no heterogeneity was observed and dopamine administration was associated with an increased risk of death (relative risk, 1.23; confidence interval, 1.05–1.43; $p < .01$). In randomized trials, for which no heterogeneity or publication bias was detected ($p = .77$), dopamine was associated with an increased risk of death (relative risk, 1.12; confidence interval, 1.01–1.20; $p = .035$). In the two trials that reported arrhythmias, these were more frequent with dopamine than with norepinephrine (relative risk, 2.34; confidence interval, 1.46–3.77; $p = .001$).

Conclusions: In patients with septic shock, dopamine administration is associated with greater mortality and a higher incidence of arrhythmic events compared to norepinephrine administration. (Crit Care Med 2012; 40:725–730)

KEY WORDS: adrenergic agents; adverse effects; mortality; outcome; vasopressor

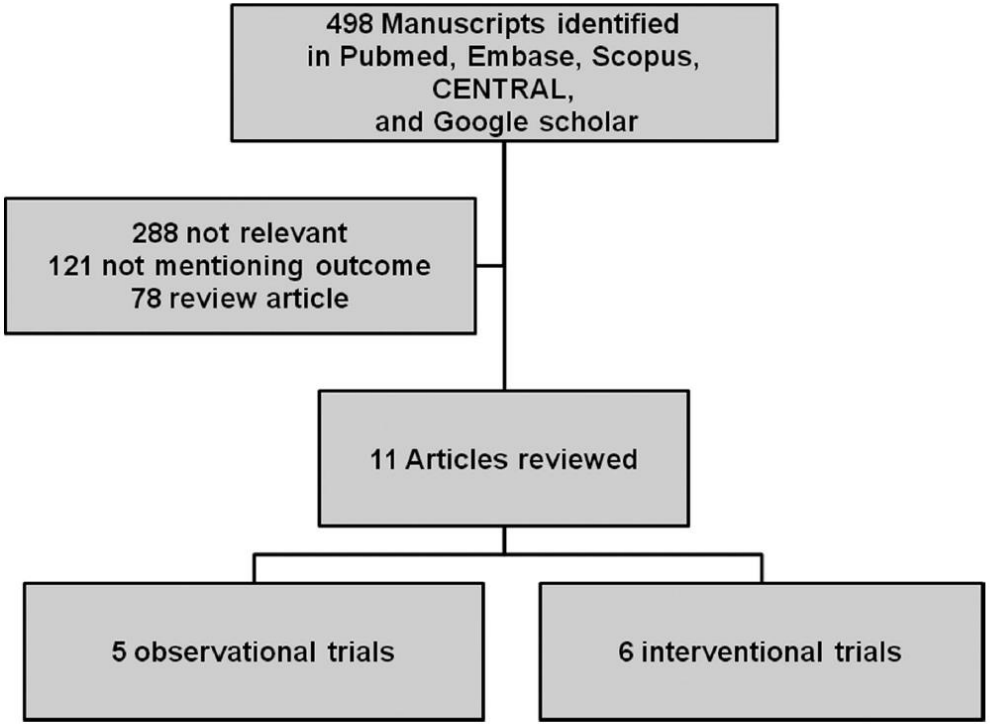


Figure 1. Flow chart of systematic search.

Table 2. Characteristics of interventional studies

	Martin (1993) (27)	Marik (1994) (30)	Ruokonen (2003) (29)	Mathur (2007) (25)	De Backer (2010) (15)	Patel (2010) (16)
Dopamine, n	16	10	5	25	542	134
Norepinephrine, n	16	10	5	25	502	118
Exposure time	Weaning or dead	3 hrs	3 hrs	6 hrs	Maximum 28 days	Maximum 28 days
Type of patients	Sepsis	Sepsis	Sepsis	Sepsis	Sepsis[a]	Sepsis
Mortality rate	Hospital	Not defined	Not defined	Not defined	28 day[b]	28 day
Cochrane risk of bias in included studies						
Concealment on allocation	No	Yes	No	No	Yes	Yes (odd or even)
Inclusion/exclusion	Yes	Yes	Yes	Yes	Yes	Yes
Patient description	No	No	No	No	Yes	Yes
Similar care	Yes	Yes	No	Yes	Yes	Yes
Blinding of caregivers	No	No	No	No	Yes	No
Blinding of assessors	No	No	No	No	Yes	No
Intention to treat	Yes	Yes	Yes	Yes	Yes	Yes
Free from selective reporting	Yes				Yes	Yes
Risk of bias for secondary outcomes assessment in included studies						
Adverse events						
Defined	No	No	No	No	No	Yes
Assessed	No	No	No	No	No	Yes
Time of assessment	No	No	No	No	No	Yes
Organ function						
Defined	No	No	No	No	Yes	Yes
Assessed	No	No	No	No	Yes	Yes
Time of assessment	No	No	No	No	Yes	Yes

[a]In this trial, patients with other sources of shock were also included. The intention-to-treat analysis covers the whole population of 1679 patients included in the trial. The authors extracted data of patients with sepsis only for this analysis. Other trials only included patients with sepsis; [b]in this trial, 28-day mortality was the primary outcome, intensive care unit, hospital, and 6-month and 12-month mortality were also provided.

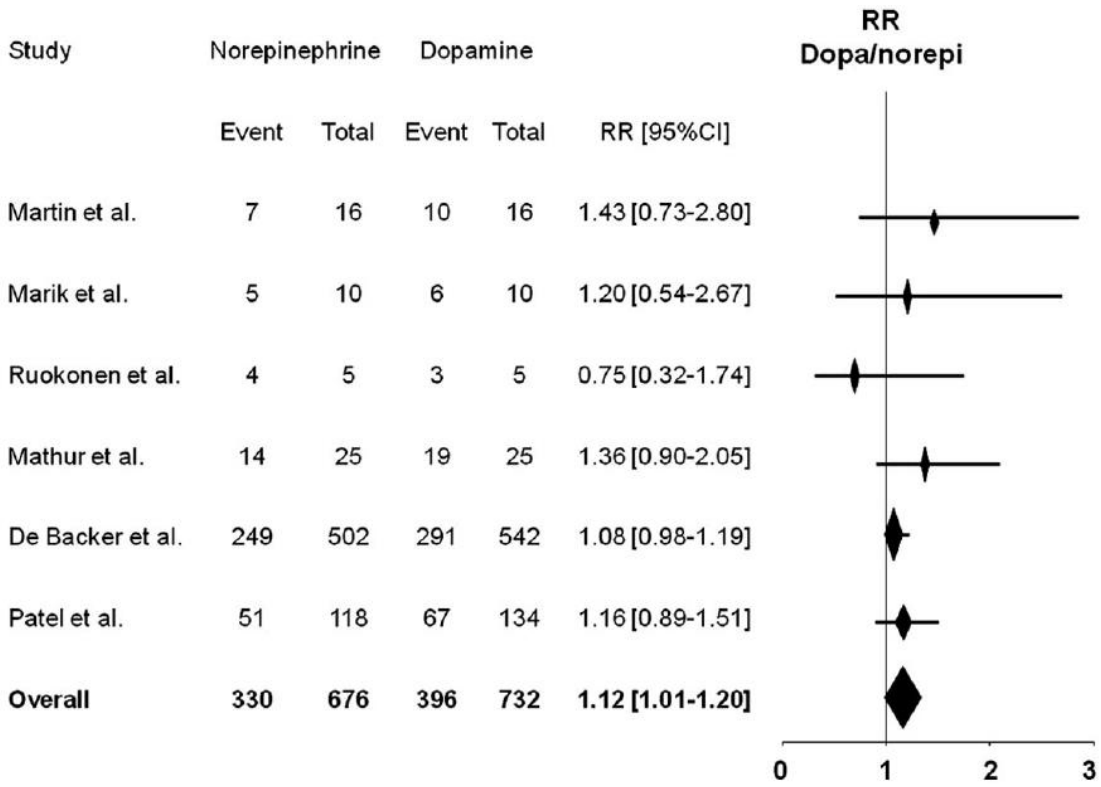


Figure 3. Forest plot of risk ratio (*RR*) of death (28 days or nearest estimate) in interventional trials. The *p* value for aggregate RR of dopamine (*dopa*) compared to norepinephrine (*norepi*) in interventional studies was .035. Relative weights of the different trials in the analysis: Martin et al (27) 2%; Marik et al (30) 1%; Ruokonen et al (29) 1%; Mathur et al (25) 4%; De Backer et al (15) 81%; and Patel et al (16) 10%. No heterogeneity was observed ($p = .77$; $I^2 = 0$; confidence interval, 0%–25%).

Diminuer la demande en oxygène

A. Ventilation artificielle (travail respiratoire)

B. Sédatifs et narcotiques

C. Réduire les stimulations adrénergiques

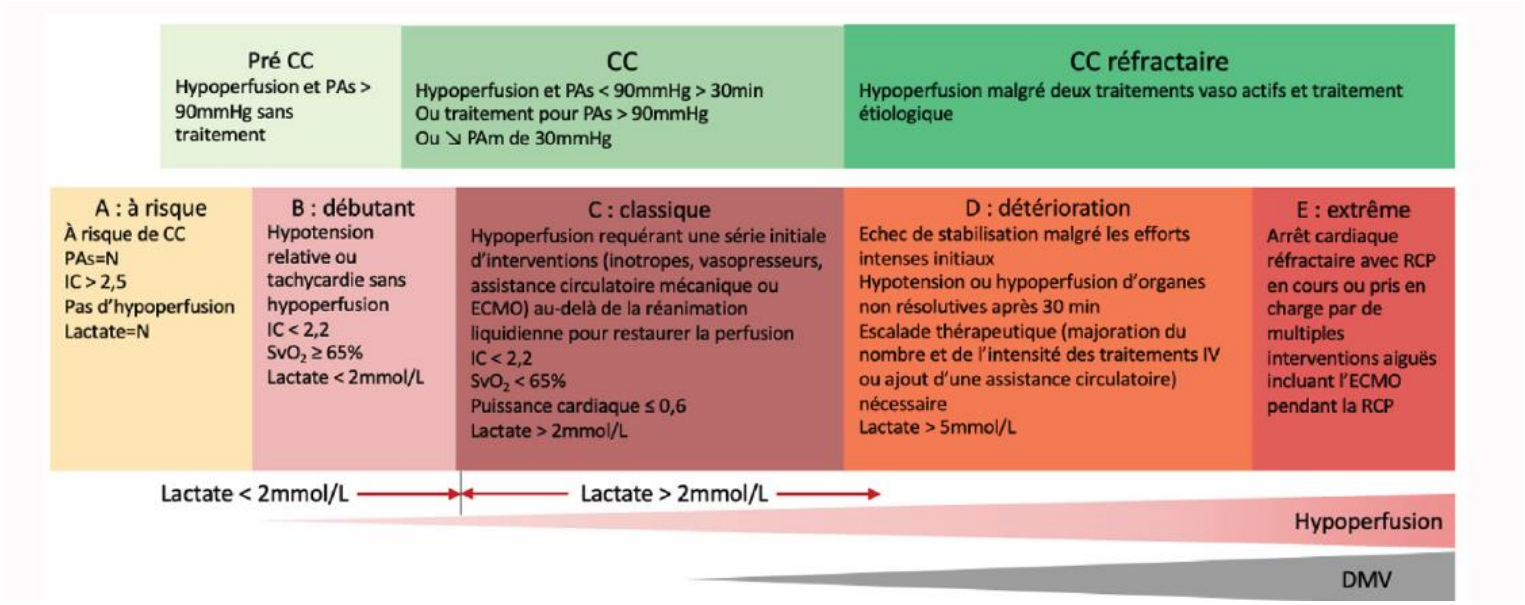
Combattre l'anurie

- remplissage vasculaire : en évitant l'Elohes^{R} (Lancet 2001)
- dopamine à dose rénale: abandonné (Lancet 2000)
- furosémide pour relancer diurèse : à éviter (JAMA 2002)

Traitement étiologique: exemples

- Choc septique : antibiothérapie empirique
- Tamponnade péricardique
- Choc hémorragique
  - Corriger troubles de coagulation
- Choc anaphylactique
- Choc cardiogénique
  - Reperfusion coronaire
- Tachyarythmies

Choc cardiogénique



Méd. Intensive Réa. 31(3):203-216
DOI : 10.37051/mir-00106

Tableau 2 - Mécanismes et étiologies du choc cardiogénique

Mécanisme	Étiologie
Atteinte du myocarde	• Infarctus du myocarde et ses complications (rupture papillaire, septale) • Myocardite • Cardiopathie de stress • Cardiopathie du post-partum • Décompensation aiguë sur insuffisance cardiaque chronique • Post cardiotomie • Post ressuscitation d'un arrêt cardiaque • Cardiomyopathie septique • Contusion myocardique
Valvulaire	• Endocardite • Rupture du pilier, cordage post infarctus du myocarde • Complication valvulaire post opératoire chirurgie cardiaque • Dissection aortique

Rythmique	• Tachycardies supraventriculaires et ventriculaires • Cardiomyopathie rythmique • Bradyarythmies
Obstructive	• Tamponnade péricardique • Pneumothorax compressif • Embolie pulmonaire
Toxique	• Intoxication aux cardiotropes (bétabloquant, inhibiteur calcique...) • Digitaliques • Médicaments à effet stabilisateur de membrane • Cocaïne • Chimiothérapies cardiotoxiques

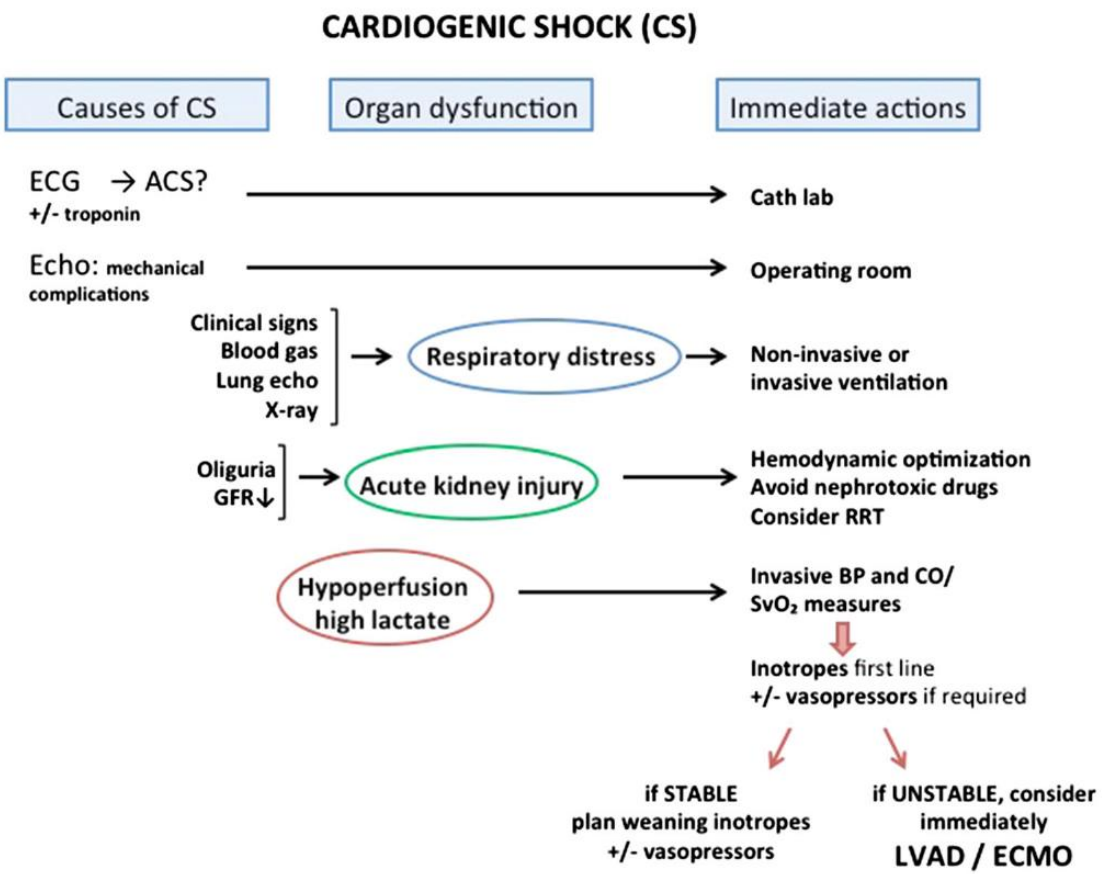


Fig. 2 Treatment schema for patients with cardiogenic shock. *ECG* electrocardiogram, *echo* echocardiography, *ACS* acute coronary syndrome, *cath lab* cardiac catheterization laboratory, *BP* blood pressure, *CO* cardiac output, SvO_2 mixed venous oxygen saturation, *LVAD* left ventricular assist device, *ECMO* extracorporeal membrane oxygenation

Intensive Care Med (2016) 42:147–163
DOI 10.1007/s00134-015-4041-5

Choc anaphylactique

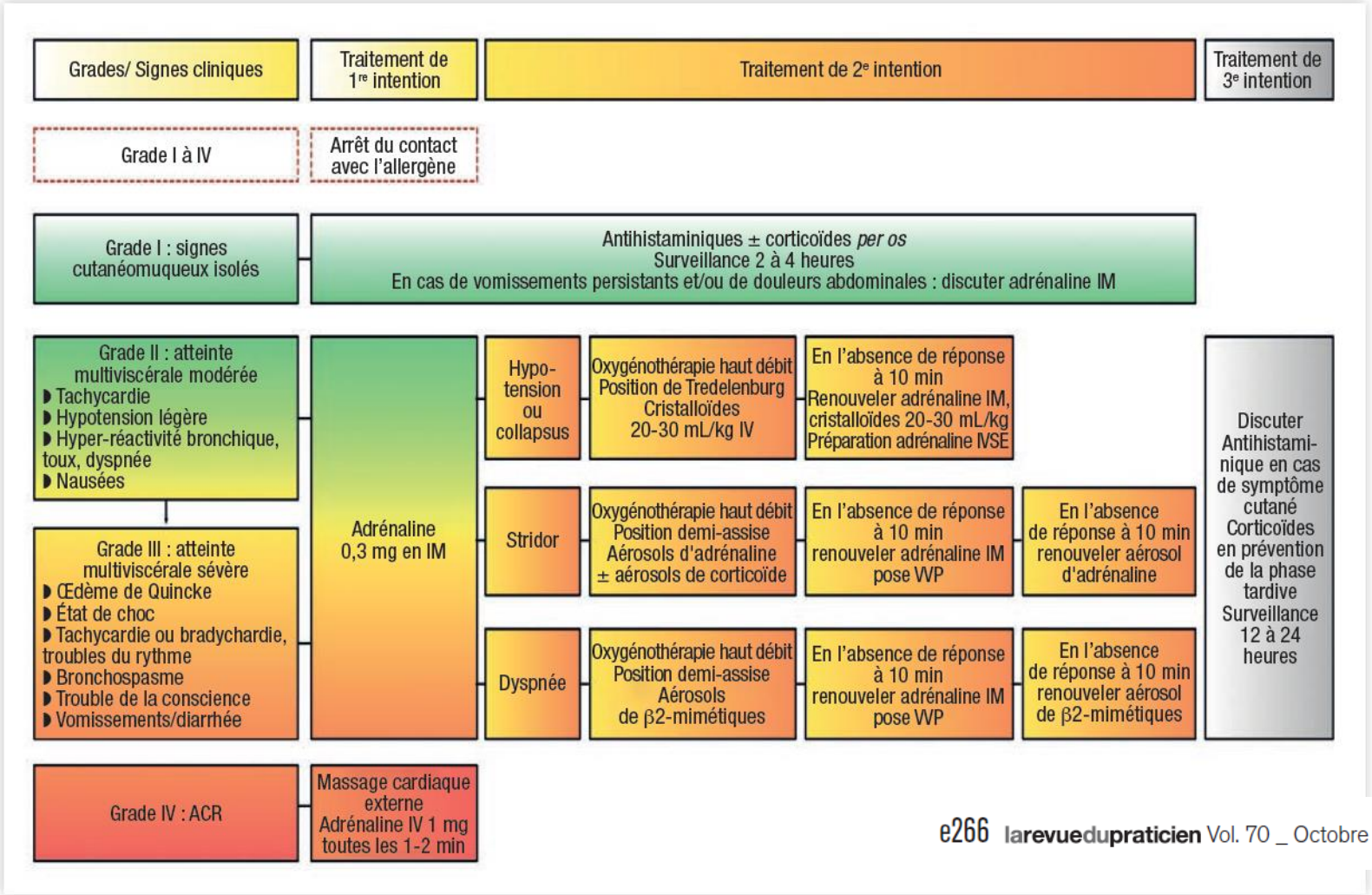


FIGURE 1 Prise en charge thérapeutique d'une anaphylaxie en fonction du grade de la réaction[29].

ACR : arrêt cardiorespiratoire ; IM : intramusculaire ; IV : intraveineux ; IVSE : intraveineux en seringue électrique ; VVP : voie veineuse périphérique ; mg : milligramme.