Place de la SvO2 dans la prise en charge des états de choc ?

LAZKANI Ali

Tuteur : Pr FAVORY

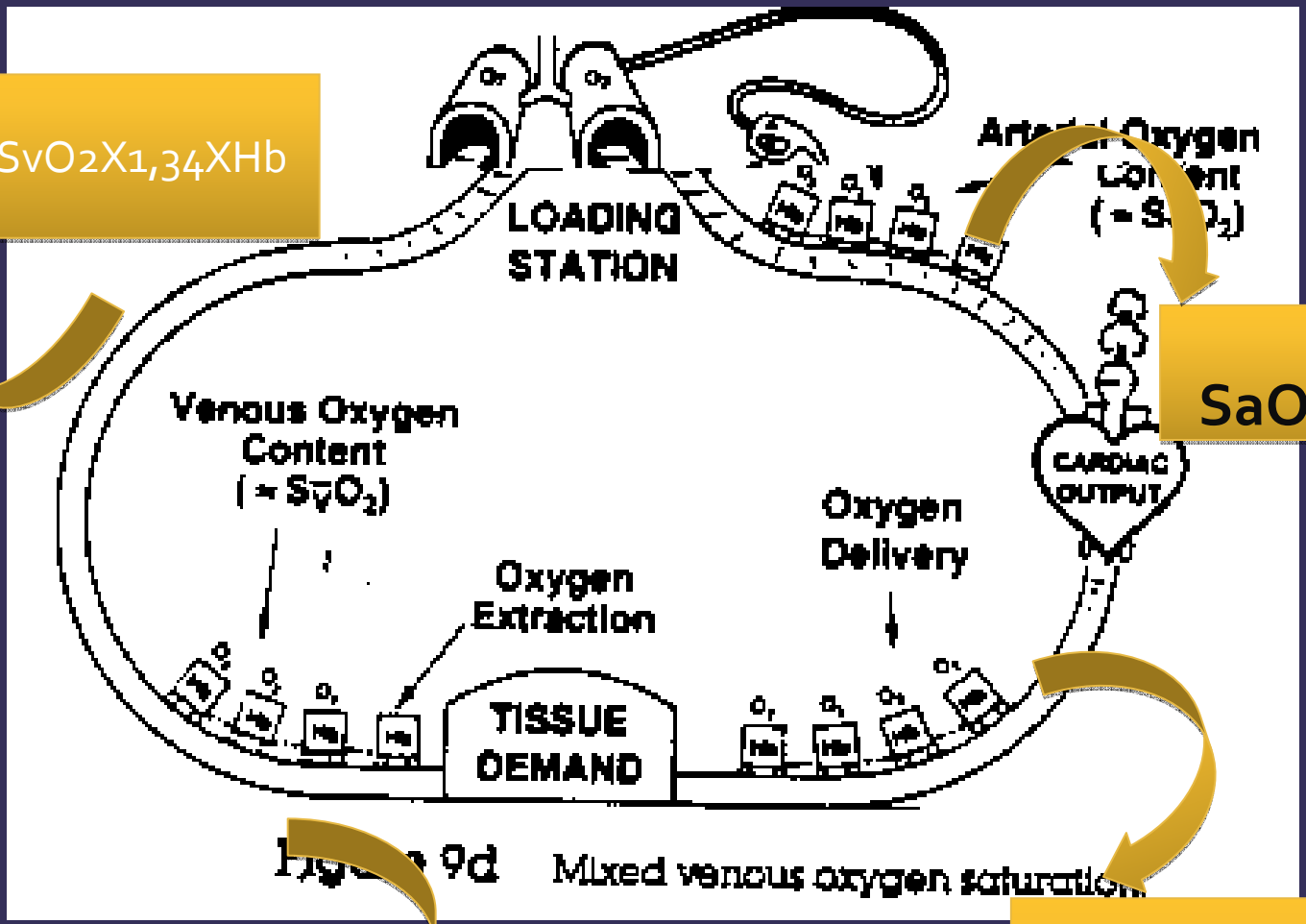
DESC réanimation médicale – Lillle -

SvO_2

- La saturation veineuse en oxygène représente la saturation d'un mélange de sang veineux provenant de la VCI , VCS , et le sinus coronaire.
- Mesurée idéalement au niveau de l'artère pulmonaire

Déterminants de la SvO2

$CvO_2 = SvO_2 X 1,34 X Hb$



$CaO_2 = SaO_2 X 1,34 x Hb$

$TaO_2 = DC \times CaO_2$

$EO_2 = VO_2 / TaO_2$

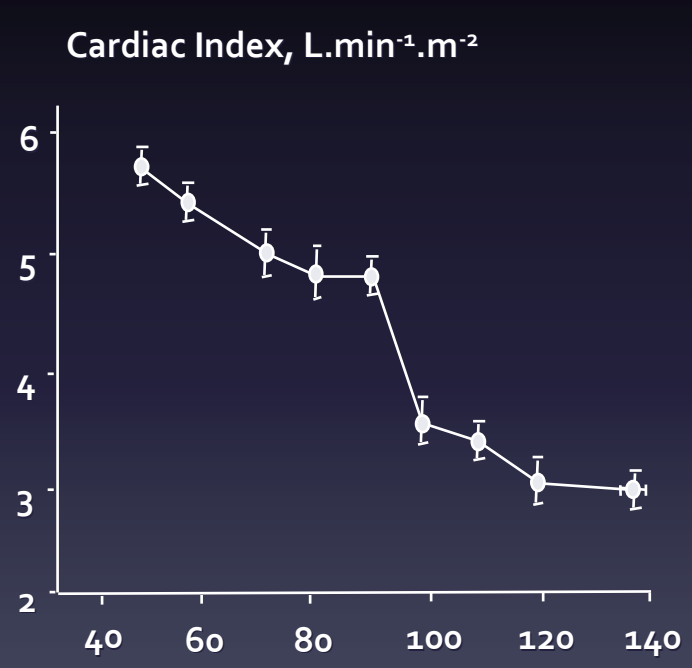
Déterminants de la SVO_2

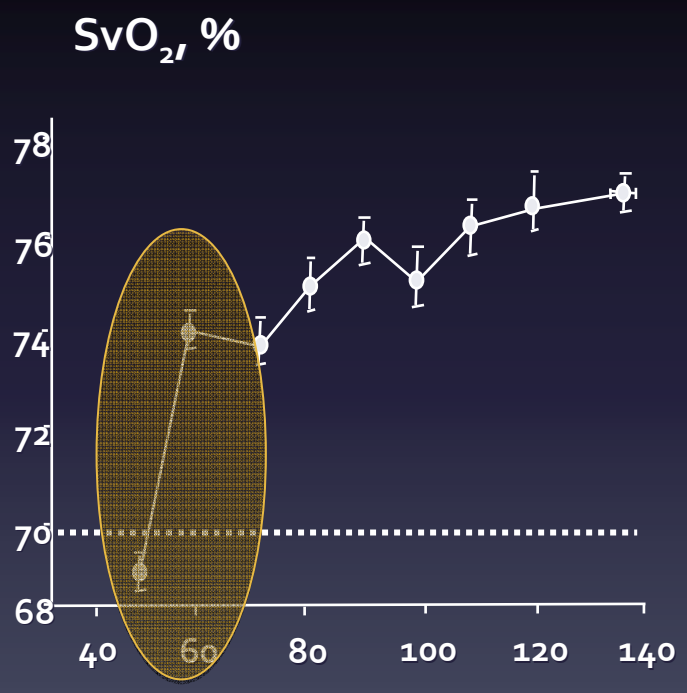
$EO_2 = 1 - SvO_2$

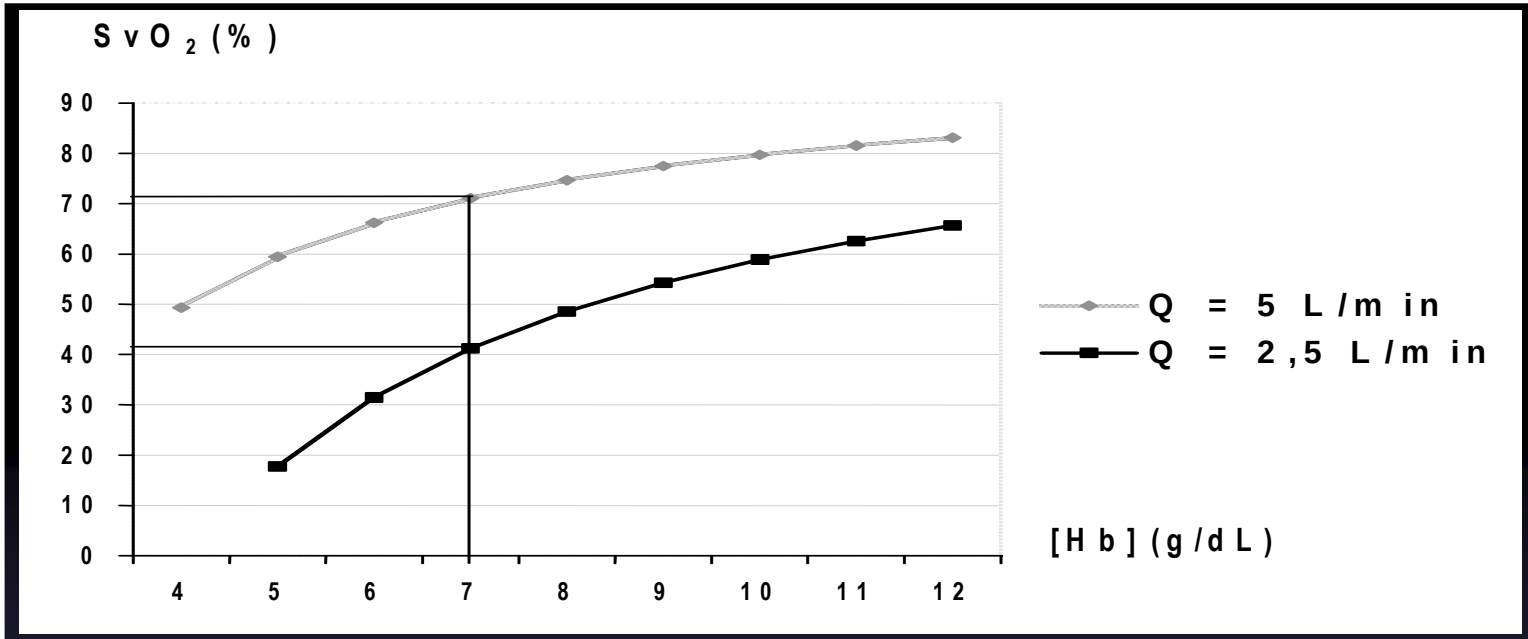
$$SvO_2 = SaO_2 - \frac{VO_2}{DC \times 1,34 \times Hb}$$

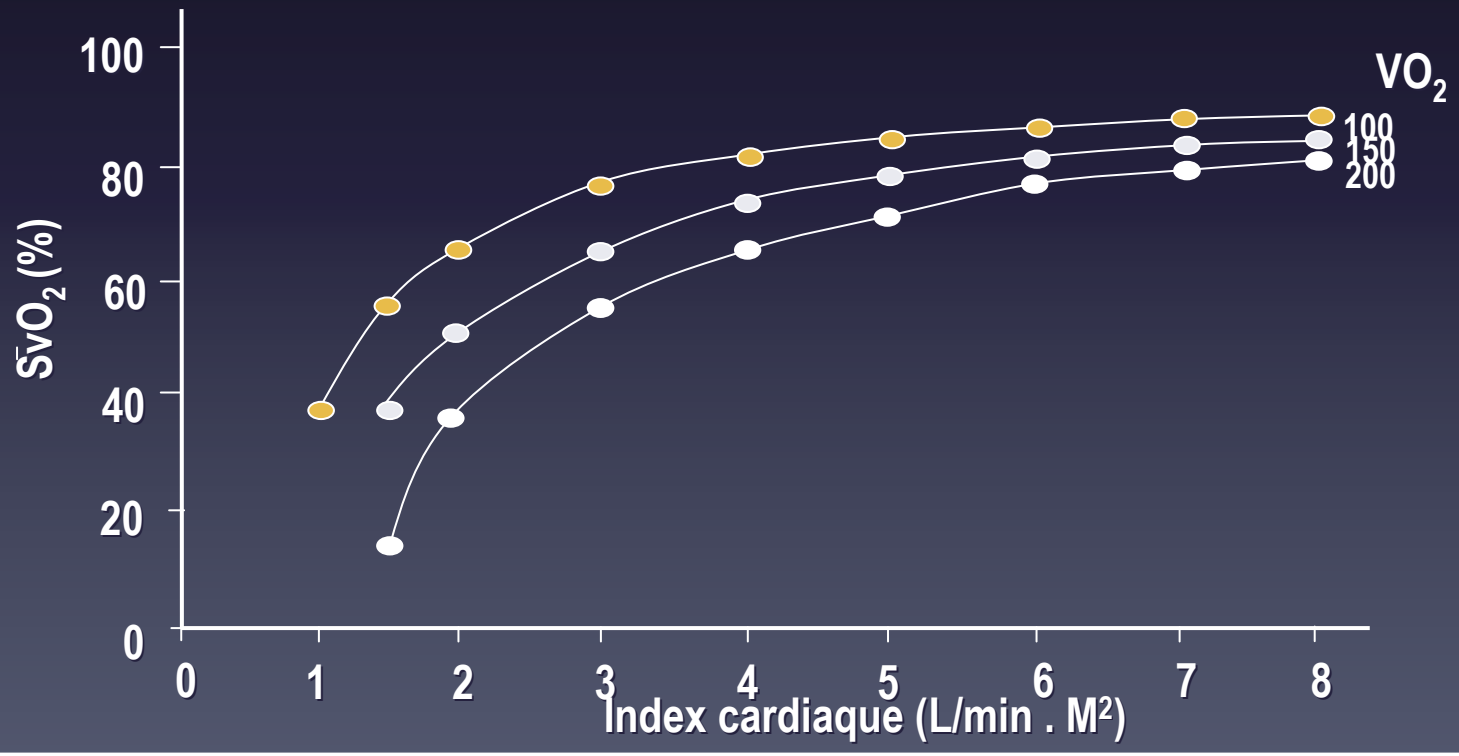
Hémodilution et SvO_2

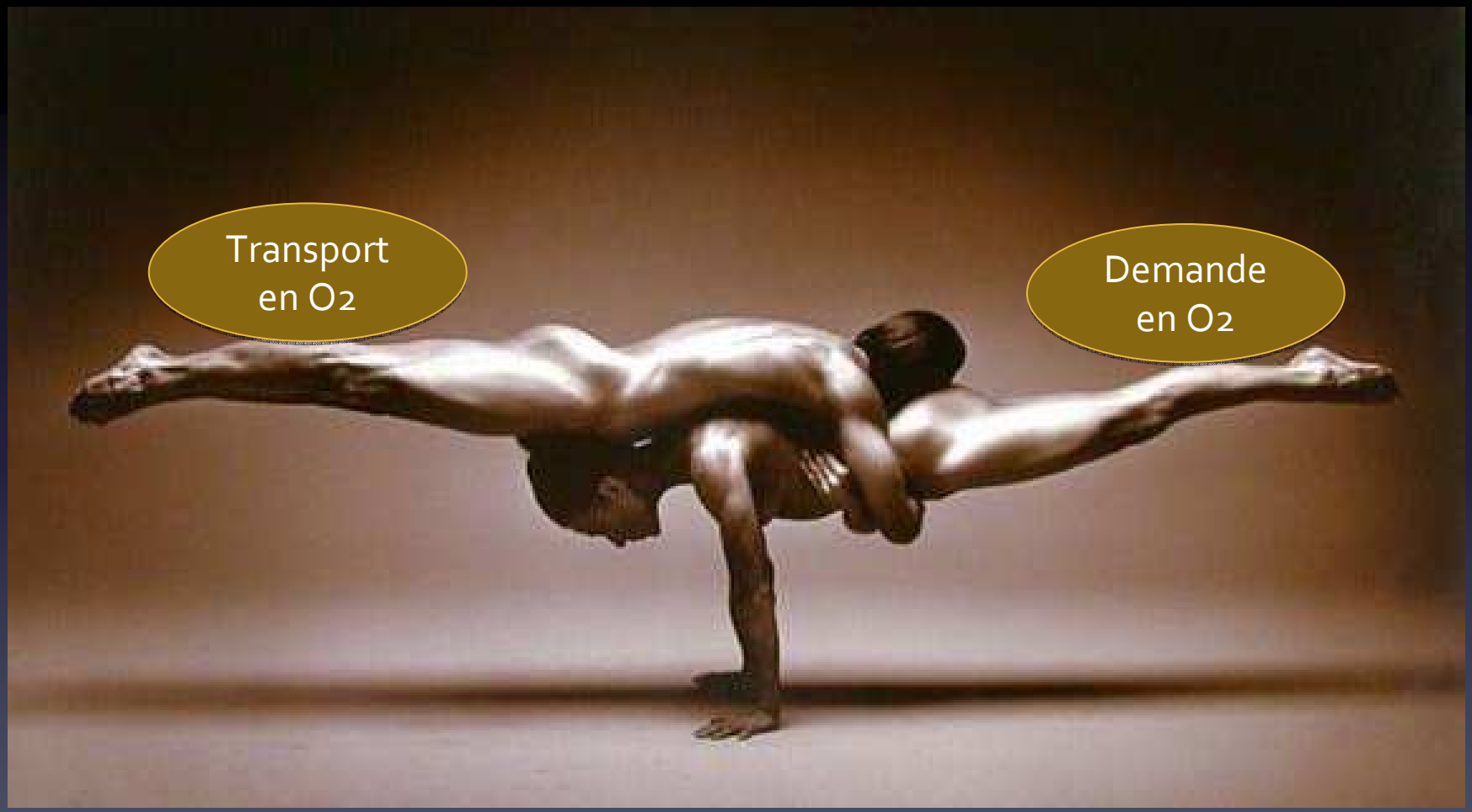
Weiskopf et al. JAMA 1998;279:217-21





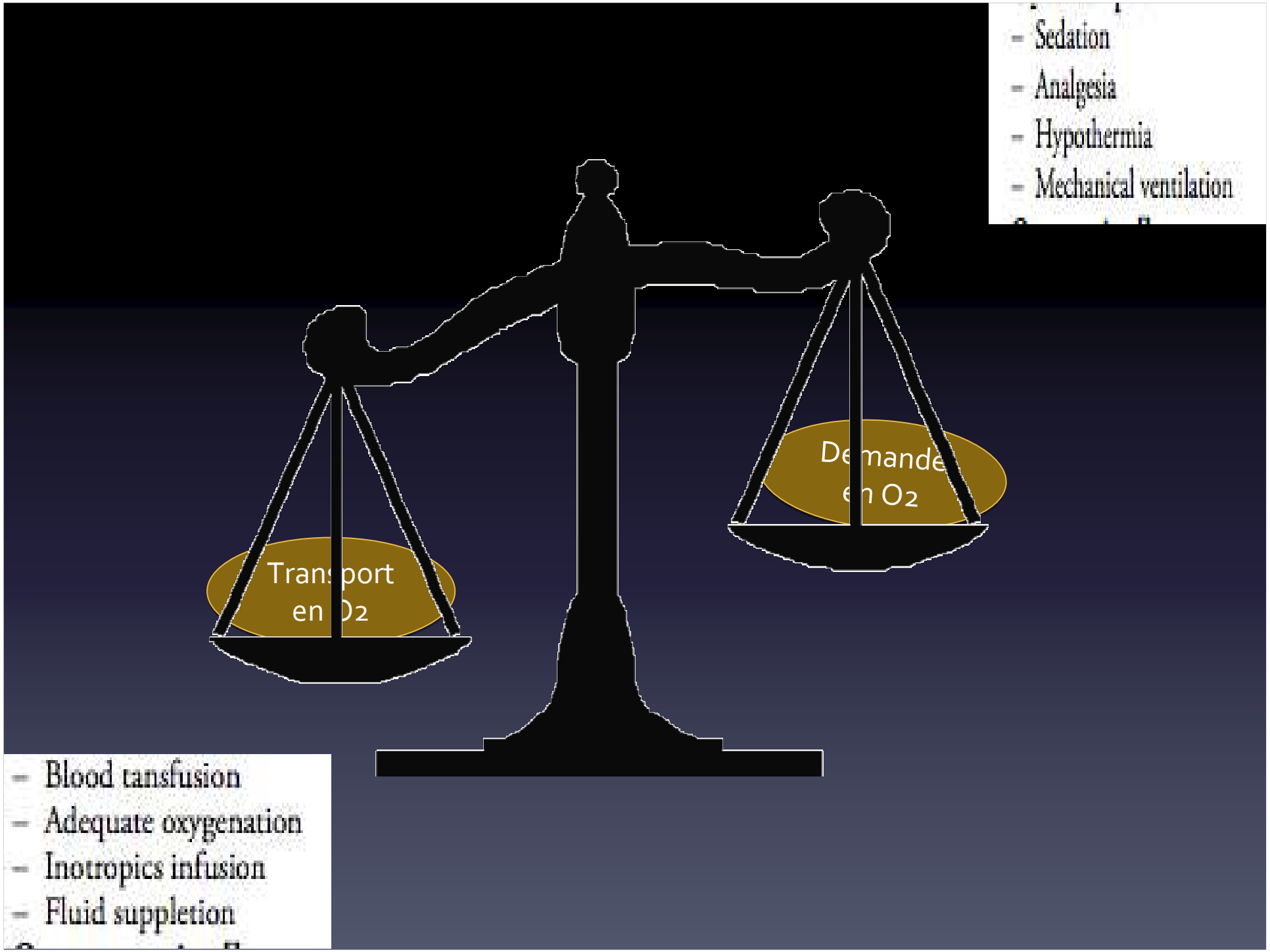

SvO2 (%)
90
80
70
60
50
40
30
20
10
0
4
5
6
7
8
9
10
11
12
Q = 5 L/min
Q = 2,5 L/min
[Hb] (g/dL)


100
80
60
40
20
0
SvO2 (%)
0
1
2
3
4
5
6
7
8
Index cardiaque (L/min . M2)
VO2
100
150
200


Transport
en O2
Demande
en O2

- Anemia
- Hypoxemia
- Myocardial dysfunction
- Hypovolemia

- Agitation
- Pain
- Hyperthermia
- Shivering
- Increase in metabolic demand


- Sedation
- Analgesia
- Hypothermia
- Mechanical ventilation
Demande en O2
Transport en O2
- Blood tansfusion
- Adequate oxygenation
- Inotropics infusion
- Fluid suppletion

Limites de la SvO2

- Pas de reflet d'une souffrance tissulaire régionale
- SvO2 haute n'est pas forcément reflet d'une bonne oxygénation tissulaire : shunt microcirculatoire ou cythopathie mitochondriale??
- Nécessite VVC / swan ganz

SvO_2 ou $SvcO_2$??

- $SvcO_2$ alternative intéressante à la SvO_2
- Valeurs différentes en fonction état normal ou pathologique

SvO2> SvcO2 état physiologique

≠

SvO2< SvcO2 état pathologique *

*Scheinman MM, Brown MA, Rapaport E (1969) Critical assessment of use of central venous oxygen saturation as a mirror of mixed venous oxygen in severely ill cardiac patients. Circulation 40:165–170

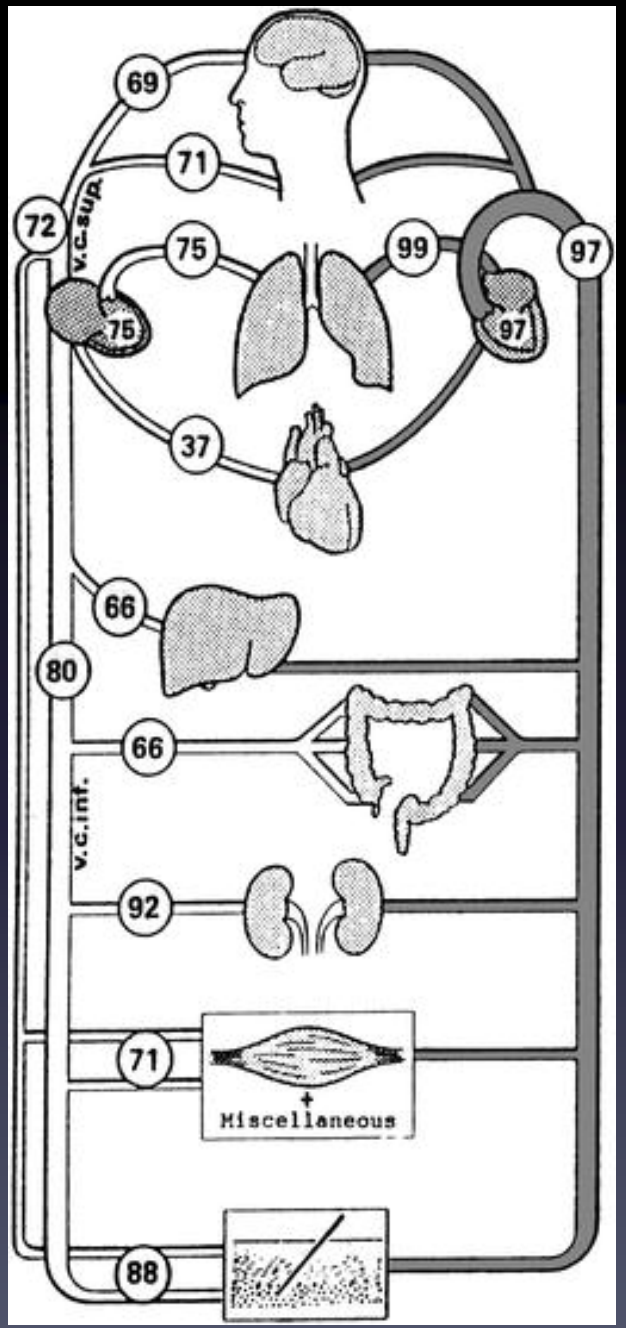


Tableau 2
Principales études comparant SvO_2 et $ScvO_2$: l'ensemble des résultats montre une corrélation significative entre $ScvO_2$ et SvO_2

Étude	Type de patient (*n*)	Conclusion
Tahvanainen et al. [11]	Réanimation (42)	
Wendt et al. [12]	Réanimation (19)	
Kong et al. [13]	Insuffisance rénale terminale (8)	
Berridge [14]	Réanimation selon index cardiaqu	
Herrera et al. [15]	Chirurgie thoracique (anesthésie)	
Pieri et al. [16]	Postopératoire de chirurgie majeu	
Ladakis et al. [17]	Réanimation et ventilation mécan	
Michael et al. [18]	Neurochirurgie (anesthésie) (70)	

Table 2—*Frequency of Differences Between Mixed and Central Venous O_2 Saturation Expressed in Magnitude of Difference

$\lvert SvO_2\text{-}ScvO_2\rvert$	n	Relative Frequency, %
Diff<3%	15883	53.8
3%<Diff<5%	6928	23.5
5%<Diff<10%	6029	20.4
10%<Diff	691	2.3

*$\lvert SvO_2\text{-}ScvO_2\rvert$, absolute value of difference between mixed and central venous O_2 saturation; n, number of comparisons within given range.

Tableau 3
Études comparant SvO_2 et $ScvO_2$ par l'analyse de Bland-A
choc septique

Étude	Patients septiques (*n*)	Échantillons	Bi (%	
Martin et al. [19]	7	580	1,1	−18,9 à 21,1
Edwards et Mayall [20]	11	30	2,9	−14,4 à 21,6
Tumaoglu et al. [21]	41	41	6,4	−7,1 à 14,1
Chawla et al. [22]	13	53	5,5	−5,2 à 15,5
Reinhart et al. [23]	11	150	7,1	−0,9 à 15
Varpula et al. [24]	16	72	4,2	−8,1 à 16,5

Corrélation des valeurs avec ≠ < 10%
Sauf si hémorragies ou hypoxémie

Corrélation ou parallélisme ds l'évolution?

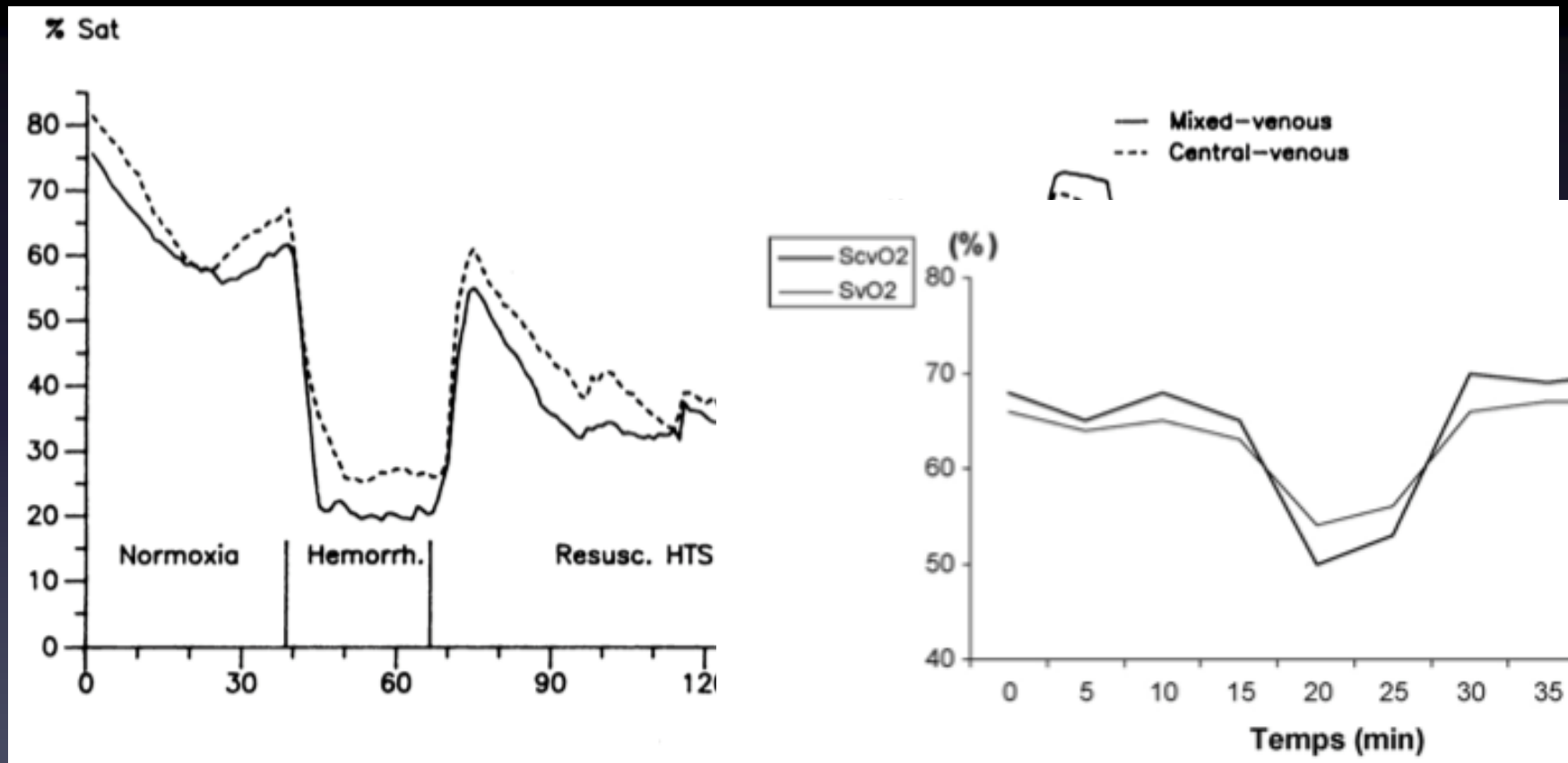
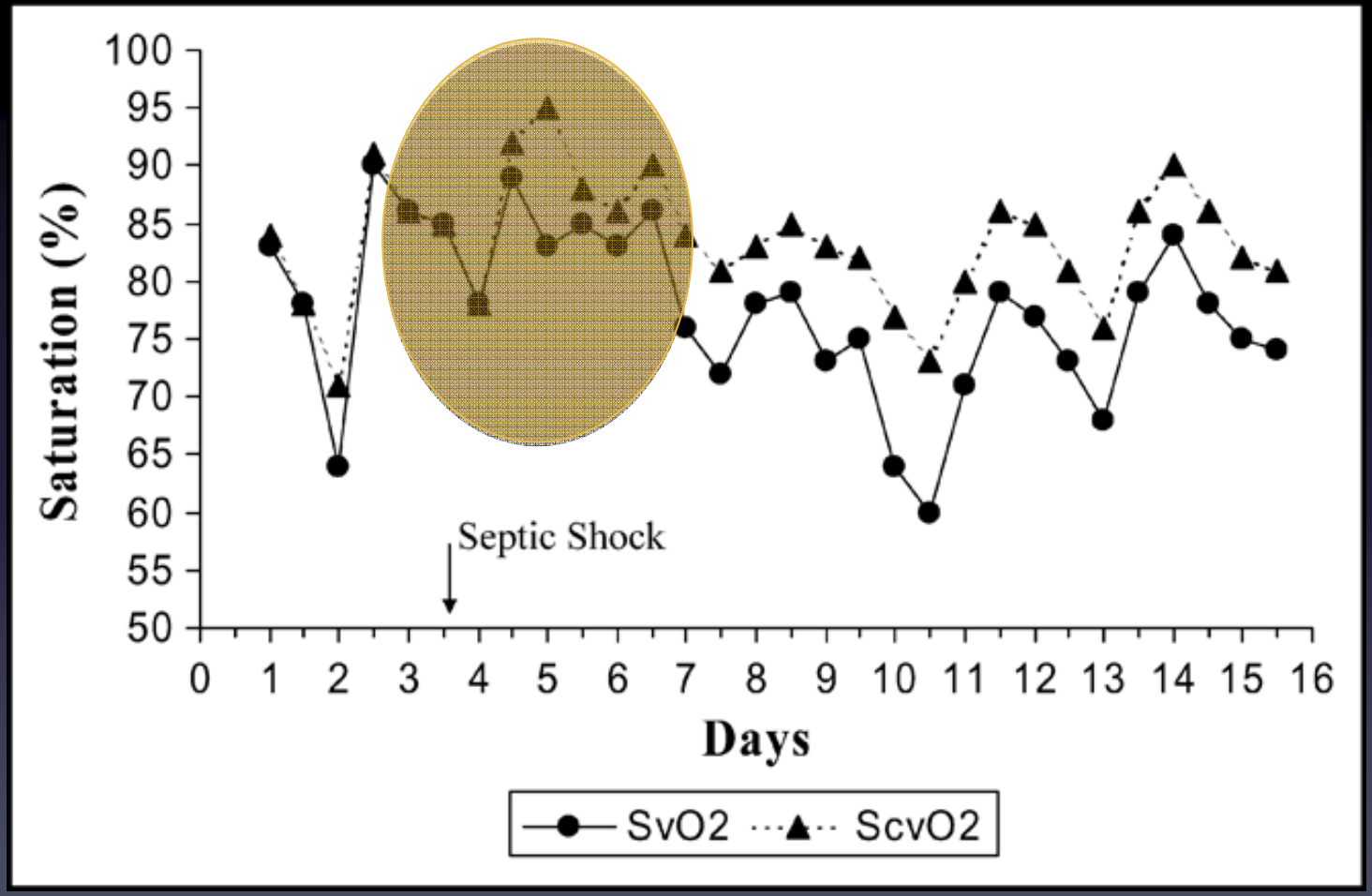


FIGURE 3. Time course of mixed and central venous O_2 saturation during different experimental perturbations of the animal. HTS = hypertonic saline solution (7.5%).

$ScvO_2$ Substitut de la SvO_2 ?

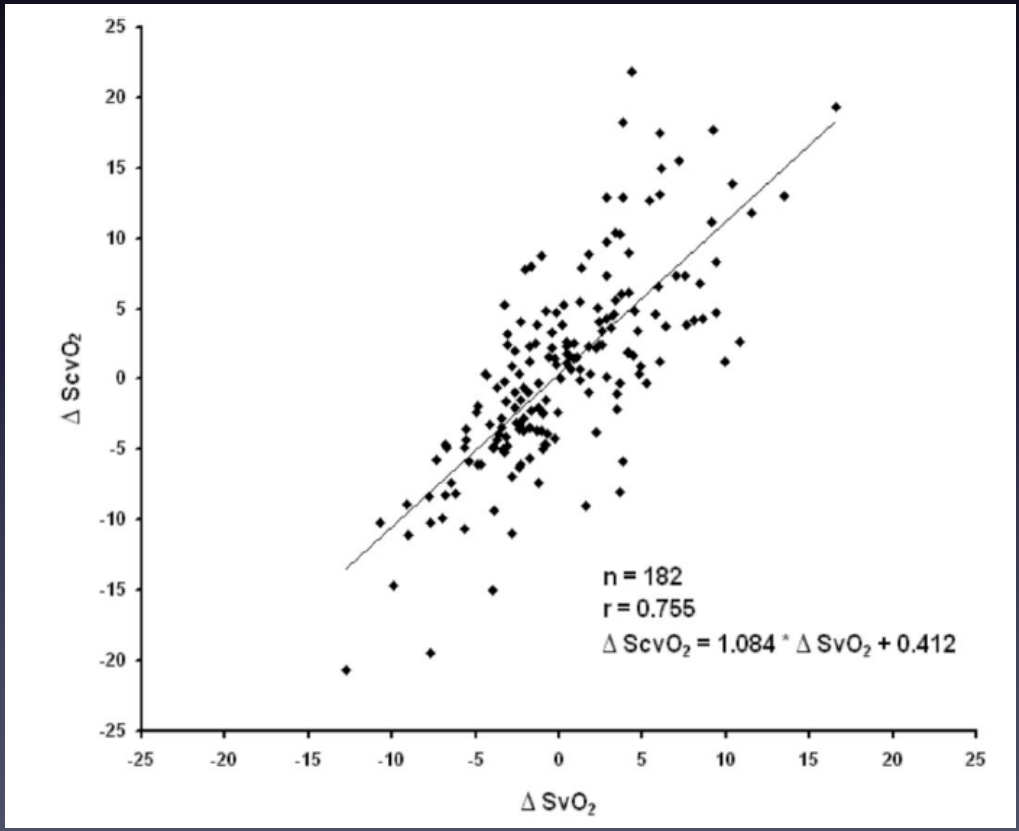
Reinhart K. Cur Op Crit Care 2005;11:259-63



Anesthesiology 2005; 103:249–57

Trends but Not Individual Values of Central Venous Oxygen Saturation Agree with Mixed Venous Oxygen Saturation during Varying Hemodynamic Conditions

Michael H. Dueck, M.D., D.E.A.A., Markus Klimek, M.D., D.E.A.A.,† Stefan Appenrodt,‡ Christoph Weigand, M.D.,* Ulf Boerner, M.D.§*



SvO_2 versus $SvcO_2$

- Donc différences des valeurs absolues mais un bon parallélisme dans l'évolution
- Dans le choc septique différence minime 3 à 5%, au cours des premières heures => intérêt d'un monitoring précoce .

SvO_2 vs $SvcO_2$

Cathéter artériel pulmonaire vs VVC cave sup??

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 25, 2006 VOL. 354 NO. 21

Pulmonary-Artery versus Central Venous Catheter to Guide Treatment of Acute Lung Injury

The National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network*

Table 2. Catheter-Related Complications.

Complication	PAC Group				CVC Group		
	Sheath	PAC	CVC	Total	Sheath	CVC	Total
	number of patients						
Technical and mechanical complications							
Difficult placement	1	8	1	10	0	2	2
Catheter malfunction	0	4	0	4	0	0	0
Pneumothorax	3	2	1	6	0	6	6
Air embolism	1	1	1	3	0	0	0
Arterial puncture	1	0	2	3	0	0	0
Arrhythmia							
Atrial	3	15	0	18	0	0	0
Ventricular	4	15	0	19	1	5	6
Conduction defect	1	4	0	5	1	0	1
Bleeding and clotting							
Hemothorax	2	1	0	3	1	0	1
Insertion-site bleeding	2	1	3	6	1	2	3
Thromboembolism	0	0	0	0	1	0	1
Local thrombosis	1	1	1	3	0	6	6
Infection							
Local	3	2	7	12	1	8	9
Bloodstream*	1	3	1	5	0	3	3
Other	0	2	1	3	0	3	3
Total	23	59	18	100	6	35	41

Impact of the Pulmonary Artery Catheter in Critically Ill Patients

Meta-analysis of Randomized Clinical Trials

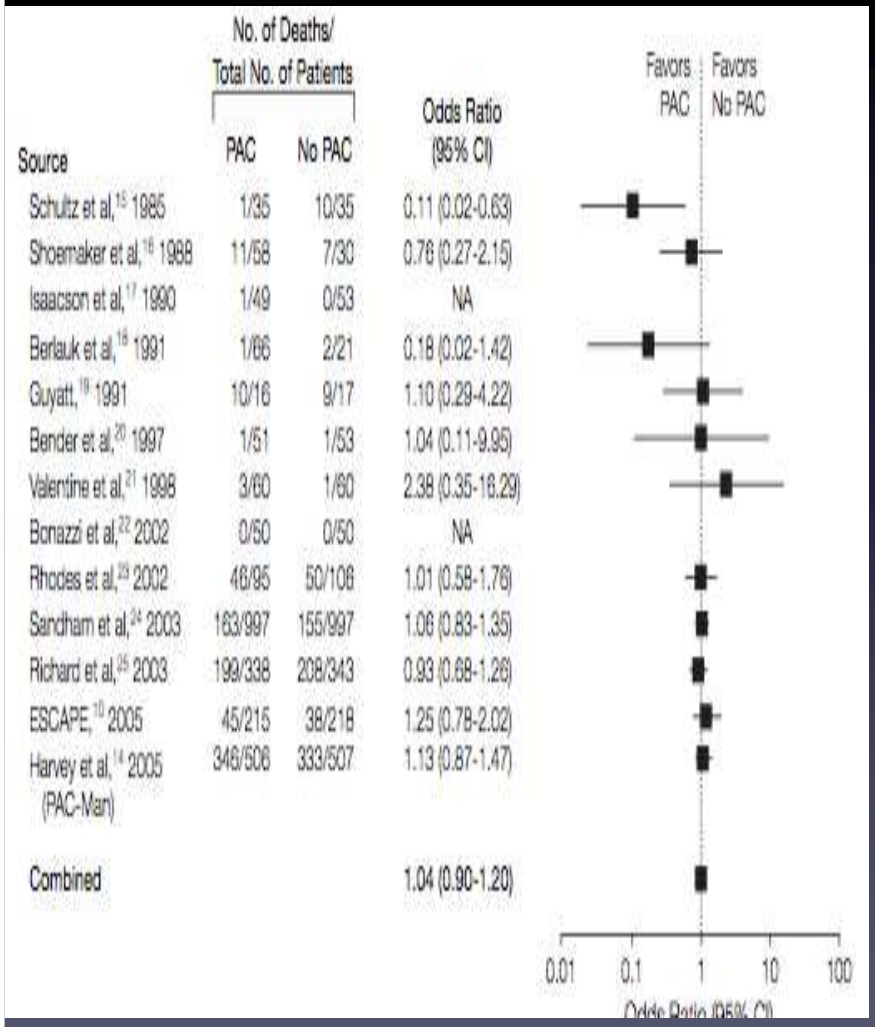
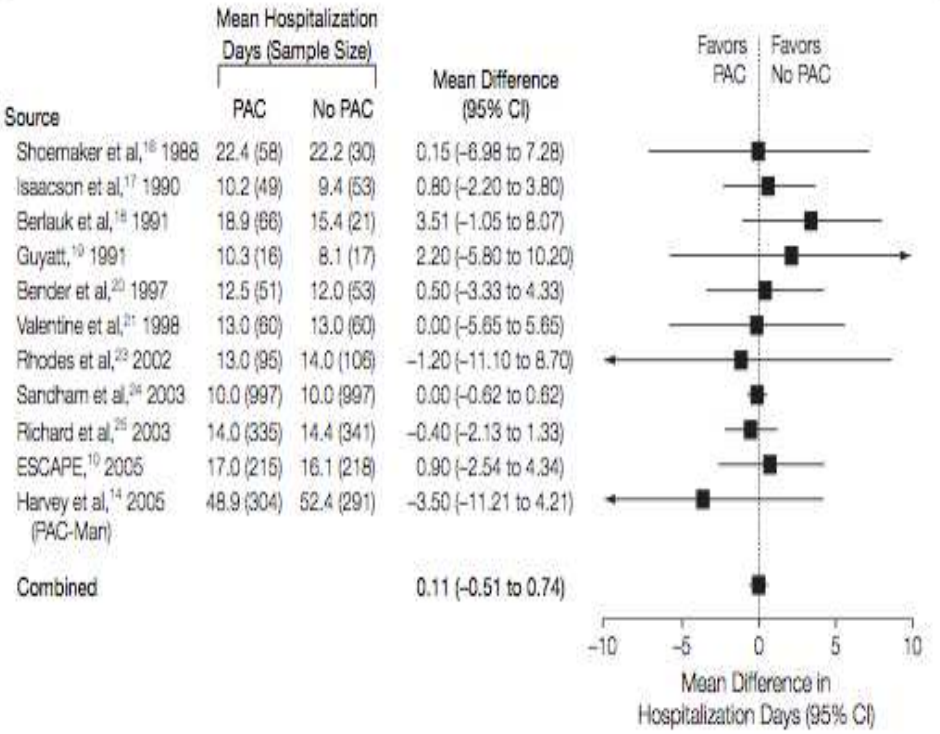


Figure 3. Mean Difference in the Average Number of Days Hospitalized in PAC Randomized Controlled Trials (Mean for PAC – Mean for No PAC)

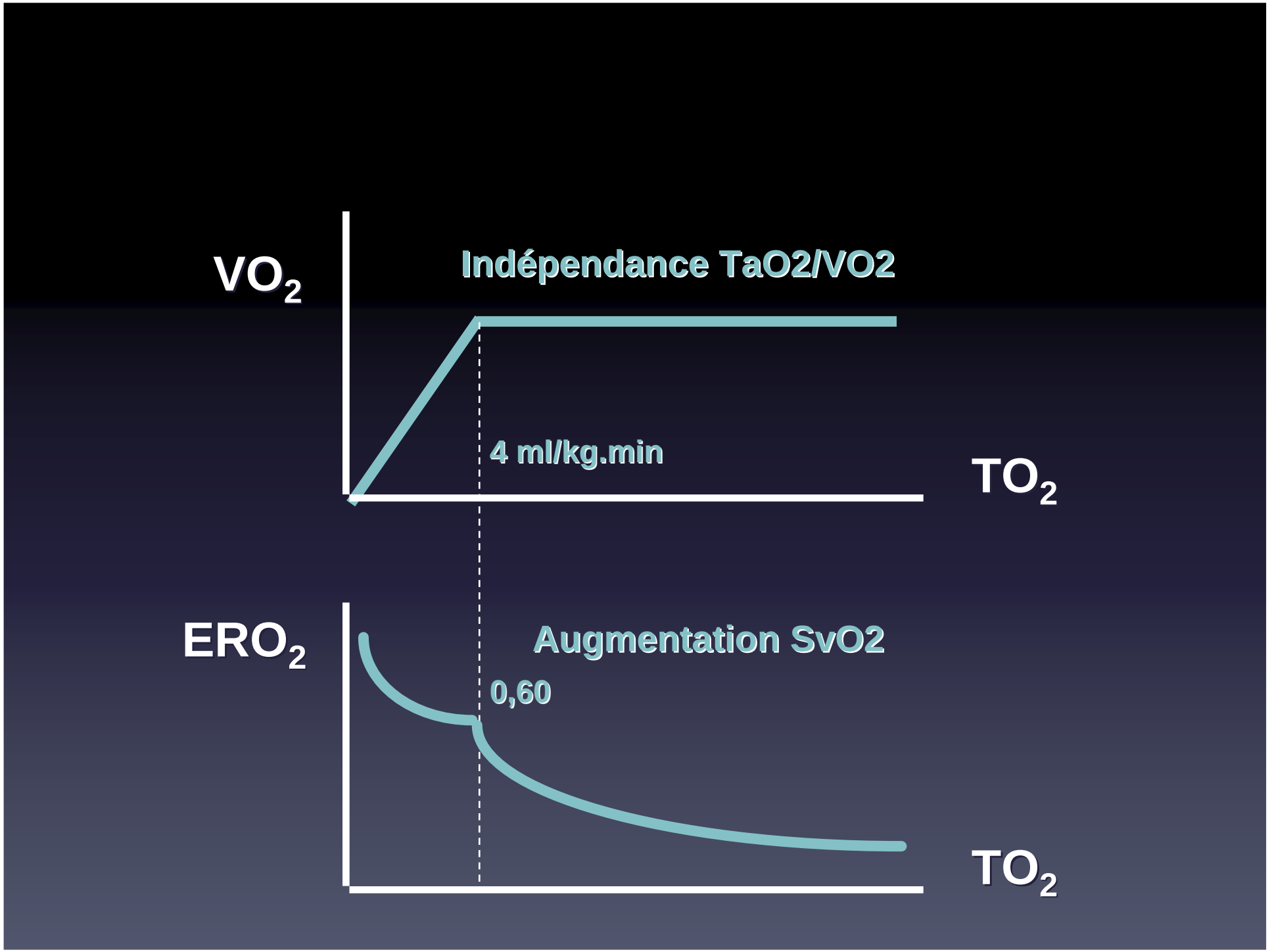


CI indicates confidence interval; PAC, pulmonary artery catheter. *P* for heterogeneity=.91.

SvO2 et les états de chocs!!!

Choc cardiogénique

- Intérprétaion simple de la SvO_2
- Relation quasi linéaire entre SvO_2 et débit cardiaque à MvO_2 constante
- L'augmenation de la SvO_2 en majorant le débit cardiaque ne se fera que pdt la phase d'indépendance TaO_2/VO_2

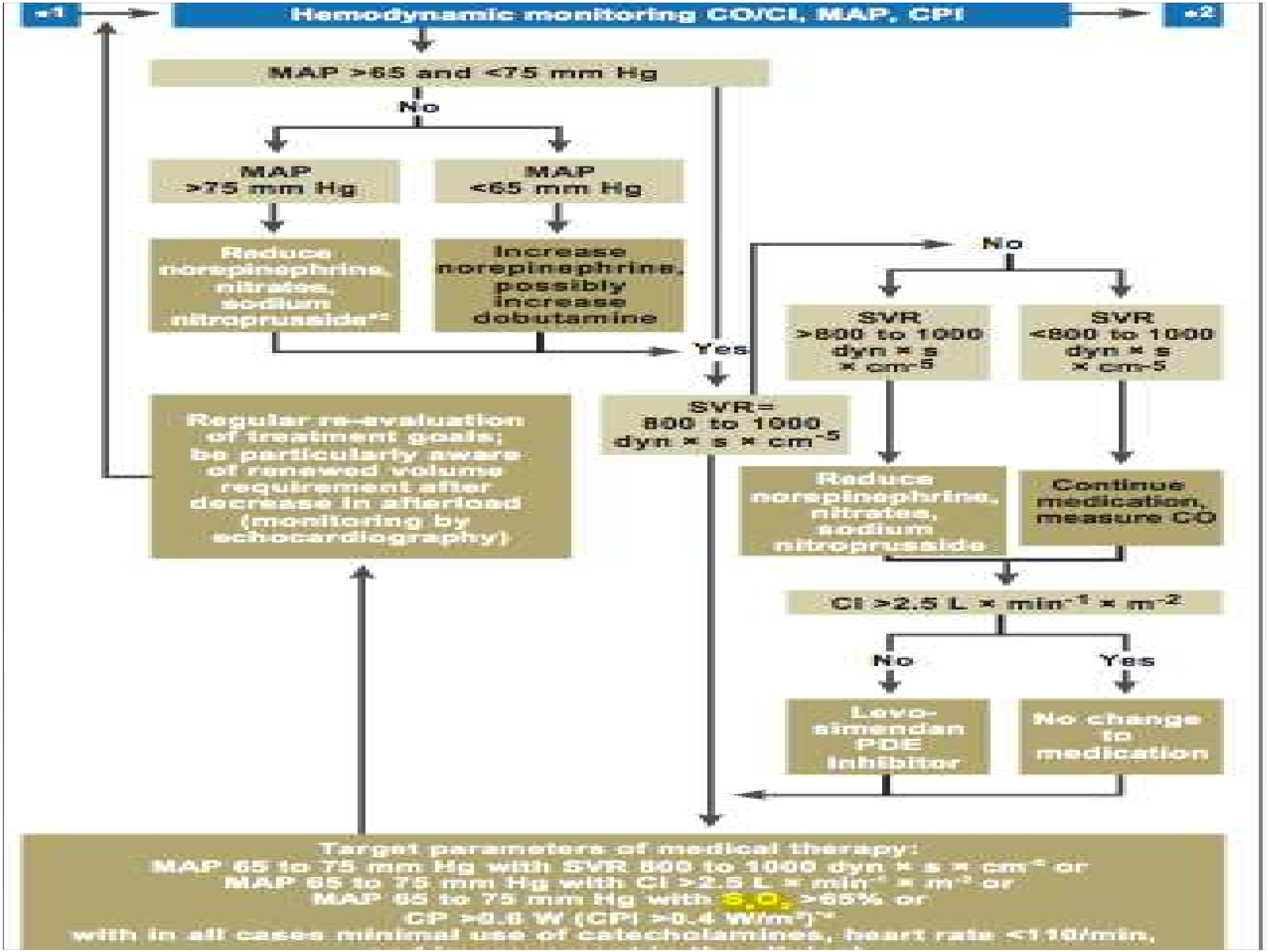

VO_2
Indépendance TaO2/VO2
4 ml/kg.min
TO_2
ERO_2
Augmentation SvO2
0,60
TO_2

CLINICAL PRACTICE GUIDELINE

Cardiogenic Shock Due to Myocardial Infarction: Diagnosis, Monitoring and Treatment

A German-Austrian S3 Guideline

Karl Werdan, Martin Ruß, Michael Buerke, Georg Delle-Karth, Alexander Geppert, Friedrich A. Schöndube


«1
Hemodynamic monitoring CO/CI, MAP, CPI
«2
MAP >65 and <75 mm Hg
No
MAP >75 mm Hg
MAP <65 mm Hg
Reduce norepinephrine, nitrates, sodium nitroprusside*:
Increase norepinephrine, possibly increase dobutamine
Yes
No
SVR >800 to 1000 dyn × s × cm-5
SVR <800 to 1000 dyn × s × cm-5
SVR= 800 to 1000 dyn × s × cm-5
Regular re-evaluation of treatment goals; be particularly aware of renewed volume requirement after decrease in afterload (monitoring by echocardiography)
Reduce norepinephrine, nitrates, sodium nitroprussside
Continue medication, measure CO
CI >2.5 L × min-1 × m-2
No
Yes
Levo-simendan PDE inhibitor
No change to medication
Target parameters of medical therapy:
MAP 65 to 75 mm Hg with SVR 800 to 1000 dyn × s × cm-5 or
MAP 65 to 75 mm Hg with CI >2.5 L × min-1 × m-2 or
MAP 65 to 75 mm Hg with SvO2 >65% or
CP >0.6 W (CPI >0.4 W/m2)**
with in all cases minimal use of catecholamines, heart rate <110/min,

Le choc hémorragique

- Interprétation simple également
- Compensation par DC
- Intérêt ds surveillance polytraumatisé : une variation significative SvO_2 est prédictive d'une hémorragie grave , avt même variation de la PAM*

calea TM, Hartnett RW, Duncan AO, Atweh NA, Phillips TF, Sclafani SJ, et al. Central venous oxygen saturation: a useful clinical tool in trauma patients. J Trauma 1990;30:1539–43.

ET le choc septique ??

The New England Journal of Medicine

EARLY GOAL-DIRECTED THERAPY IN THE TREATMENT OF SEVERE SEPSIS AND SEPTIC SHOCK

EMANUEL RIVERS, M.D., M.P.H., BRYANT NGUYEN, M.D., SUZANNE HAVSTAD, M.A., JULIE RESSLER, B.S., ALEXANDRIA MUZZIN, B.S., BERNHARD KNOBLICH, M.D., EDWARD PETERSON, PH.D., AND MICHAEL TOMLANOVICH, M.D., FOR THE EARLY GOAL-DIRECTED THERAPY COLLABORATIVE GROUP*

- **Optimiser la $ScvO_2$ (> 70%):**
- SaO_2 > 93%
- Hématocrite > 30%
- Index cardiaque avec la dobutamine (≤20 µg/kg.min) après remplissage
- Diminuer la VO_2 (VM et sédation)

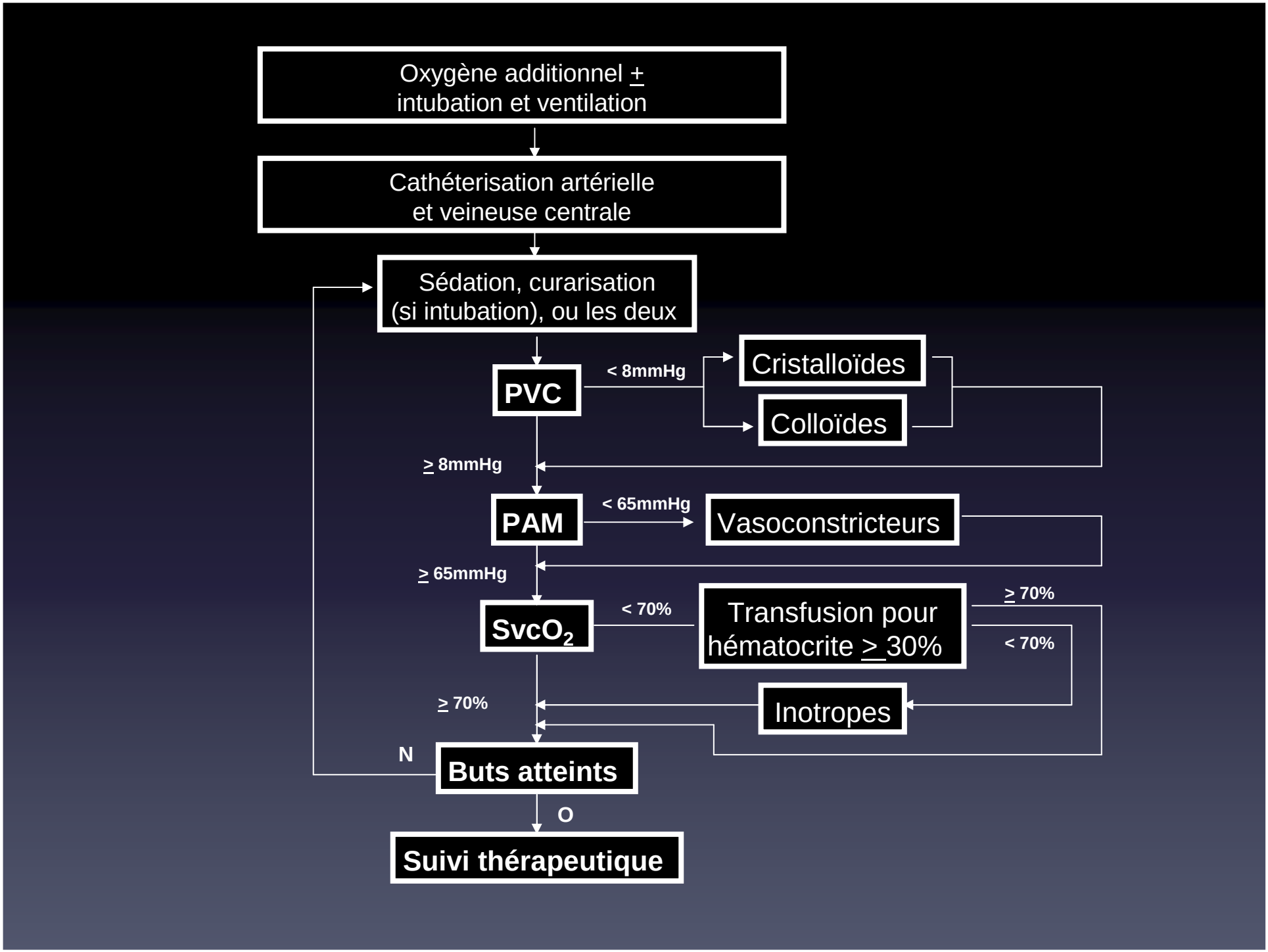
"Early Goal-Directed Therapy" (EGDT) et Traitement du Sepsis Sévère et du Choc Septique

Rivers et al. N Engl J Med 2001;345:1368-77

Critères de « SIRS » et PAS $\leq$ 90 mmHg
ou lactate $\geq$ 4 mM/L

Traitement standard
(n = 133)
PVC $\geq$ 8-12 mmHg
PAM $\geq$ 65 mmHg
DH $\geq$ 0,5 mL/kg.hr

$ScvO_2$ + EGDT $\geq$ 6 hr
(n = 130)
PVC $\geq$ 8-12 mmHg
PAM $\geq$ 65 mmHg
DH $\geq$ 0,5 mL/kg.hr
$ScvO_2 \geq 70\%$


Oxygène additionnel ±
intubation et ventilation
Cathéterisation artérielle
et veineuse centrale
Sédation, curarisation
(si intubation), ou les deux
PVC
< 8mmHg
Cristalloïdes
Colloïdes
≥ 8mmHg
PAM
< 65mmHg
Vasoconstricteurs
≥ 65mmHg
SvcO2
< 70%
Transfusion pour
hématocrite ≥ 30%
≥ 70%
< 70%
≥ 70%
Inotropes
N
Buts atteints
O
Suivi thérapeutique

"Early Goal-Directed Therapy" (EGDT) et Traitement du Sepsis Sévère et du Choc Septique

Rivers et al. N Engl J Med 2001;345:1368-77

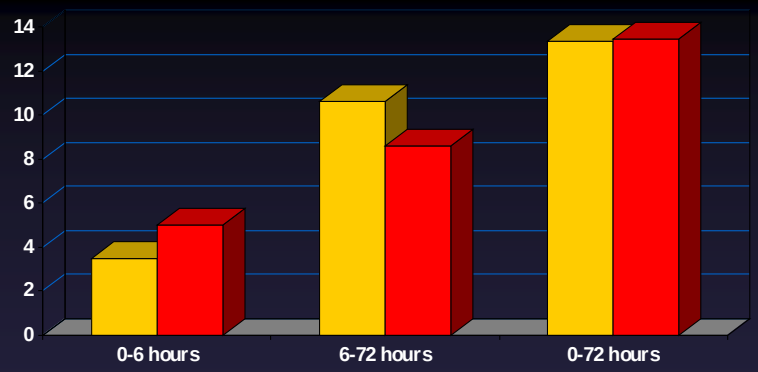
REMPLISSAGE (ml) APRES INCLUSION			
Heures après inclusion	*0–6*	*7–72*	*0–72*
Traitement standard	3499 ± 2438	10.602 ± 6.216	13.358±7.729
EGDT	**4981 ± 2984**	**8.625 ± 5.162**	**13.443 ± 6.390**
Valeur de P	*<0,001*	*0,01*	*0,73*

“Early Goal-Directed Therapy” (EGDT) et Traitement du Sepsis Sévère et du Choc Septique

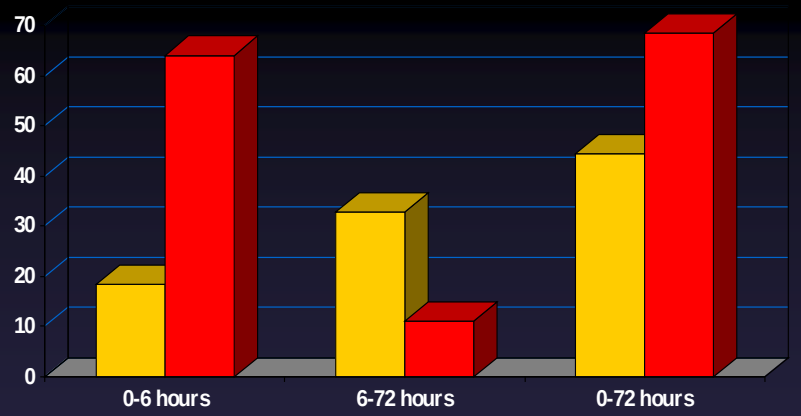
Rivers et al. N Engl J Med 2001;345:1368-77

Control
EGDT

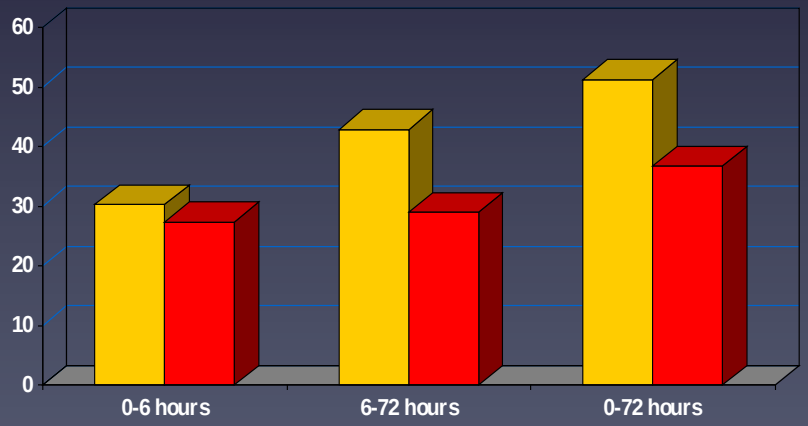
Crystalloids (L)



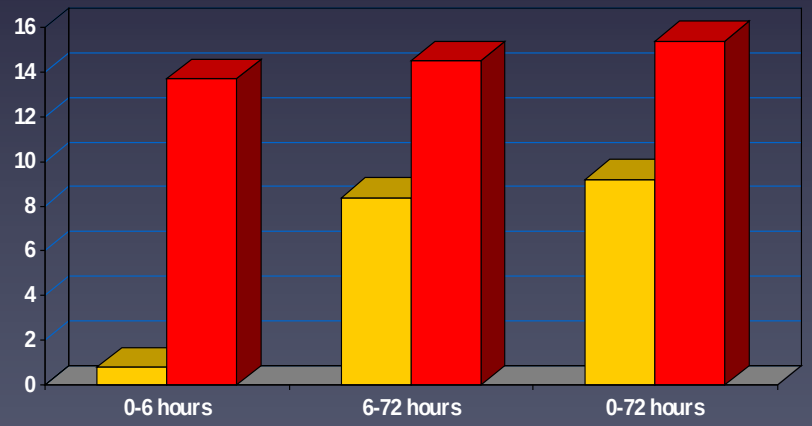
Transfusion (%)



Vasopressor (%)



Dobutamine (%)



"Early Goal-Directed Therapy" (EGDT) et Traitement du Sepsis Sévère et du Choc Septique

Rivers et al. N Engl J Med 2001;345:1368-77

	Traitement standard	EGDT
PAM base (mmHg) PAM 7-72 hr traitement	76 ± 24 80 ± 15	74 ± 27 87 ± 15*
$ScvO_2$ base (%) $ScvO_2$ 7-72 hr traitement	49,2 ± 13,3 65,3 ± 11,4	48,6 ± 11,4 70,4 ± 10,7*
BD base (mM/L) BD 7-72 hr traitement	8,9 ± 7,5 8,9 ± 8,1	5,1 ± 6,7 2,0 ± 6,6*
Hct base (%) Hct 7-72 hr traitement	34,7 ± 8,5 30,1 ± 4,1	34,6 ± 8,3 32,1 ± 4,2*
TP base (sec) TP 7-72 hr traitement	16,5 ± 6,3 17,3 ± 6,1	15,8 ± 5,0 15,4 ± 6,1*
D-dimères baseline (mg/mL) D-dimères 7-72 hr traitement	3,66 ± 8,45 5,65 ± 9,06	4,46 ± 10,70 3,34 ± 9,02*

* $p<0,001$

"Early Goal-Directed Therapy" (EGDT) et Traitement du Sepsis Sévère et du Choc Septique

Rivers et al. N Engl J Med 2001;345:1368-77

Mortalité hospitalière (%)	Traitement standard	EGDT
Tous les patients	46,5	30,5 (p = 0,009)
Sepsis sévère	30,0	14,9 (p = 0,06)
Choc septique	56,8 ???	42,3 (p = 0,04)
Sepsis syndrome	45,4	35,1 (p = 0,07)
Mortalité à J28	49,2	33,3 (p = 0,01)
Mortalité à J60	56,9	44,3 (p = 0,03)

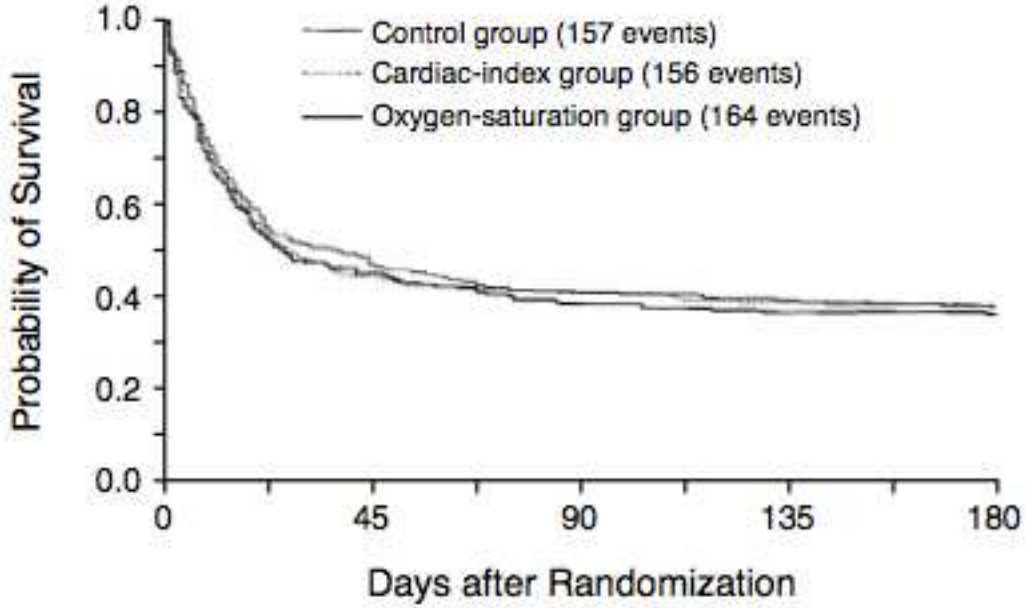
EGDT « bundle » et une polémique qui dure plus que 10 ans !!!

The New England
Journal of Medicine

Volume 333 OCTOBER 19, 1995 Number 16

A TRIAL OF GOAL-ORIENTED HEMODYNAMIC THERAPY IN CRITICALLY ILL PATIENTS

LUCIANO GATTINONI, M.D., LUCA BRAZZI, M.D., PAOLO PELOSI, M.D., ROBERTO LATINI, M.D., GIANNI TOGNONI, M.D., ANTONIO PESENTI, M.D., AND ROBERTO FUMAGALLI, M.D., FOR THE SvO_2 COLLABORATIVE GROUP*



PATIENTS AT RISK (NO. OF EVENTS)

Control group	252 (129)	108 (13)	94 (4)	90 (3)	87
Cardiac-index group	253 (133)	102 (8)	90 (4)	86 (3)	83
Oxygen-saturation group	257 (133)	106 (16)	89 (4)	85 (1)	84

Figure 2. Survival Curves from Study Entry to the Six-Month Follow-up in the Three Study Groups.

La controverse de Rivers

- Etude monocentrique
- PVC n'est pas un bon marquer de précharge dépendance / delta PP, levée de jambe , VCI*
- **SvcO2< 50% à l'admission non retrouvé dans les autres études**

*Marik PE, Baram M, Vahid B. Does the central venous pressure predict fluid responsiveness? A systematic review of the literature and the tale of seven mares. Chest 2008;134:172-8.
[11] Marik PE, Cavallazzi R, Vasu T, et al. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients. A systematic review of the literature. Crit Care Med 2009;37:2642-7.

Sepsis et SvO2<50%???

Research

Open Access

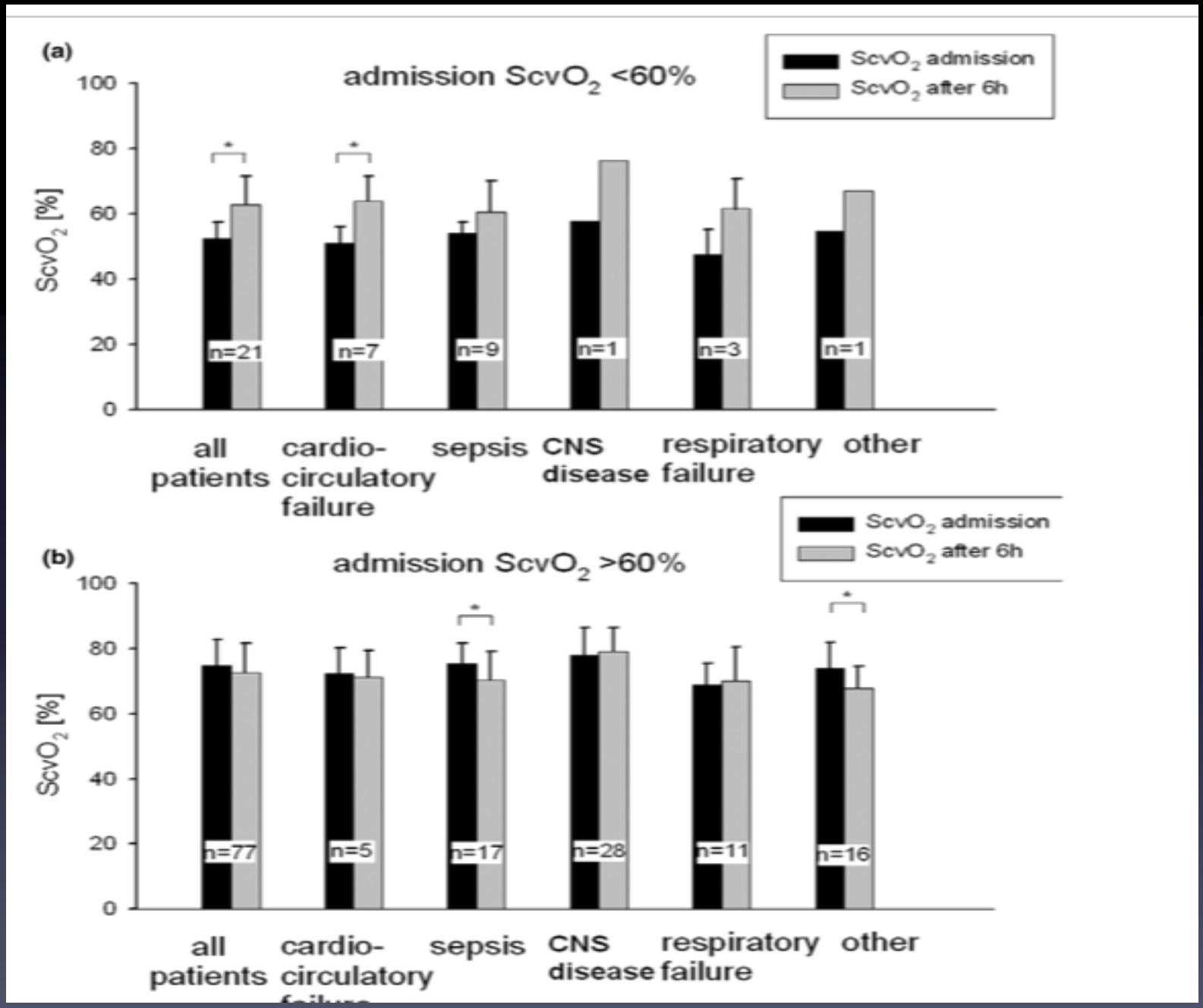
Incidence of low central venous oxygen saturation during unplanned admissions in a multidisciplinary intensive care unit: an observational study

Hendrik Bracht, Matthias Hänggi, Barbara Jeker, Ninja Wegmüller, Francesca Porta, David Tüller, Jukka Takala and Stephan M Jakob

Table 1

Demographic, $ScvO_2$, and outcome data

	All patients ($n = 98$)	Cardiocirculatory failure ($n = 12$)	Sepsis ($n = 26$)	CNS disease ($n = 29$)	Respiratory failure ($n = 14$)	Other ($n = 17$)
Median age in years[a]	63 (19–83)	69 (39–79)	65 (35–83)	51 (19–79)	73 (32–83)	70 (28–83)
SAPS II	43 (11–92)	43 (32–89)	45 (11–87)	50 (11–92)	35 (19–86)	34 (13–58)
$ScvO_2$ at ICU admission (%)[a]	70 ± 12	60 ± 13	68 ± 12	77 ± 12	64 ± 11	73 ± 9
$ScvO_2$ after six hours in ICU (%)[a]	71 ± 10	67 ± 9	67 ± 10	79 ± 7	68 ± 10	68 ± 6
LOS_{ICU} in days[a]	3 (1–28)	3 (1–9)	4 (1–25)	3 (1–28)	6 (1–28)	1 (1–10)
$LOS_{hospital}$ in days	19 (1–28)	13 (1–28)	28 (1–28)	12 (1–28)	22 (7–28)	18 (5–28)
$LOS_{before\ ICU}$ in days	0.3 (0–38)	0.1 (0–20)	0.8 (0–39)	0.1 (0–20)	2.4 (0–26)	0.5 (0–15)
28-day mortality (%)	18	33	27	24	7	0
FiO_2 at ICU admission	0.6 (0.3–1.0)	0.7 (0.4–1.0)	0.5 (0.3–1.0)	0.5 (0.3–1.0)	0.8 (0.4–1.0)	0.5 (0.4–0.7)
Number of organ failures	2 (0–4)	2 (1–4)	3 (0–4)[a]	1 (0–3)	2 (0–4)	2 (0–4)
Percentage of patients per group with low (< 60%) $ScvO_2$ on ICU admission	21	17	35	3	21	6


(a)
admission ScvO2 <60%
ScvO2 admission
ScvO2 after 6h
ScvO2 [%]
100
80
60
40
20
0
*
*
n=21
n=7
n=9
n=1
n=3
n=1
all patients
cardio-circulatory failure
sepsis
CNS disease
respiratory failure
other
(b)
admission ScvO2 >60%
ScvO2 admission
ScvO2 after 6h
ScvO2 [%]
100
80
60
40
20
0
*
*
n=77
n=5
n=17
n=28
n=11
n=16
all patients
cardio-circulatory failure
sepsis
CNS disease
respiratory failure
other

Research

Open Access

The incidence of low venous oxygen saturation on admission to the intensive care unit: a multi-center observational study in The Netherlands

PA van Beest[1,2], JJ Hofstra[3], MJ Schultz[3,4], EC Boerma[1], PE Spronk[3,4,5] and MA Kuiper[1,3,4]

Table 2

Demographic data, variables and outcome data; comparisons of sepsis patients with EGDT study [8] data

Variable	Present cohort ($n = 263$)	Sepsis ($n = 125$)	EGDT study ($n = 263$)	p Value[a,b]
Age (years)	67.3 ± 14.2	68.9 ± 13.5	65.7 ± 17.2	0.01*
Female (%)	41	38	49.4	
Male (%)	59	62	50.6	
Heart rate (beats/min)	107 ± 27	115 ± 26	115 ± 29	1.0
CVP (mmHg)	9.8 ± 5.4	10.8 ± 4.9	5.7 ± 8.5	< 0.01*
MAP (mmHg)	58 ± 16	60 ± 13	75 ± 25	< 0.01*
$ScvO_2$ (%)	72.0 ± 12.3	74.0 ± 10.2	48.9 ± 12.3	< 0.01*
Lactate (mmol/l)	3.3 ± 3.3	2.7 ± 2.2	7.3 ± 4.6	< 0.01*
Arterial pH	7.33 ± 0.12	7.35 ± 0.10	7.32 ± 0.18	0.42
Hematocrit (%)	31.0 ± 7.0	30.3 ± 6.9	34.7 ± 8.5	< 0.01*
APACHE II score	21.5 ± 8.5	20.9 ± 7.3	20.9 ± 7.2	1.0
SOFA score	9.5 ± 3.6	9.6 ± 3.0		
In-hospital mortality (%)	31.0	26.0		
Standard therapy			46.5	
EGDT			30.5	

Table 1—*Comparison of Hemodynamic Optimization Studies

Variables	Astiz et al[10]/1988†	Gattinoni et al[27]/1995	Hayes et al[26]/1994	Rivers et al[12]/2001
Setting	Early ICU	ICU	ICU	ED or Pre-ICU
Enrollment time, h	< 6	Up to 72	Up to 24	< 2
Lactate, mmol/L	5.3 ± 0.5	NA	2.2–3.5	6.9–7.7
MAP, mm Hg	68 ± 2	NA	NA	74–76
$S\bar{v}O_2$, %	57 ± 2	67.3	NA	48.6–49.2
CVP, mm Hg	NA	10.6	Optimized	5.3–6.1
Cardiac index, L/min/m^2	2.7 ± 0.2	3.7–3.8	3.2–3.4	1.7–1.9
SVRI, dyne · s · cm^{-5} · m^2	2,394 ± 178	708–735	NA	1,181–1,192

*NA = not applicable; SVRI = systemic vascular resistance index.

†Values are given as the mean ± SE.

La controverse de Rivers

- PVC n'est pas un bon marquer de précharge dépendance / delta PP, levée de jambe , VCI*
- SvO2< 50% à l'admission non retrouvé dans les autres études=> mauvaise conditions socio économiques? Admission tardive ?
- **Transfusion ??**

*Marik PE, Baram M, Vahid B. Does the central venous pressure predict fluid responsiveness? A systematic review of the literature and the tale of seven mares. Chest 2008;134:172-8.
[11] Marik PE, Cavallazzi R, Vasu T, et al. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients. A systematic review of the literature. Crit Care Med 2009;37:2642-7.

Transfusion et SvcO2

- Amélioration SvcO2 peut être mais ??
  - majoration risque infectieux , SDRA, , décès .*
  - CG pro inflammatoire et prothrombogène
  - Altération microcirculation possible?

*Marik PE, Corwin HL. Efficacy of RBC transfusion in the critically ill: a systematic review of the literature. Crit Care Med 2008;36:2667-74. []
* Marik PE, Corwin HL. Acute lung injury following blood transfusion: expanding the definition. Crit Care Med 2008;36:3080-4.

**Twomley KM, Rao SV, Becker RC. Proinflammatory, immunomo- dulating, and prothrombotic properties of anemia and red blood cell transfusions. J Thromb Thrombolysis 2006;21:167-74.
** Sweeney J, Kouttab N, Kurtis J. Stored red blood cell supernant facilititates thrombin generation. Transfusion 2009;49:1569-79.
*** Marik PE, Sibbald WJ. Effect of stored-blood transfusion on oxygen delivery in patients with sepsis. JAMA 1993;269:3024-9.
*** Suttner S, Piper SN, Kumle B, et al. The influence of allogeneic red blood cell transfusion compared with 100% oxygen ventilation on systemic oxygen transport and skeletal muscle oxygen tension after cardiac surgery. Anesth Analg 2004;99:2-11.

La controverse de Rivers

- PVC n'est pas un bon marquer de précharge dépendance / delta PP, levée de jambe , VCI*
- SvO_2< 50% à l'admission non retrouvé dans les autres études=> mauvaise conditions socio économiques? Admission tardive ?
- Transfusion ??
- **Utilisation des inotropes (dobu) après échec remplissage en se basant sur SvO_2 et PVC qui ne sont pas du tt des marqueurs d'iontropisme !!**

*Marik PE, Baram M, Vahid B. Does the central venous pressure predict fluid responsiveness? A systematic review of the literature and the tale of seven mares. Chest 2008;134:172-8.
[11] Marik PE, Cavallazzi R, Vasu T, et al. Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients. A systematic review of the literature. Crit Care Med 2009;37:2642-7.

Early goal-directed therapy: on terminal life support?☆

Paul E. Marik MD[a,*], Joseph Varon MD[b]

Although the 3 major pillars that form the basis of EGDT are not supported by evidence-based medicine and are potentially harmful, what is more troubling is that the results of the EGDT study are "just too good to be true" and would appear to be scientifically implausible. However, at least 40

supportive scientific evidence, the EGDT "bundle" has been adopted worldwide with cult-like religious fervor. The Australian Resuscitation in Sepsis Evaluation (Australia), the Protocolized Care for Early Septic Shock (United States), and the Protocolised Management In Sepsis (United Kingdom) studies are national, multicenter randomized controlled trials designed to test "EGDT" in patients with severe sepsis [37]. The final chapter of this sordid tale remains to be written.

THE WALL STREET JOURNAL.

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AUGUST 14, 2008

New Therapy for Sepsis Infections Raises Hope but Many Questions

By THOMAS M. BURTON

Medical Center. The new therapy typically costs about $1,100 more per patient, by the estimate of Derek Angus, chief of critical care at the University of Pittsburgh. The U.S. has about 750,000 cases of sepsis each year.

Hospital in Detroit. The controversy has taken on an ugly tone rare in medicine. Dr. Rivers has called his critics in Pittsburgh "the Pittsburgh pirates." In an email to a Toronto doctor, Dr. Rivers said some see criticism of his therapy as a "thinly veiled academic lynching."

For instance, Edwards paid $150,000 between 2001 and 2003 to Henry Ford Hospital for what Edwards terms "nonexclusive patent rights [and] ongoing research" into blood oxygen and the mechanism of shock. Dr. Rivers, in an interview, described this as "money I've gotten from the catheter...all for research."

In addition, Edwards said, it has paid Dr. Rivers $158,000 to make speeches about his research, $20,000 to reimburse him for patent legal fees, $36,000 in reimbursed expenses and $40,000 in consulting fees.

Table 4—*An Outcome Survey of Sepsis Initiatives With EGDT Legend

Program	Total Patients, No.	Patients, No. (Mortality %) [95% CI]		Comments
		Preimplementation	Postimplementation	
Loma Linda University (6-h bundle)[106]	330	253 (39.5) [0.33–0.45]	77 (20.8) [0.13–0.31]	Nguyen et al[108] implemented EGDT and the 6-h sepsis bundle over a 2-yr implementation period; there was no statistical difference in ED LOS or ICU LOS (for mortality: $p \leq 0.01$; RR, 0.53; OR, 0.4; RRR, 46.9%; ARR, 18.4%; NNT, 5)
Birmingham Heartlands[109]	101	52 (49) [0.36–0.62]	49 (23) [0.13–0.37]	Gao et al[109] reviewed daily admissions for severe sepsis and septic shock from ED to ICU settings; the rates of compliance with these sepsis bundles were 52% at 6 h and 30% at 24 h (for mortality: $p = 0.045$; RR, 0.7; OR, 0.49; RRR, 30%; ARR, 17.6%; NNT, 6)
Friedrich-Schiller (SOP)[110]	60	30 (53) [0.36–0.70]	30 (27) [0.14–0.45]	Kortgen et al[110] examined outcomes in patients before and after implementing an SOP for patients with severe sepsis (for mortality: $p < 0.05$; RR, 0.51; OR, 0.33; RRR, 49%; ARR, 26.0%; NNT, 4)
Redding Medical Center (shock team)[107]	85	36 (50) [0.35–0.66]	49 (33) [0.21–0.47]	Sebat et al[107] compared preimplementation and postimplementation results in a community hospital shock program; 1 yr after implementation, a significant reduction was seen in mortality, time until patients received central line placement, 2-L infusion of fluids, and antibiotic administration (for sepsis patients in particular: $p = 0.05$; RR, 0.65; OR, 0.48; RRR, 34.7%; ARR, 17.4%; NNT, 6)
Beth Israel Deaconness (sepsis team)[83]	167	51 (29.3) [0.19–0.43]	116 (20.3) [0.14–0.29]	Shapiro et al[83] implemented a multidisciplinary sepsis team, utilizing an SOP procedure for sepsis; a statistically significant improvement in appropriate empiric antimicrobial coverage and tighter glycemic control was found; there was a nonstatistical trend toward decreased mortality ($p = 0.3$; RR, 0.7; OR, 0.62; RRR, 31%; ARR, 9.0%; NNT, 11)
University of Medicine and Dentistry of New Jersey-Camden (EGDT)[82]	38	16 (43.8) [0.17–0. 6]	22 (18.2) [0.73–0.39]	Trzeciak et al[82] implemented a collaborative ED and ICU quality improvement initiative utilizing EGDT; they found that 91% of patients with severe sepsis achieved the EGDT hemodynamic end points of MAP > 65 mm Hg and $Scvo_2 > 70\%$ in < 6 h; nonstatistical decrease in mortality ($p = 0.09$; RR, 0.51; OR, 0.4; RRR, 48.9%; ARR, 17.4%; NNT, 6)

				RRR, 48.9%; ARR, 17.4%; NNT, 6)
University of Pennsylvania (EGDT)[111]	38	22 (55) [0.35–0.74]	16 (25) [0.10–0. 50]	Gaieski et al[111] compared historical standard care for septic patients admitted to the ED who qualified and received EGDT, and evaluated 28-d and 60-d mortality (p = 0.1; RR, 0.46; OR, 0.27; RRR, 54.6%; ARR, 30.0%; NNT, 3)
Hahnemann University (SSC/ IHI)[112]	54	20 (47) [0.27–0.68]	34 (31) [0.18–0.48]	Verceles et al[112] examined a hospital-wide program similar to that of Sebat et al[107]; there were statistically significant decreases in time to antibiotic administration, CVP measurement, and attainment of MAP and $ScvO_2$ goals (for mortality: p value, not reported; RR, 0.66; OR, 0.5; RRR, 34.3%; ARR, 16.1%; NNT, 6)
Good Samaritan (shock team)[113]	131	68 (43) [0.39–0.63]	63 (21) [0.18–0.39]	Armstrong et al[113] utilized a rapid-response team in a community hospital; significant reductions in time until administration of IV fluids, ICU admission, and intensivist arrival; APACHE II scores were 21.9 and 23.0, respectively, for preimplementation and postimplementation (for mortality: p < 0.03; RR, 0.53; OR, 0.35; RRR, 47.1%; ARR, 24%; NNT, 4)
Barnes Jewish Hospital (EGDT)[114]	120	60 (48.3) [0.36–0.61]	60 (30) [0.20–0.43]	Micek et al[114] found a significant mortality benefit when all components of this protocol including education, standing orders, and equipment were available; there was a decreased use of vasopressor and steroids (p = 0.04; RR, 0.63; OR, 0.46; RRR, 37.8%; ARR, 18.2%; NNT, 6)
Hoag Hospital[115]	78	12 (32.5) [0.13–0.60]	66 (21.7) [0.13–0.33]	Rogove[115] conducted a preimplementation and postimplementation study, and found decreased rate of critical care admission (12.3–10.8%; p = 0.403), a decreased median critical care LOS (5.4–3.7 d), and decreased critical care mortality reduction (19.2–12.0%; p = 0.132) (for overall mortality: p = 0.060; RR, 0.67; OR, 0.57; RRR, 33.3%; ARR, 10.8%; NNT, 9)
St. Paul's Hospital, Vancouver[116]	96	51 (46.7) [0.34–0.60]	45 (23.2) [0.13–0.37]	Stenstrom et al[116] studied 50 patients admitted to the ICU from the ED; mean APACHE II score was 24; there was no significant difference in time to ICU transfer (for mortality: p < 0.018; RR, 0.49; OR, 0.34; RRR, 50.4%; ARR, 23.5%; NNT, 4)
Summary of all above centers†	1,298	671 (44.8) ± 7.8 [0.41–0.49]	627 (24.5) ± 5.5 [0.21–0.28]	For all centers reporting mortality data: RR, 0.54; OR, 0.39; RRR, 45%; ARR, 20.3%; NNT, 5
Henry Ford Hospital (EGDT)[12]	263	130 (46.5) [0.36–0.53]	133 (30.0) [0.22–0.38]	Survivors in standard-care group had a significantly longer LOS (18.4 d) those in EGDT group (14.6 d) (in-hospital mortality: p < 01; RR, 0.65; OR, 0.51; RRR, 34.1%; ARR, 15.1%; NNT, 7)

Surviving Sepsis Campaign: International Guidelines for Management of Severe Sepsis and Septic Shock: 2012

A. Initial Resuscitation

1. Protocolized, quantitative resuscitation of patients with sepsis- induced tissue hypoperfusion (defined in this document as hypotension persisting after initial fluid challenge or blood lactate concentration ≥ 4 mmol/L). Goals during the first 6 hrs of resuscitation:

   a) Central venous pressure 8–12 mm Hg

   b) Mean arterial pressure (MAP) ≥ 65 mm Hg

   c) Urine output ≥ 0.5 mL/kg/hr

   d) Central venous (superior vena cava) or mixed venous oxygen saturation 70% or 65%, respectively (grade 1C).

2. In patients with elevated lactate levels targeting resuscitation to normalize lactate (grade 2C).

Lactate et/ou $ScvO_2$??

Le lactate

- Lactate élévé =>↗ mortalité *
- Paramètre reconnu comme critère diagnostic état de choc , critère pr initiation EGDT.

*ArnoldRC,ShapiroNI,JonesAE,SchonC,PopeJ,Casner E et al. Multi-Center Study of Early Lactate Clearance as a Determinant of Survival in Patients with Presumed Sepsis. Shock 2009;32:35-9.

* Nichol AD, Egi M, Pettila V, Bellomo R, French C, Hart G *et al*. Relative hyperlactatemia and hospital mortality in critically ill patients: a retrospective multi-centre study. Crit Care 2010;14:R25.
* Shapiro NI, Howell MD, Talmor D, Nathanson LA, Lis- bon A, Wolfe RE *et al*. Serum lactate as a predictor of mor- tality in emergency department patients with infection. Ann Emerg Med 2005;45:524-8.
*Meregalli A, Oliveira RP, Friedman G. Occult hypoper- fusion is associated with increased mortality in hemody- namically stable, high-risk, surgical patients. Crit Care 2004;8:R60-R65.
* MikkelsenME,MiltiadesAN,GaieskiDF,GoyalM,Fuchs BD, Shah CV *et al*. Serum lactate is associated with mortal- ity in severe sepsis independent of organ failure and shock. Crit Care Med 2009;37:1670-7.

Lactate et/ou SvO_2

- Fluctuations du lactate au cours du choc septique , avec cinétique complexe /
- SvO_2 variation instantanné reflet déséquilibre TaO_2/VO_2, mais interprétation complexe en fonction stade de l'état de choc

Lactate Clearance vs Central Venous Oxygen Saturation as Goals of Early Sepsis Therapy

A Randomized Clinical Trial

Table 4. Administered Treatments and Resuscitation Goals

Intervention, h	No. (%) of Patients: Lactate Clearance Group (n = 150)	No. (%) of Patients: $Scvo_2$ Group (n = 150)	*P* Value[a]
Crystalloid volume, mean (SD), L			
0-<6	4.5 (2.36)	4.3 (2.21)	.55
6-72	12.4 (6.15)	11.8 (6.41)	.44
Vasopressor administration			
0-<6	108 (72)	113 (75)	.60
6-72	100 (67)	108 (72)	.45
Dobutamine administration			
0-<6	5 (3)	8 (5)	.57
6-72	10 (7)	13 (9)	.66
PRBC transfusion			
0-<6	11 (7)	5 (3)	.20
6-72	35 (23)	31 (21)	.78
Mechanical ventilation			
0-<6	40 (27)	39 (26)	.99
6-72	69 (46)	75 (50)	.56
Activated protein C			
0-<6	0	0	
6-72	3 (2)	2 (1)	.68
Parenteral corticosteroids			
0-<6	18 (12)	26 (17)	.25
6-72	59 (39)	51 (34)	.40

Abbreviations: PRBC, packed red blood cell; $Scvo_2$, central venous oxygen saturation.
[a] Continuous variables are compared using unpaired *t* test; categorical variables, using χ^2 test except activated protein C which was analyzed using Fisher exact test.

Lactate Clearance vs Central Venous Oxygen Saturation as Goals of Early Sepsis Therapy

A Randomized Clinical Trial

Table 5. Hospital Mortality and Length of Stay

Variable	Lactate Clearance Group (n = 150)	$Scvo_2$ Group (n = 150)	Proportion Difference (95% Confidence Interval)	*P* Value[b]
In-hospital mortality, No. (%)[a]				
Intent to treat	25 (17)	34 (23)	6 (−3 to 15)	
Per protocol	25 (17)	33 (22)	5 (−3 to 14)	
Length of stay, mean (SD), d				
ICU	5.9 (8.46)	5.6 (7.39)		.75
Hospital	11.4 (10.89)	12.1 (11.68)		.60
Hospital complications				
Ventilator-free days, mean (SD)	9.3 (10.31)	9.9 (11.09)		.67
Multiple organ failure, No. (%)	37 (25)	33 (22)		.68
Care withdrawn, No. (%)	14 (9)	23 (15)		.15

Abbreviations: ICU, intensive care unit; $Scvo_2$, central venous oxygen saturation.
[a] Primary study end point.
[b] Continuous data are compared using an unpaired *t* test; categorical variables, using the χ^2 test.

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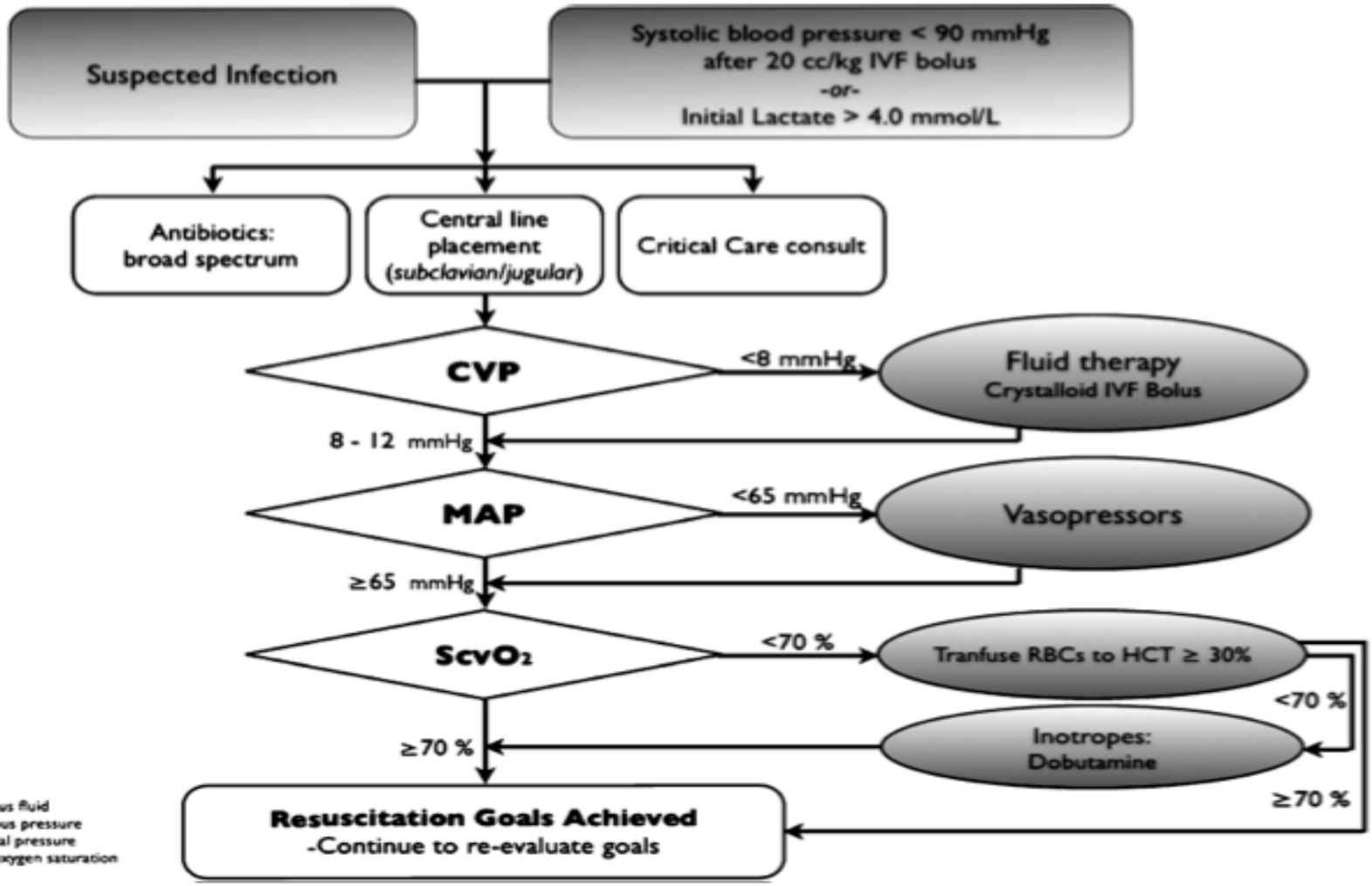
MULTICENTER STUDY OF EARLY LACTATE CLEARANCE AS A DETERMINANT OF SURVIVAL IN PATIENTS WITH PRESUMED SEPSIS

Ryan C. Arnold,* Nathan I. Shapiro,† Alan E. Jones,‡ Christa Schorr,§ Jennifer Pope,† Elisabeth Casner,‡ Joseph E. Parrillo,§ R. Phillip Dellinger,§ Stephen Trzeciak,* and on behalf of the Emergency Medicine Shock Research Network (EMShockNet) Investigators



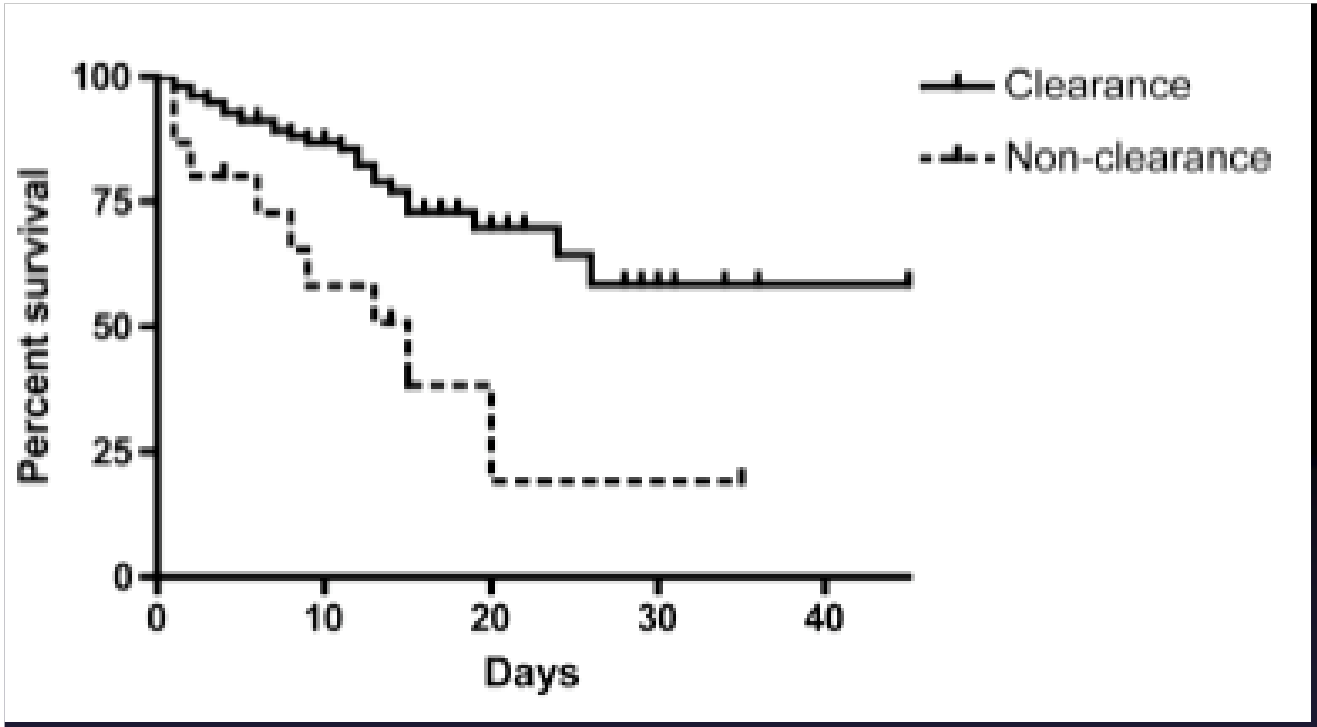


TABLE 3. **Lactate clearance and $Scvo_2$ goals**

	Lactate non-clearance	Lactate clearance	Total
$Scvo_2$ <70%	3	20	23
$Scvo_2$ ≥70%	11	114	125
	14	134	148

TABLE 4. **Survivors versus nonsurvivors (n = 166)**

	Survivors (n = 128)	Nonsurvivors (n = 38)	*P*
Age, mean (SD), y	66 (15)	66 (16)	1.00
SBP <90 mmHg despite i.v. fluids, n (%)	42 (33)	21 (55)	0.02
Initial serum lactate, mean (SD)	4.3 (2.6)	4.7 (2.8)	0.41
Serial serum lactate, mean (SD)	2.2 (1.6)	3.6 (2.8)	<0.001
Individual organ failure, n (%)			
Cardiovascular	42 (33)	21 (55)	0.02
Pulmonary	20 (16)	8 (21)	0.64
Renal	43 (34)	11 (29)	0.70
Hepatic	9 (7)	5 (13)	0.40
Coagulopathy	15 (12)	8 (21)	0.26
Total SOFA score, mean (SD)	3.6 (2.6)	3.7 (2.7)	0.84
Continuous $Scvo_2$ monitoring, n (%)	112 (87)	36 (95)	0.28
$Scvo_2$ ≥70% achieved, n (%)	99 (88)	26 (72)	0.03
Lactate clearance ≥10%, n (%)	122 (95)	29 (76)	0.001

Prognostic Value and Agreement of Achieving Lactate Clearance or Central Venous Oxygen Saturation Goals During Early Sepsis Resuscitation

Concordance between reaching central venous oxygen saturation and lactate clearance goals.

	Met LC goal	Failed to meet LC goal	Total
Met $ScvO_2$ goal	153	22	175
Failed to meet $ScvO_2$ goal	25	3	28
Total	178	25	203

$ScvO_2$ = central venous oxygen saturation; LC = lactate clearance

Lactate et /ou SvO_2

- 2 paramètres non équivalents , mais complémentaires!!!
- Inclusion récente ds SCC bundle de la clairance du lactate, un des critères de la goal therapy

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2. In patients with elevated lactate levels targeting resuscitation to normalize lactate (grade 2C).

Outcome effectiveness of the severe sepsis resuscitation bundle with addition of lactate clearance as a bundle item: a multi-national evaluation

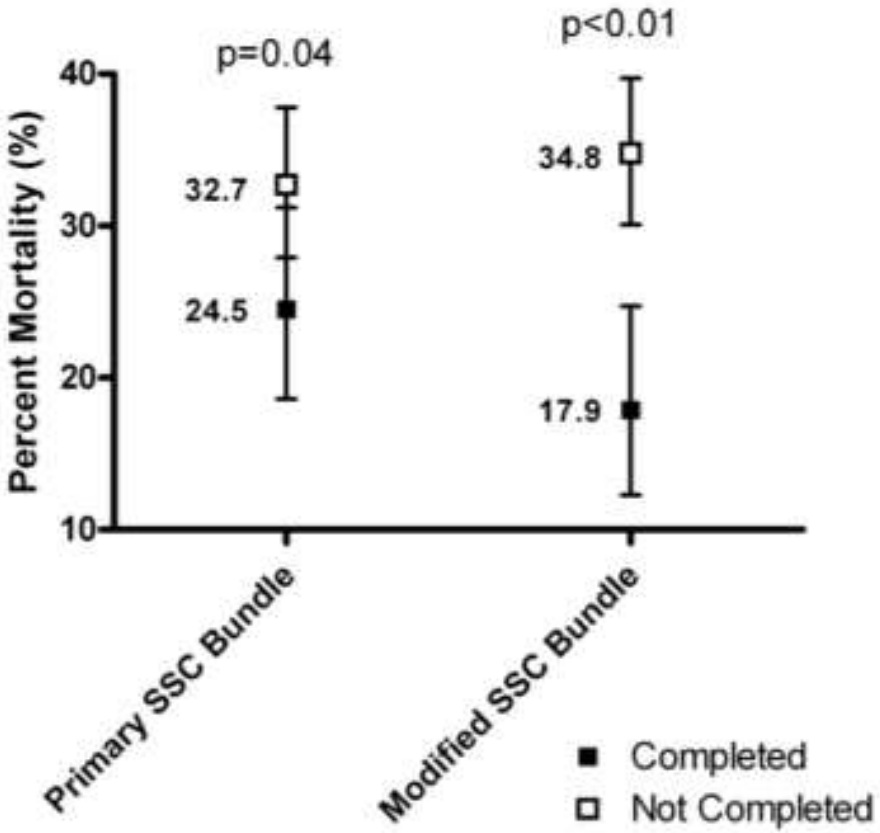


Figure 2 Mortality differences for the Surviving Sepsis Campaign bundles. Mortality differences for the Primary Surviving

Et si on ramenait trop d'O_2?

Multi-Center Study of Central Venous Oxygen Saturation ($ScvO_2$) as a Predictor of Mortality in Patients with Sepsis

Jennifer V. Pope, MD, Alan E. Jones, MD, David F. Gaieski, MD, Ryan C. Arnold, MD, Stephen Trzeciak, MD, MPH, and Nathan I. Shapiro, MD, MPH the EMShocknet investigators

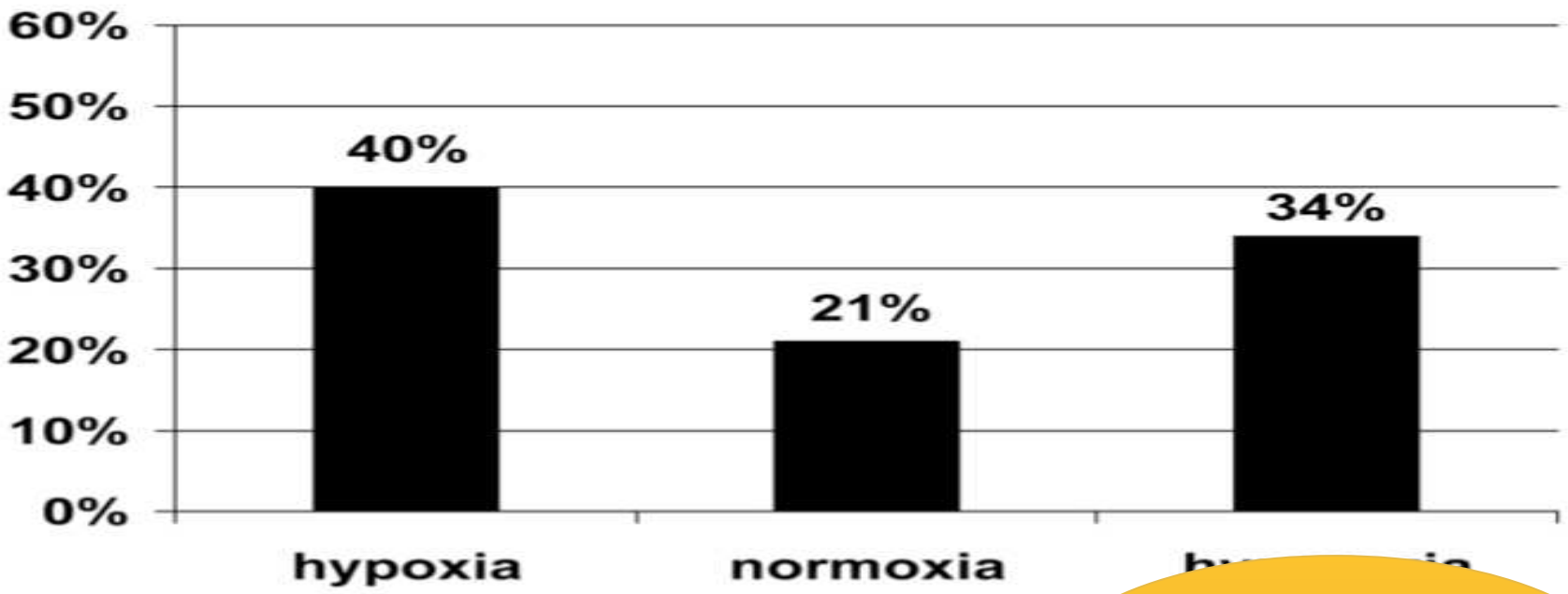
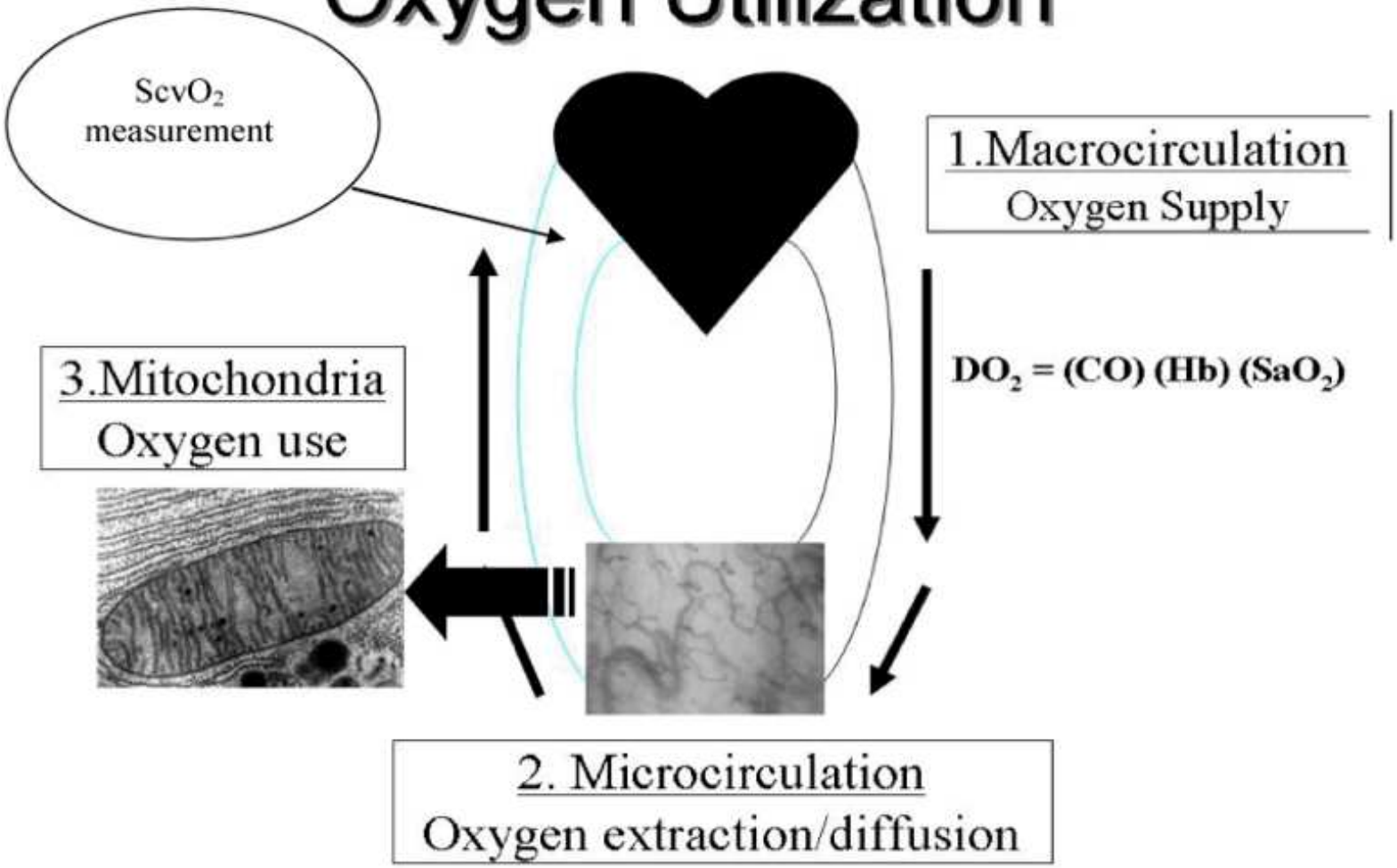


Figure 1. Maximum ScvO2 groups – The Association of Hypoxia, N Mortality
The figure above shows the mortality rates by ScvO2 groups of (70-90%), and hyperoxia (> 90%). There was a significant differ mortality rates for the hypoxia group (40%; 29 – 53%) versus the 25%) and hyperoxia group (34%; 25 – 44%) versus normoxia (21%;

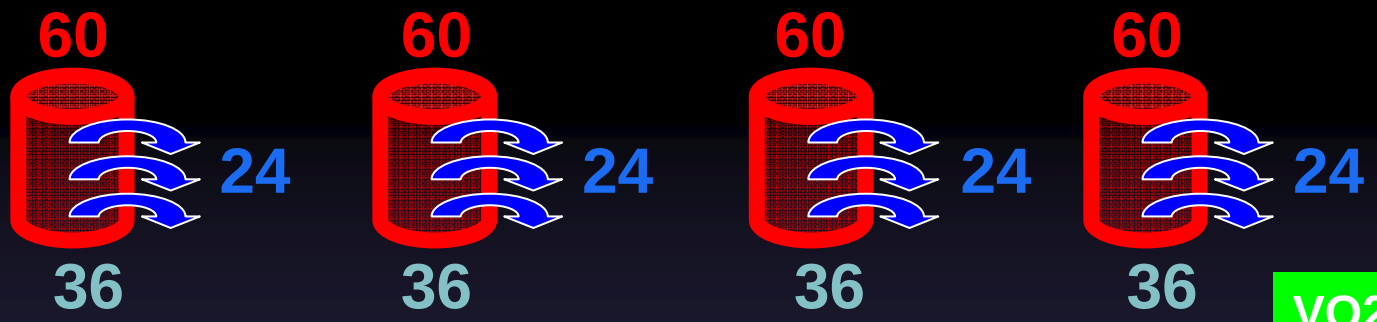
Anomalies d'EO2!!!!

Oxygen Utilization

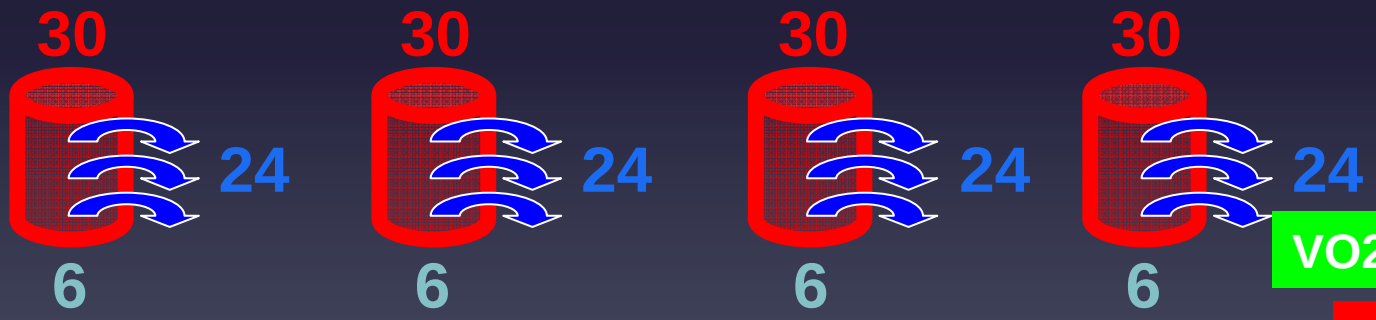


Etats de bas débit et EO2

Flux normal



VO2 globale = 96

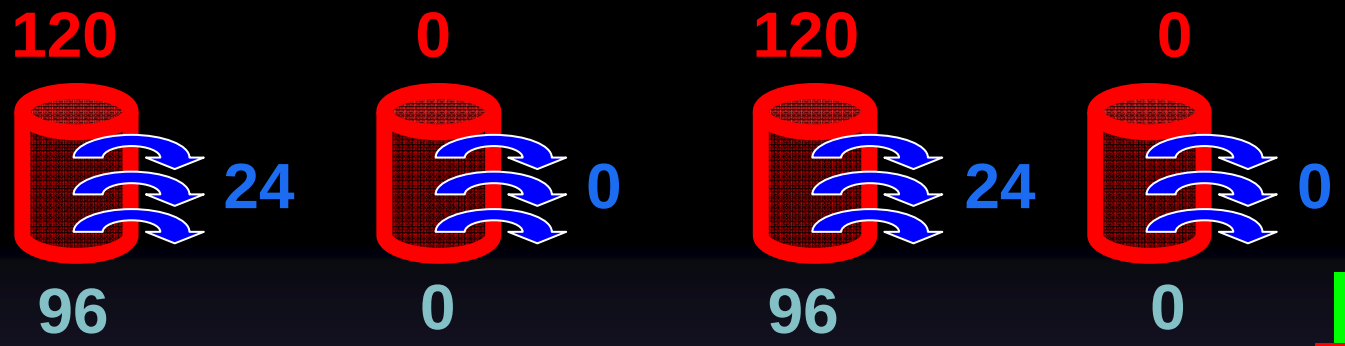


VO2 globale = 96

Bas débit homogène

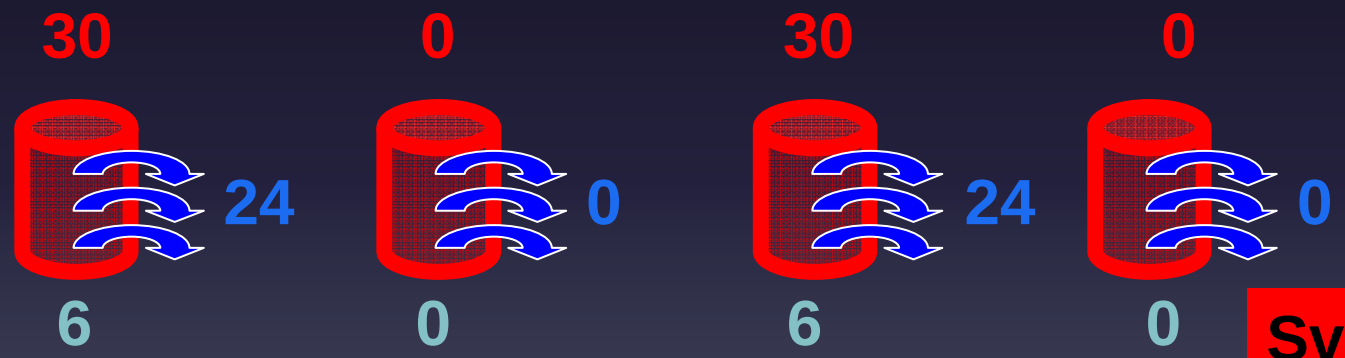
SvO2 basse

Choc distributif « réanimé »



VO2 globale = 48

SvO2 normale



VO2 globale = 48

SvO2 très basse

Choc distributif avant réanimation

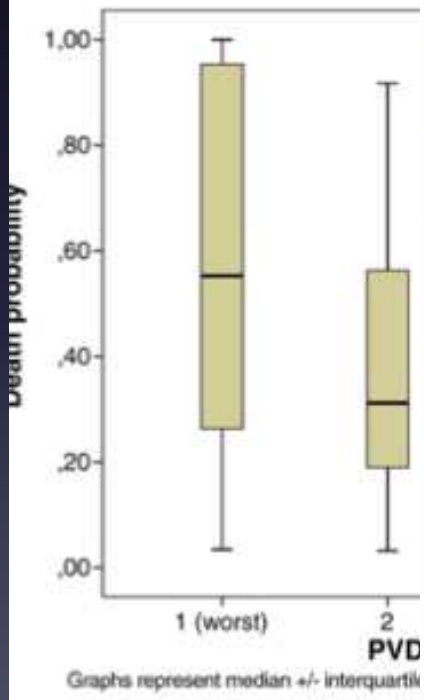
Severe abnormalities in microvascular perfused vessel density are associated to organ dysfunctions and mortality and can be predicted by hyperlactatemia and norepinephrine requirements in septic shock patients

Glenn Hernandez MD[a,b,*], E. Christiaan Boerma MD, PhD[c], Arnaldo Dubin MD, PhD[d], Alejandro Bruhn MD, PhD[b], Matty Koopmans RN[c], Vanina Kanoore Edul MD[d], Carolina Ruiz MD[b], Ricardo Castro MD[b], Mario Omar Pozo MD[d], Cesar Pedreros MD[b], Enrique Veas M
Maximiliano R

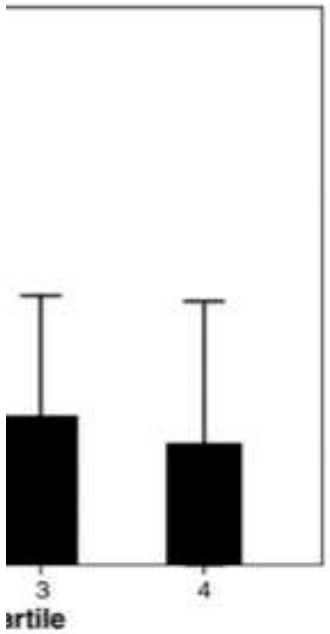
Table 1 Comparison of lowest vs upper PVD quartile

Quartile	First (n = 30)	Second to fourth (n = 92)	*P*
Age (y)	56 (48-68)	63 (55-76)	.22
APACHE II score	23 (18-27)	20 (16-23)	.02 *
SOFA score	12 (10-14)	9 (7-11)	.001 *
SOFA 24 h	12 (8-16)	9 (7-11)	.002 *
MAP (mm Hg)	67 (63-73)	70 (64-77)	.21
NE dose (μg/kg per minute)	0.37 (0.16-0.72)	0.05 (0-0.13)	.0001 *
Lactate (mmol/L)	5.8 (2.3-9.5)	2.1 (1.2-3.4)	.002 *
Svo_2 (%)	75 (67-80)	71 (66-75)	.064
Cardiac index (L/min per square meter)	4.6 (3.2-5.5)	4.0 (3.5-4.9)	.68

Values are expressed as median (interquartile range).
* Mann-Whitney *U* test.



ig. 1 Relation between PVD quartile and mortality (estimate robability).

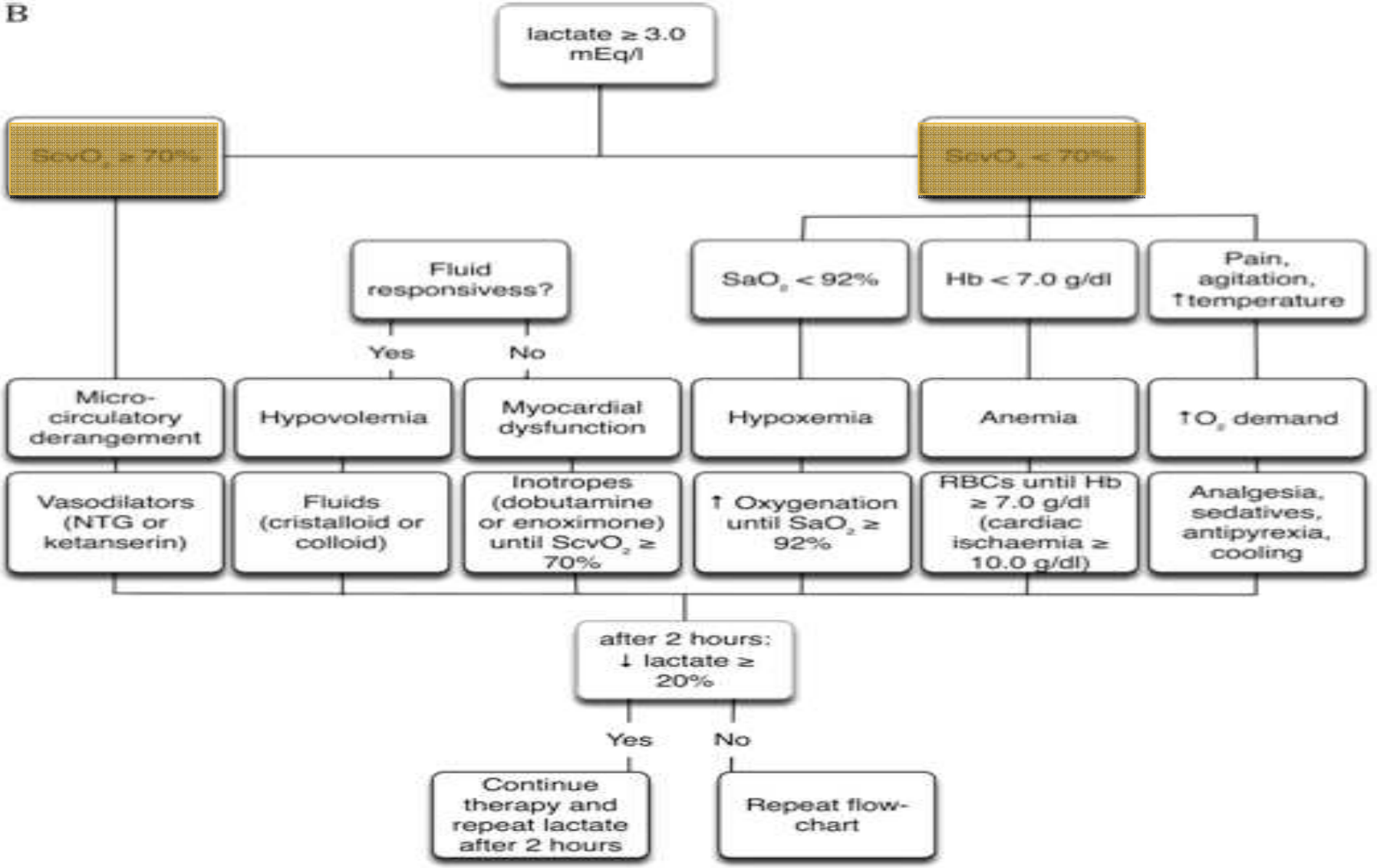


ording to PVD quartile. A significant difference between the lowest and any other PVD quartile was observed (analysis of variance, $P = .001$, Bonferroni post hoc).

Early Lactate-Guided Therapy in Intensive Care Unit Patients

A Multicenter, Open-Label, Randomized Controlled Trial

B



Conclusion

- SvO_2 /$SvcO_2$ bon paramètre de monitoring HD
- Interprétation délicate nécessitant une connaissance des subtilités des états de chocs
- Intérêt d'un monitoring continu ou régulier++++, et surtout précoce
- un des critères de la goal therapy ds choc septique admis par SSC
- Intérêt d'un couplage lactate /$SvcO_2$
- Mesure intermittente vs continue (risque infectieux ? Et impact économique?)