Évaluation de la fonction cardiaque et instabilité hémodynamique: Partie I

André Denault MD PhD

Université de Montréal

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

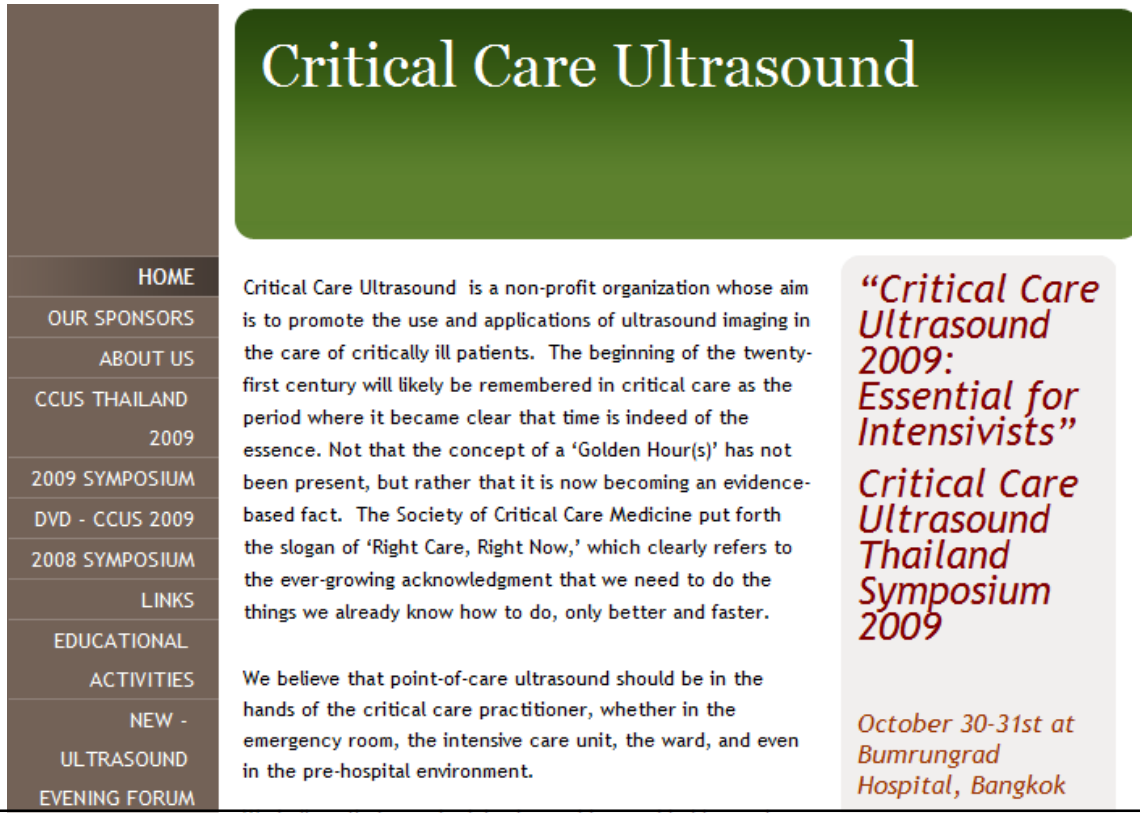
CHUM

Montréal, le 22 septembre 2010

Ressources

- Articles du JCA
  - –Deslauriers, Rochon Denault, Coutu, Latulipe Lapointe
- TEE multimedia manual
  - –Chapitre 10

www.criticalcareultrasound.com/

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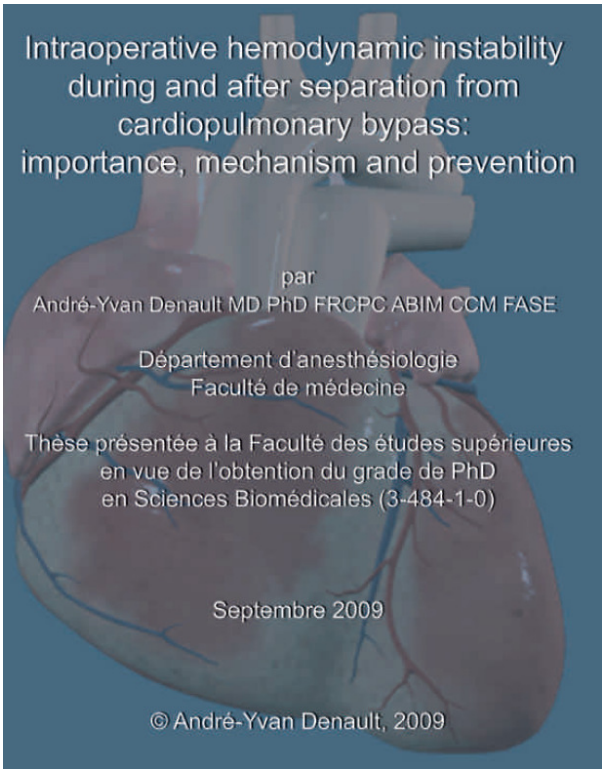
Montréal, Québec, Canada
Directeur de la formation échographie CAE Santé

andre.denault@umontreal.ca

Objectifs

- Revoir les mécanismes d'instabilité hémodynamique en combinant le concept du retour veineux, les courbes pression-volume et l'échographie
- Proposer une approche systématique en présence d'un patient instable hémodynamiquement en SOP ou aux SI


Intraoperative hemodynamic instability during and after separation from cardiopulmonary bypass: importance, mechanism and prevention
par
André-Yvan Denault MD PhD FRCPC ABIM CCM FASE
Département d'anesthésiologie
Faculté de médecine
Thèse présentée à la Faculté des études supérieures en vue de l'obtention du grade de PhD en Sciences Biomédicales (3-484-1-0)
Septembre 2009
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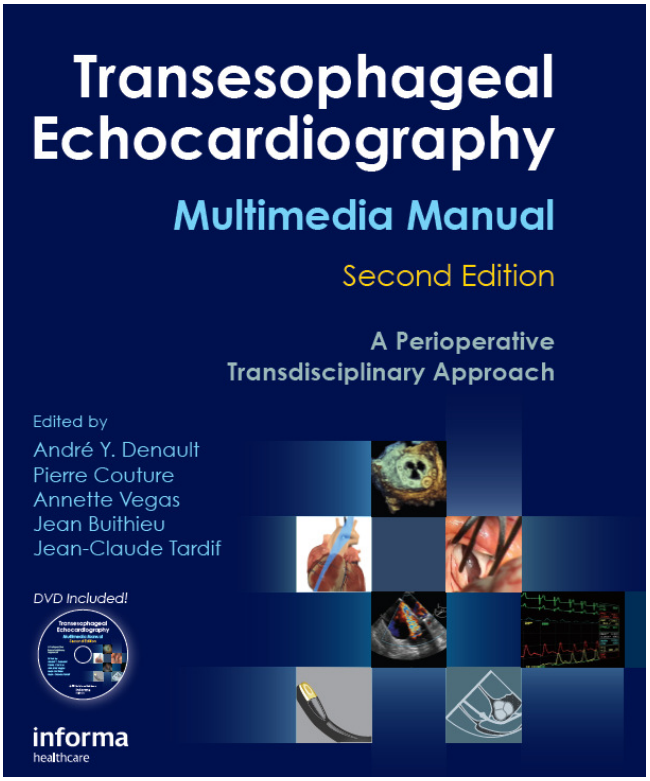
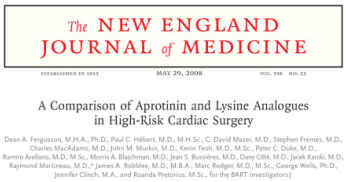

Transesophageal Echocardiography
Multimedia Manual
Second Edition
A Perioperative Transdisciplinary Approach
Edited by
André Y. Denault
Pierre Couture
Annette Vegas
Jean Buithieu
Jean-Claude Tardif
DVD Included!
informa
healthcare

Définition

Importance



The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 29, 2008 VOL. 358 NO. 22

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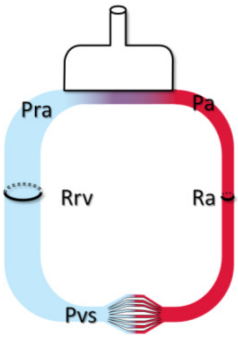
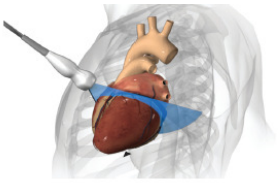
Mécanisme



Approche



Support à la recherche

Fondation de la Recherche en Santé du Québec

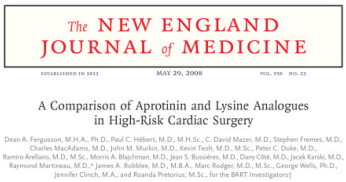
Earl Wynands Award of the CAS

Fondation de l'Institut de Cardiologie de Montréal

Instituts de recherche en santé du Canada
Canadian Institutes of Health Research

Définition

Importance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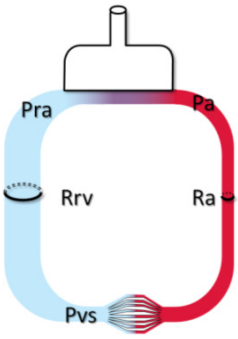

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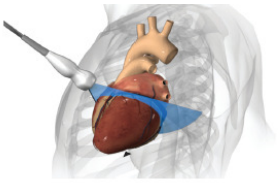
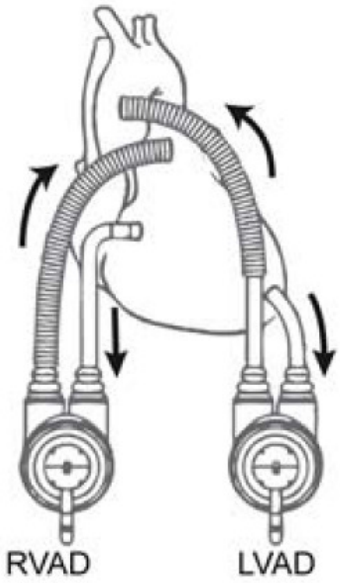
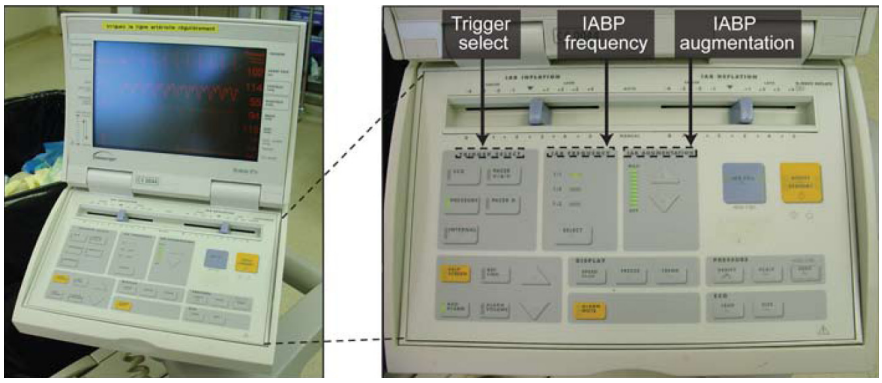
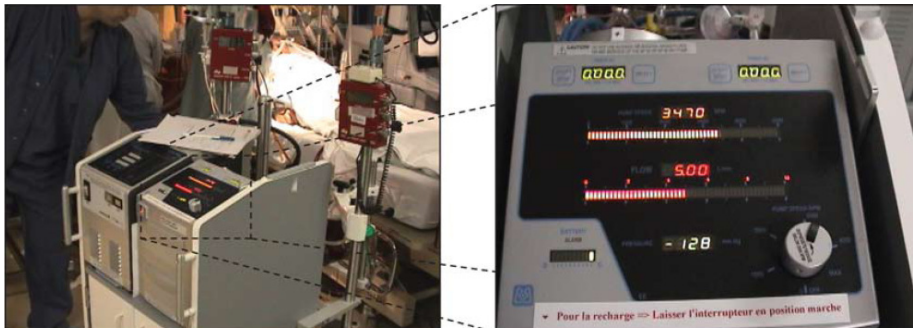


Difficult separation from CPB


ALARMES DE
II
V
PAP
PVC
107
-0.2
0.1
104/37
44/29
57/16
(31)
34


RVAD
LVAD

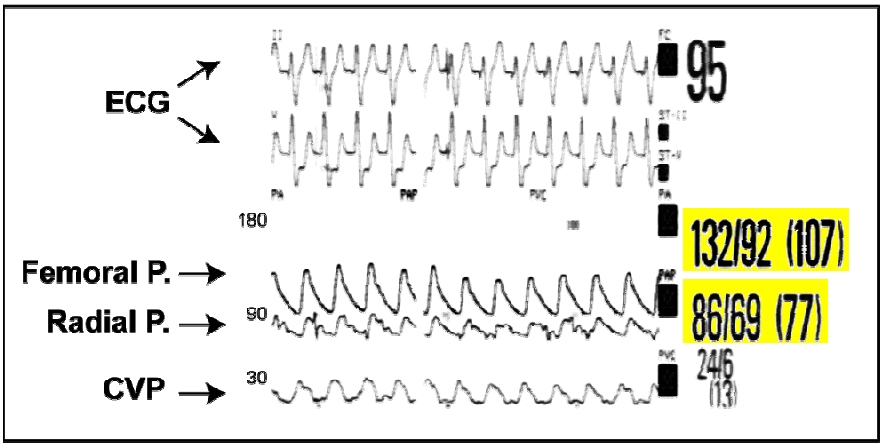

Trigger select
IABP frequency
IABP augmentation

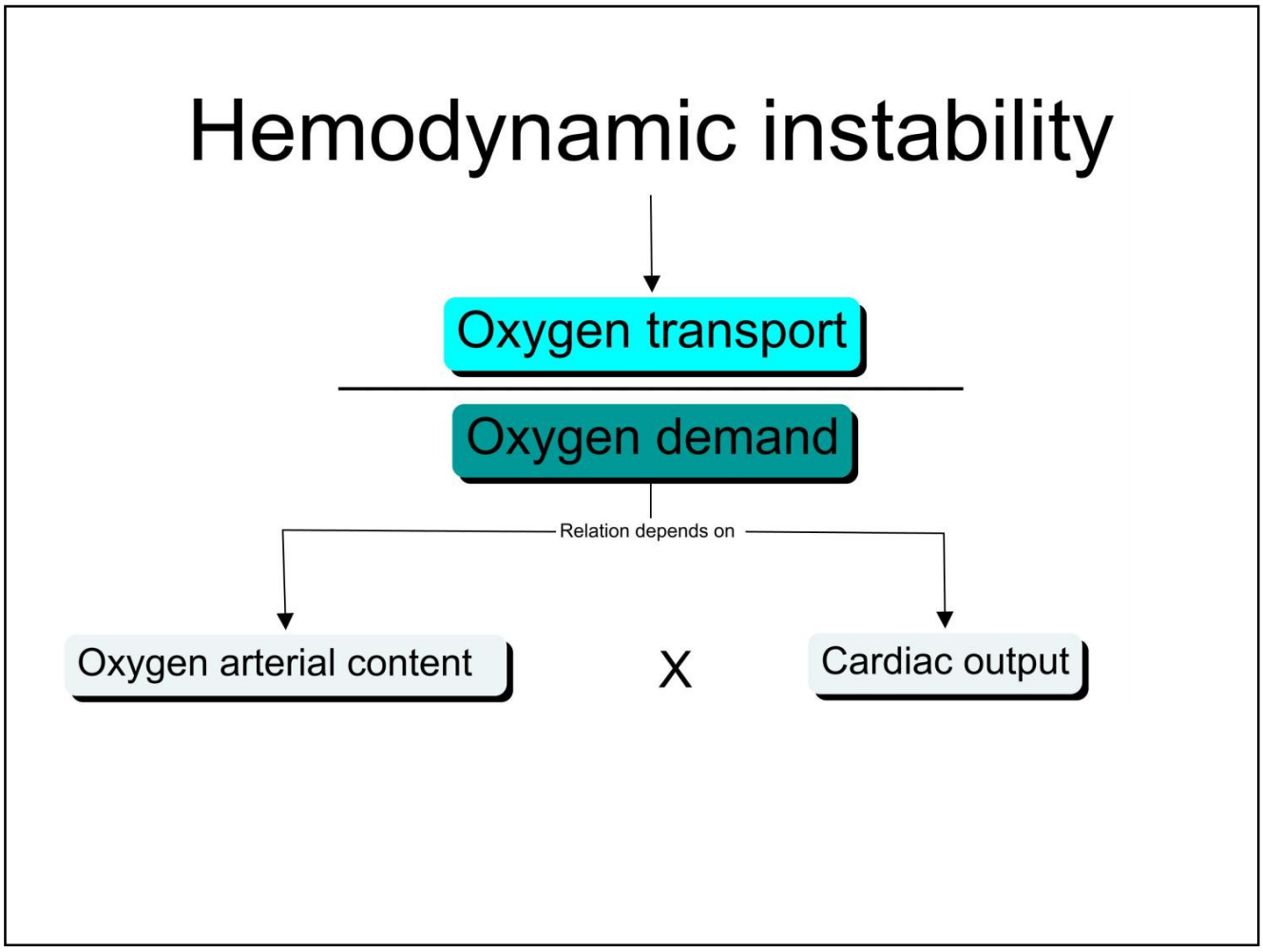

3470
500
128
Pour la recharge => Laisser l'interrupteur en position marche


FC 48
FR
PA (91)
132/ 66
AP (13)
21/ 8
PVC(6)
P4A(94)
139/ 67
%SO2 100
PR 50
T1A
T1B33.5
DC 3.0
TS 33.1

Abnormal aortic-to-radial arterial pressure gradients resulting in misdiagnosis of hemodynamic instability

André Denault, MD · Alain Deschamps, MD, PhD

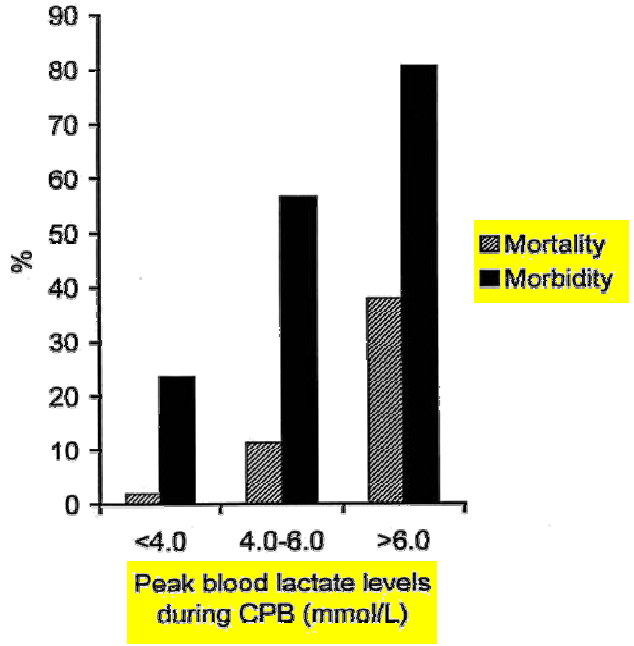



Hemodynamic instability
Oxygen transport
Oxygen demand
Relation depends on
Oxygen arterial content
X
Cardiac output

Outcome With High Blood Lactate Levels During Cardiopulmonary Bypass in Adult Cardiac Operation

Philippe Demers, MD, Stéphane Elkouri, MD, Raymond Martineau, MD, André Couturier, MSc, and Raymond Cartier, MD

Division of Cardiothoracic Surgery, Departments of Surgery, and Departments of Anesthesia and Biostatistics, Montreal Heart Institute, Montreal, Quebec, Canada



Demers et al ATS 2000


BIS
ASPECT
97

Association of Perioperative Risk Factors and Cumulative Duration of Low Bispectral Index with Intermediate-term Mortality after Cardiac Surgery in the B-Unaware Trial

Miklos D. Kertai, M.D., Ph.D.,* Nirvik Pal, M.D.,* Ben J. A. Palanca, M.D., Ph.D.,† Nan Lin, Ph.D.,‡ Sylvia A. Searleman, B.S.,§ Lini Zhang, M.D.,§ Beth A. Burnside, B.A.,§ Kevin J. Finkel, M.D.,‖ Michael S. Avidan, M.B., B.Ch., F.C.A.S.A.#; on behalf of the B-Unaware Study Group**

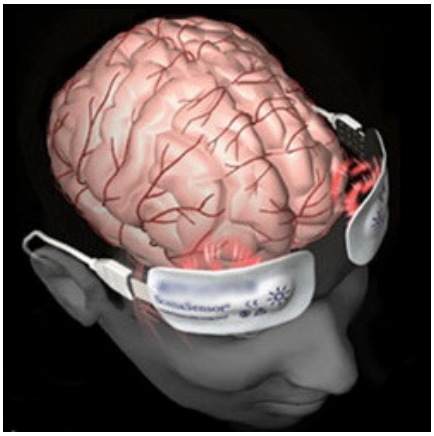
Anesthesiology 2010; 112:1116–27

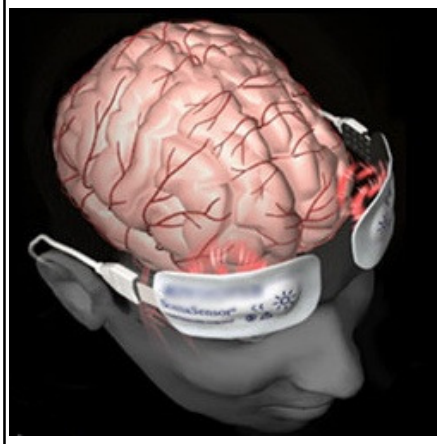
Table 5. Multivariable Predictors of Intermediate-term Mortality

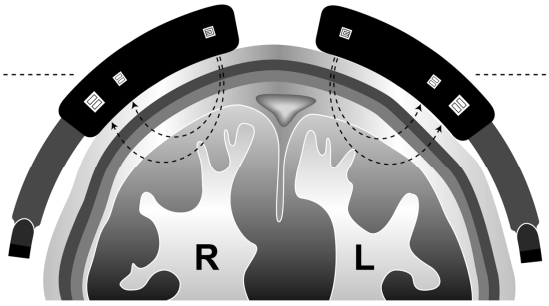
Predictors	Hazard Ratio (95% Confidence Interval)	*P* Value
Additive Euroscore per 1 point increase	1.13 (1.10–1.22)	0.001
Preoperative hemoglobin, per 1 g/dl increase	0.84 (0.74–0.95)	0.007
Erythrocyte transfusion per unit increase	1.10 (1.02–1.18)	0.01
Cumulative duration of bispectral index < 45, per hour	1.29 (1.12–1.49)	< 0.0001
Intraoperative infusion of norepinephrine	1.89 (1.15–3.10)	0.01
Intraoperative administration of tranexamic acid	0.56 (0.36–0.88)	0.01
Intensive care unit stay, per day increase	1.05 (1.04–1.07)	< 0.0001

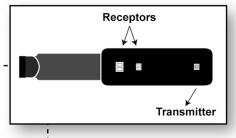
N = 460 patients

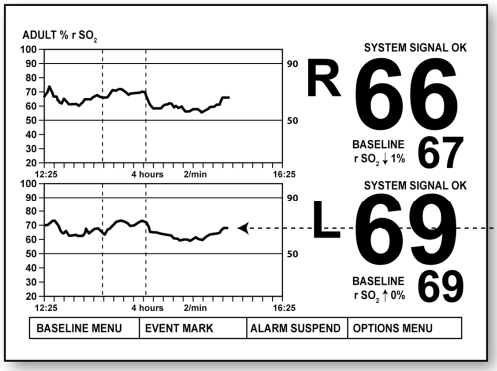
At the same time

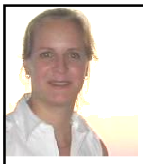





R
L

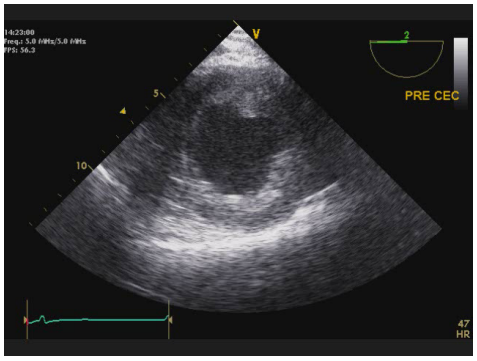

Receptors
Transmitter


ADULT % r SO2
100
90
80
70
60
50
40
30
20
12:25
4 hours
2/min
16:25
SYSTEM SIGNAL OK
R
66
BASELINE
r SO2 ↓ 1%
67
SYSTEM SIGNAL OK
L
69
BASELINE
r SO2 ↑ 0%
69
BASELINE MENU
EVENT MARK
ALARM SUSPEND
OPTIONS MENU

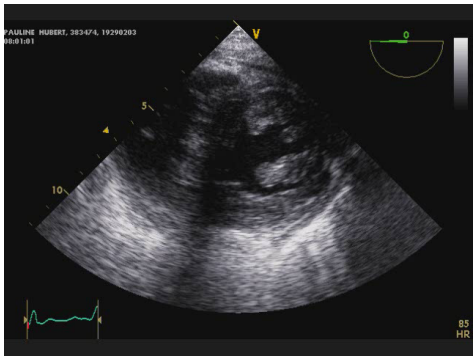


Fonction cardiaque et rSO_2

♂ 74 ans avant PAC et RVA



♀ 77 ans retour en SOP après PAC



Journal of Cardiothoracic and Vascular Anesthesia, ***2008***

A Proposed Algorithm for the Intraoperative Use of Cerebral Near-Infrared Spectroscopy

André Denault, MD, FRCPC, ABIM-CCM,
Alain Deschamps, MD, FRCPC, PhD,
and John M. Murkin, MD, FRCPC

Seminars in Cardiothoracic and Vascular Anesthesia 2007

En résumé

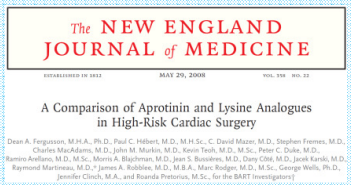

107
-0.2
0.1
104/37
44/29
57/16
34
PAP
PVC
ST-II
ST-V

=


PEDIATRIC
25.09.05
05:07:20
ALARM LOW
L 36
SYSTEM SIGNAL OK
R 43
4 HOURS
2/MIN
LEFT
RIGHT
MAIN MENU

Définition

Importance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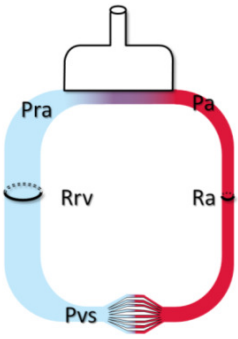

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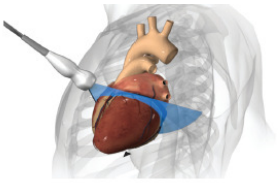
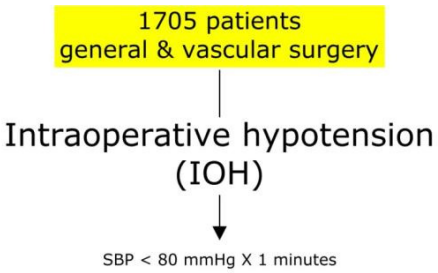


Anesthesiology 2009; 111:1217–26

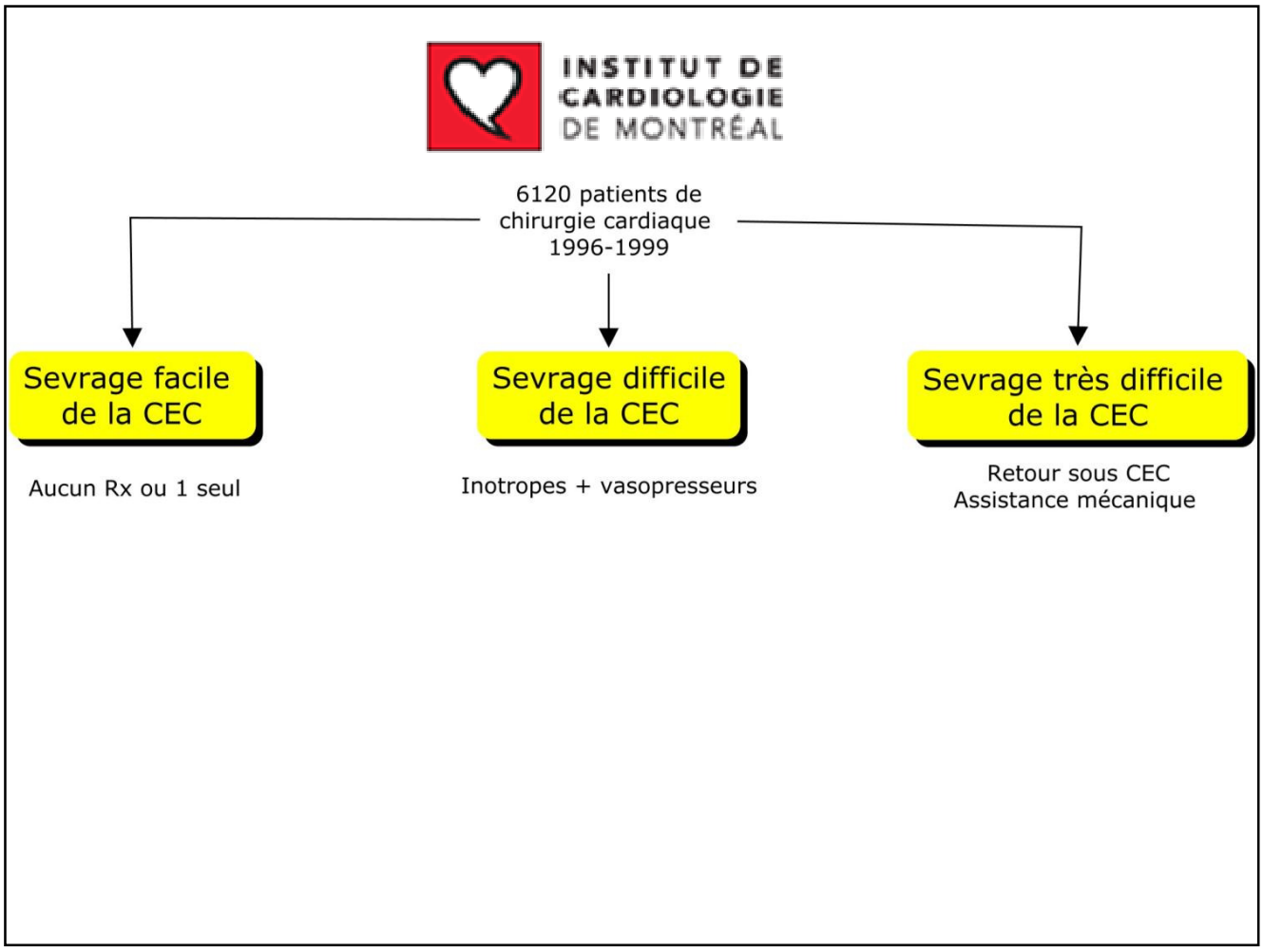
Intraoperative Hypotension and 1-Year Mortality after Noncardiac Surgery

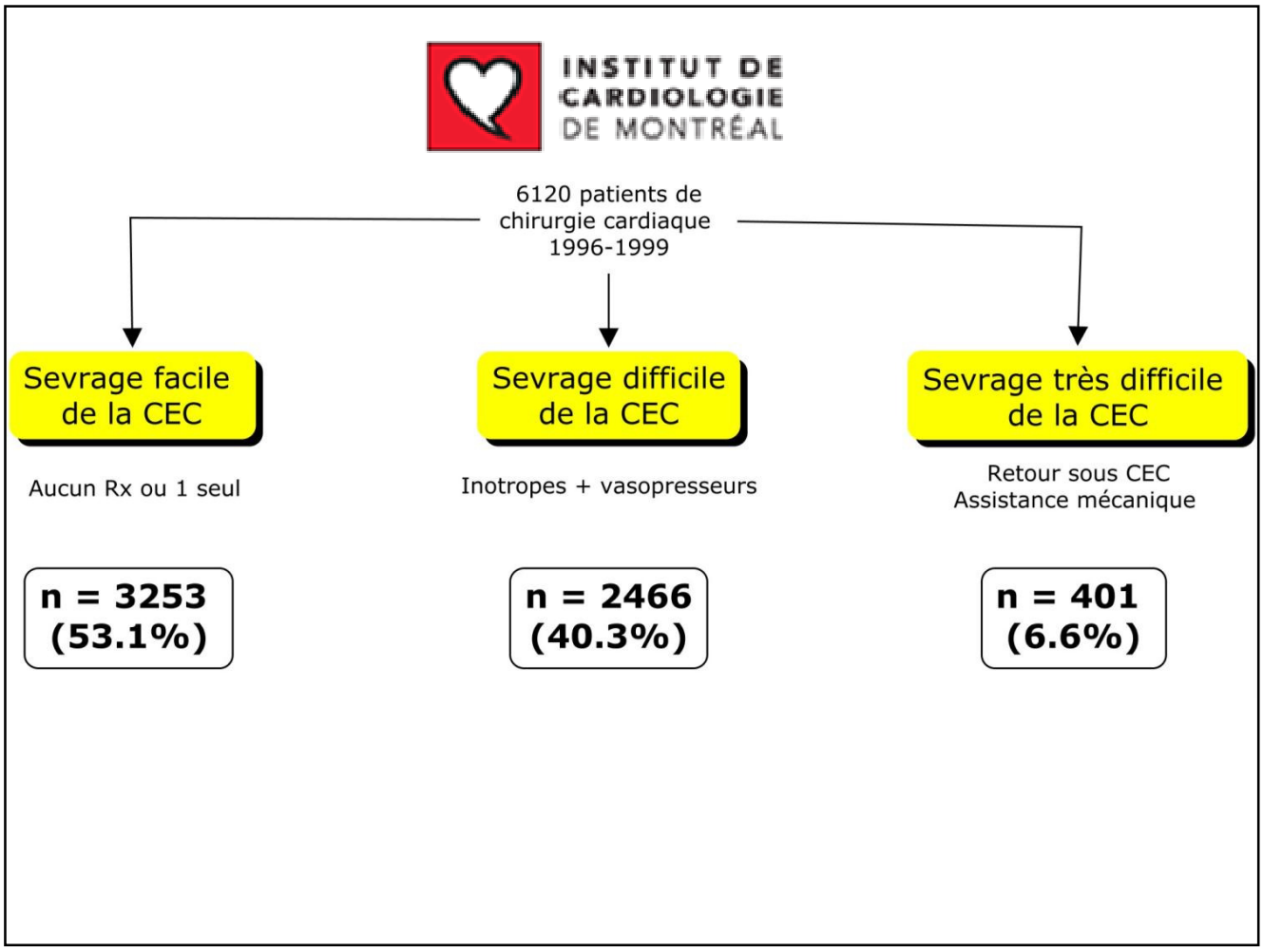
Jilles B. Bijker, M.D., Wilton A. van Klei, M.D., Ph.D.,† Yvonne Vergouwe, Ph.D.,‡ Douglas J. Eleveld, Ph.D.,§ Leo van Wolfswinkel, M.D., Ph.D.,† Karel G. M. Moons, Ph.D.,‡ Cor J. Kalkman, M.D., Ph.D.#*



current study. However, CART analysis revealed that in elderly patients, IOH is associated with 1-yr mortality according to a range of blood pressure thresholds and corresponding durations of the hypotensive episode, *i.e.*, lower blood pressures were tolerated for shorter durations. This confirms the clinical experience that


Advil
Dr MARTINEAU
RAYMOND
1949- 2005


INSTITUT DE CARDIOLOGIE DE MONTRÉAL
6120 patients de chirurgie cardiaque 1996-1999
Sevrage facile de la CEC
Aucun Rx ou 1 seul
Sevrage difficile de la CEC
Inotropes + vasopresseurs
Sevrage très difficile de la CEC
Retour sous CEC
Assistance mécanique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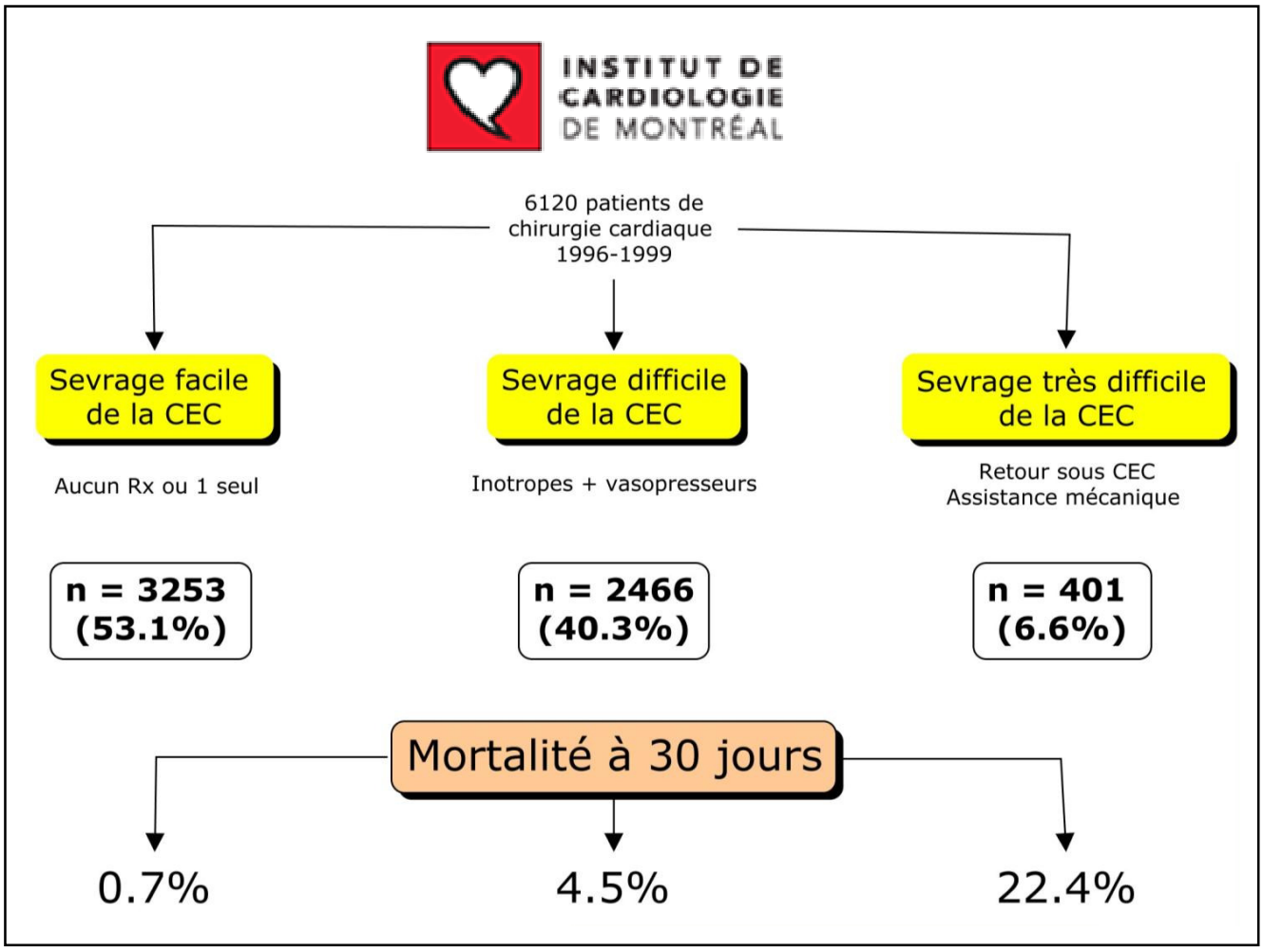
Sevrage facile de la CEC
Aucun Rx ou 1 seul
n = 3253 (53.1%)
Sevrage difficile de la CEC
Inotropes + vasopresseurs
n = 2466 (40.3%)
Sevrage très difficile de la CEC
Retour sous CEC
Assistance mécanique
n = 401 (6.6%)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Retour sous CEC
Assistance mécanique
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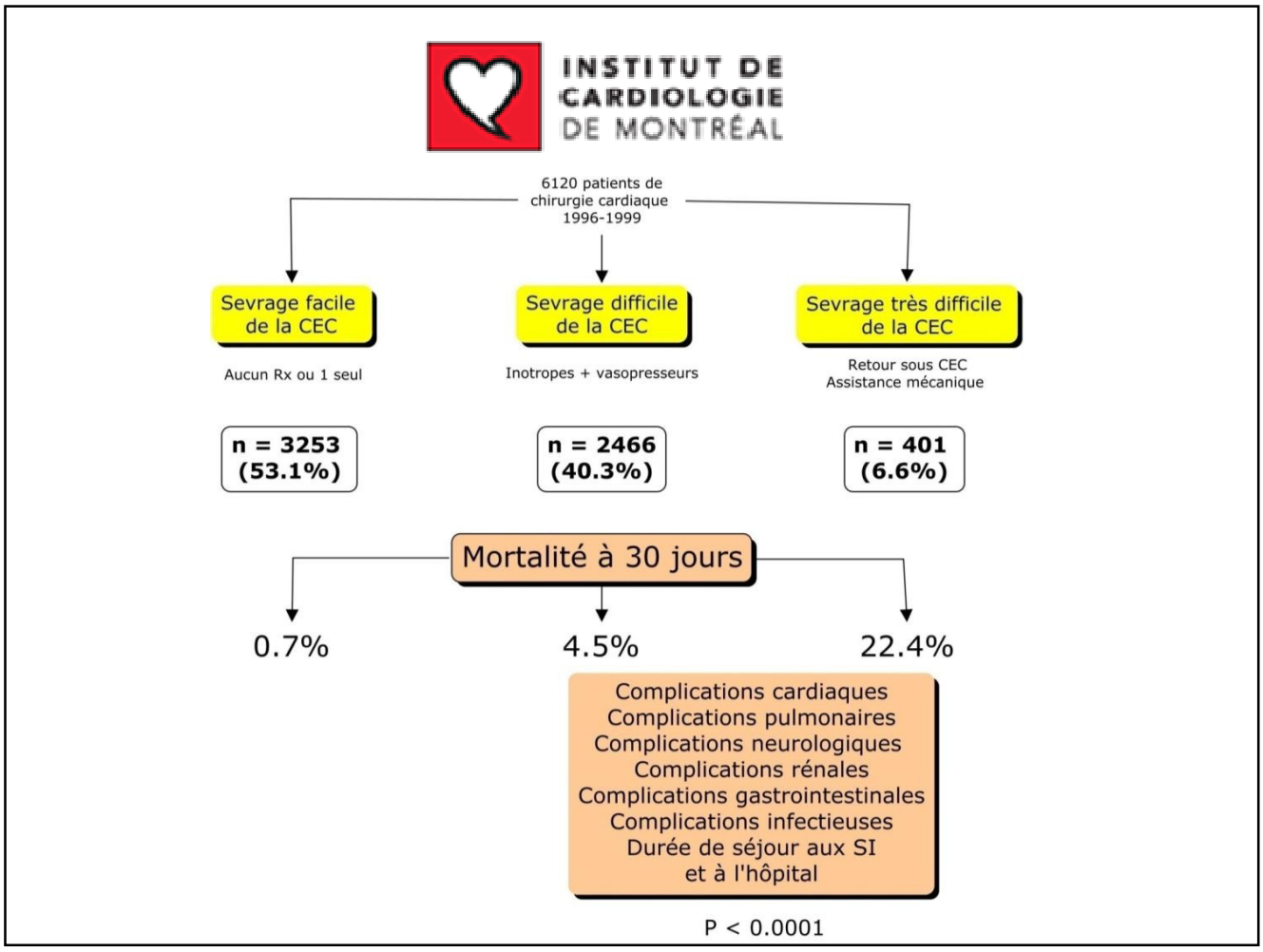
Mortalité à 30 jours
0.7%
4.5%
22.4%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Retour sous CEC
Assistance mécanique
n = 401 (6.6%)
Mortalité à 30 jours
0.7%
4.5%
22.4%
Complications cardiaques
Complications pulmonaires
Complications neurologiques
Complications rénales
Complications gastrointestinales
Complications infectieuses
Durée de séjour aux SI
et à l'hôpital
P < 0.0001

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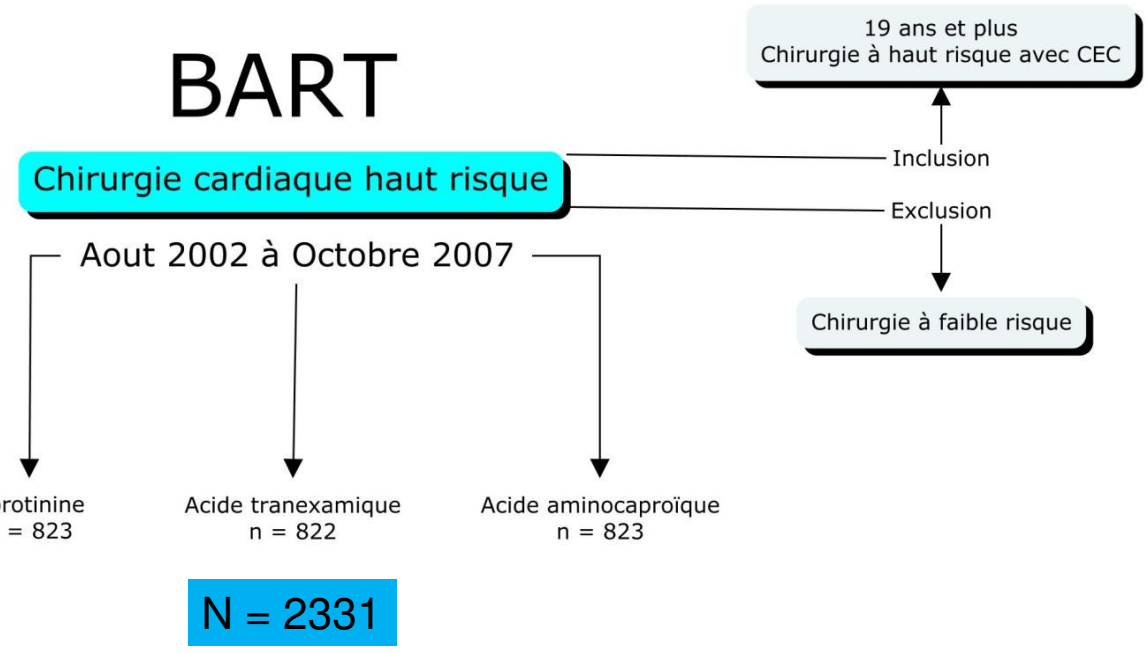

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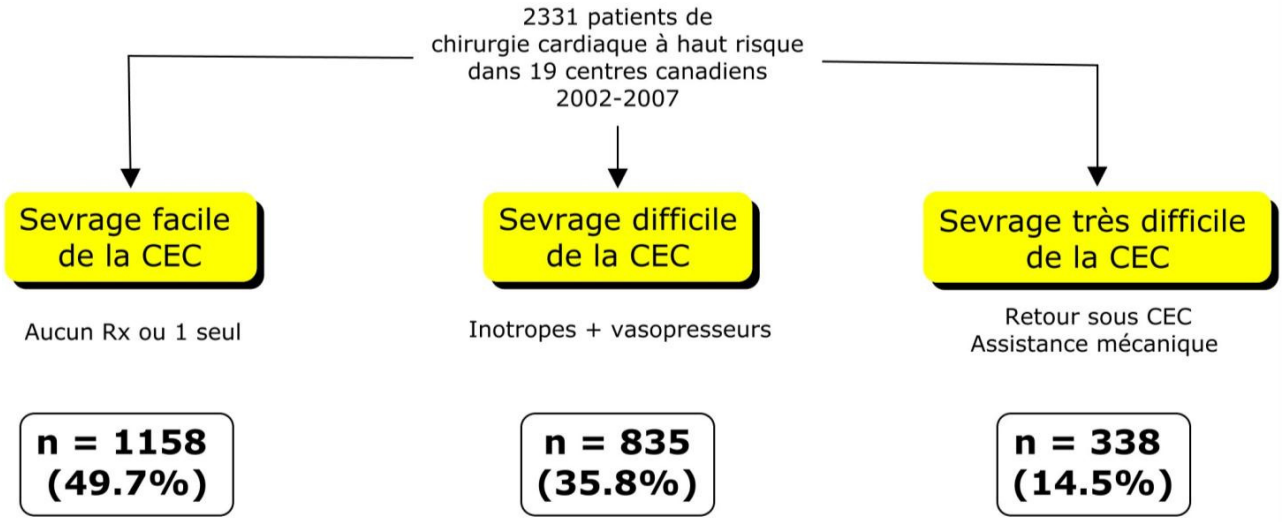

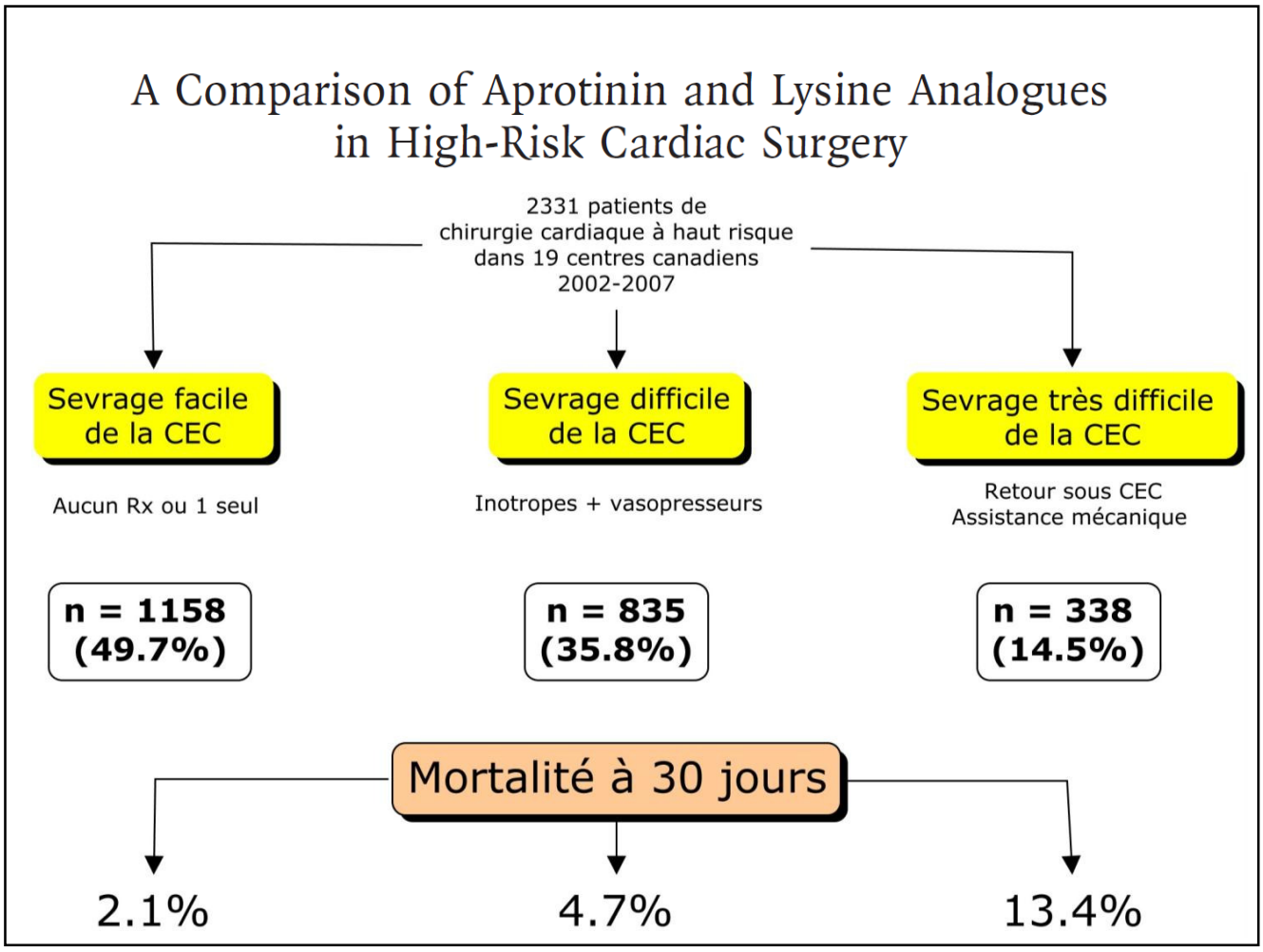
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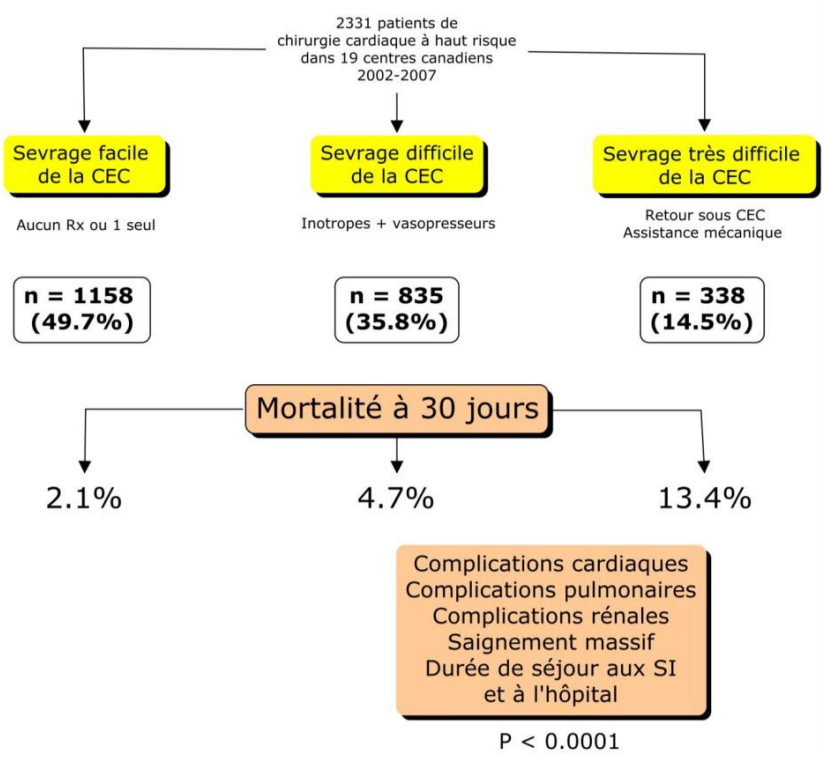
2331 patients de chirurgie cardiaque à haut risque dans 19 centres canadiens 2002-2007
Sevrage facile de la CEC
Aucun Rx ou 1 seul
n = 1158 (49.7%)
Sevrage difficile de la CEC
Inotropes + vasopresseurs
n = 835 (35.8%)
Sevrage très difficile de la CEC
Retour sous CEC
Assistance mécanique
n = 338 (14.5%)
Mortalité à 30 jours
2.1%
4.7%
13.4%

A Comparison of Aprotinin and Lysine Analogues in High-Risk Cardiac Surgery



A Comparison of Aprotinin and Lysine Analogues in High-Risk Cardiac Surgery

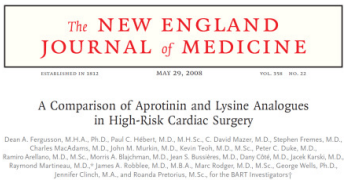
Prédictors of mortality

Variables	B ± SE	Odds Ratio	95% CI	*P* value
Age (10 units)	0.0443 ± 0.0131	1.557	1.213-2.028	0.0007
Renal disease	0.6526 ± 0.3184	1.921	1.029-3.585	0.0404
Use of diuretics	0.5644 ± 0.2355	1.758	1.108-2.790	0.0165
Hemoglobin (1 unit)	-0.0147 ± 0.00692	0.985	0.972-0.999	0.0342
Prothrombin time (10 units)	0.0091 ± 0.00316	1.096	1.024-1.164	0.0039
Easy vs. difficult separation from CPB	0.5155 ± 0.2875	1.674	0.953-2.942	0.0730
Easy vs. very difficult separation from CPB	1.1285 ± 0.3033	3.091	1.706-5.601	0.0002
CPB duration (60 units)	0.0097 ± 0.0013	1.788	1.529-2.103	< 0.0001

B, estimate; BART, Blood Conservation Using Antifibrinolytics in a Randomized Trial; CI, confidence interval; CPB, cardiopulmonary bypass; SE, standard error

Définition

Importance

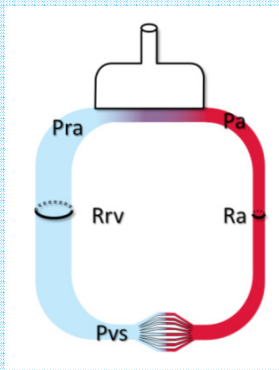

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 MAY 29, 2008 VOL. 358 NO. 22

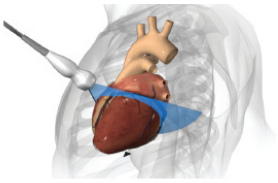
A Comparison of Aprotinin and Lysine Analogues in High-Risk Cardiac Surgery

Dean A. Fergusson, M.H.A., Ph.D., Paul C. Hébert, M.D., M.H.Sc., C. David Mazer, M.D., Stephen Fremes, M.D., Charles MacAdams, M.D., John M. Murkin, M.D., Kevin Teoh, M.D., M.Sc., Peter C. Duke, M.D., Ramiro Arellano, M.D., M.Sc., Morris A. Blajchman, M.D., Jean S. Bussières, M.D., Dany Côté, M.D., Jacek Karski, M.D., Raymond Martineau, M.D., James A. Robblee, M.D., M.B.A., Marc Rodger, M.D., M.Sc., George Wells, Ph.D., Jennifer Clinch, M.A., and Roanda Pretorius, M.Sc., for the BART Investigators*

Mécanisme



Approche



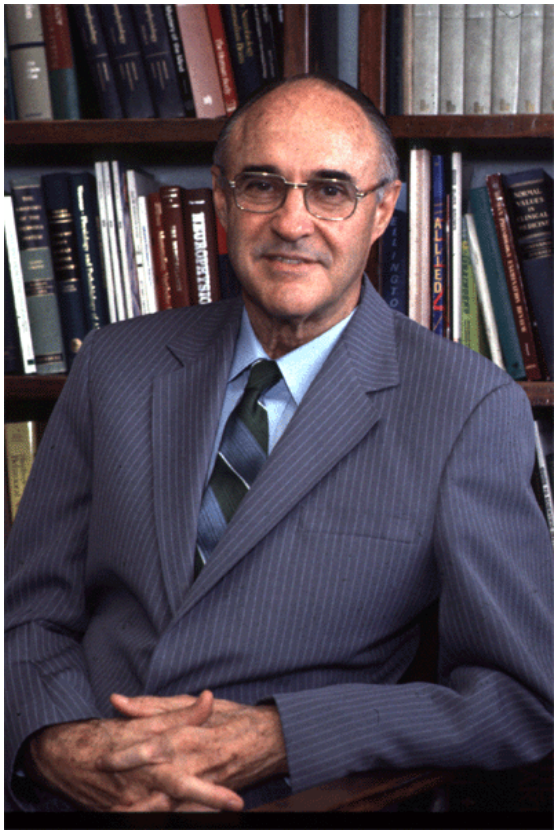
Méchanismes

- Déterminants du transport d'O_2
- Concept du retour veineux
- Courbes pression-Volume

Tools in the diagnosis

- History and physical
- EKG
- Pulse oximetry
- Pressure waveforms
- Capnography
- Bedside echocardiography
- Others: labs, brain oximetry, Hb monitoring, thermodilution-derived CO

Arthur C. Guyton



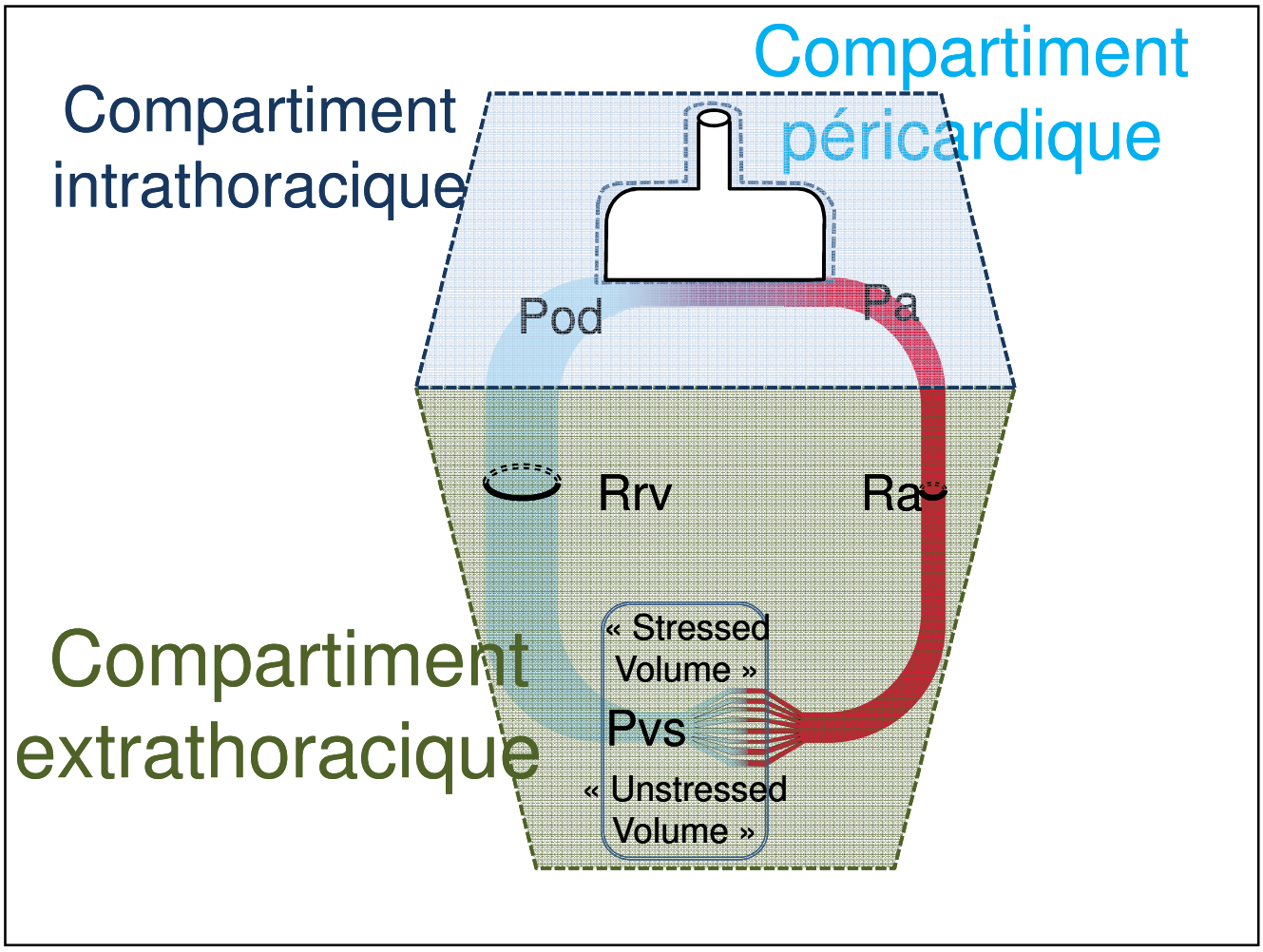
1919 - 2003

Eric Jacobsohn MB CHB FRCPC,*
Robin Chorn BSc MB CHB FRCPC,†
Michael O'Connor MD*

Review Article

The role of the vasculature in regulating venous return and cardiac output: historical and graphical approach

CAN J ANAESTH 1997 / 44: 8 / pp 849–867

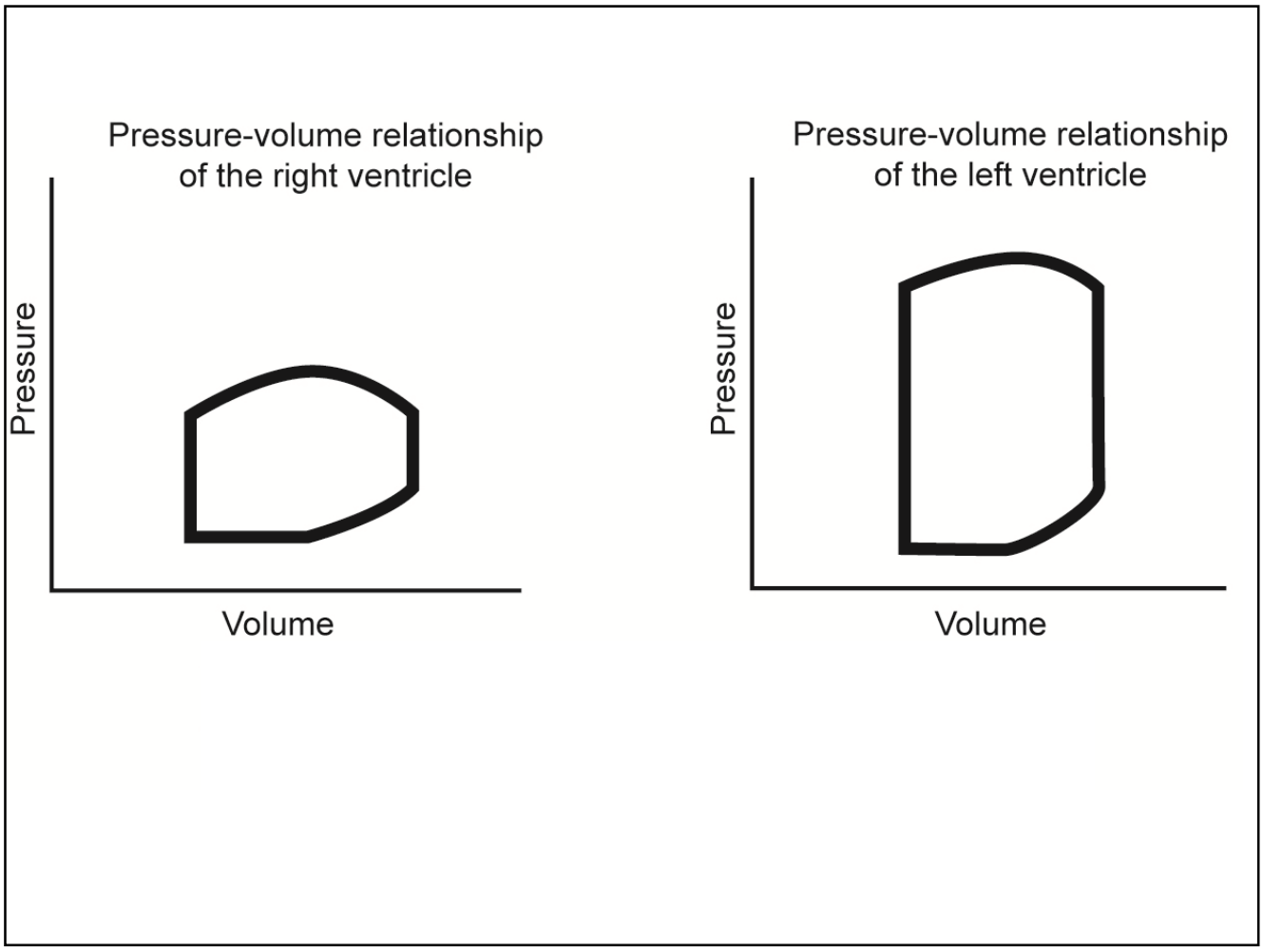

Compartiment intrathoracique
Compartiment péricardique
Pod
Pa
Rrv
Ra
Compartiment extrathoracique
« Stressed Volume »
Pvs
« Unstressed Volume »

Can J Anesth/J Can Anesth (2009) 56:678–682
DOI 10.1007/s12630-009-9140-8

PERIOPERATIVE CARDIOVASCULAR ROUNDS

Acute abdominal compartment syndrome

Nancy Deslauriers, MD · Renée Déry, MD · André Denault, MD

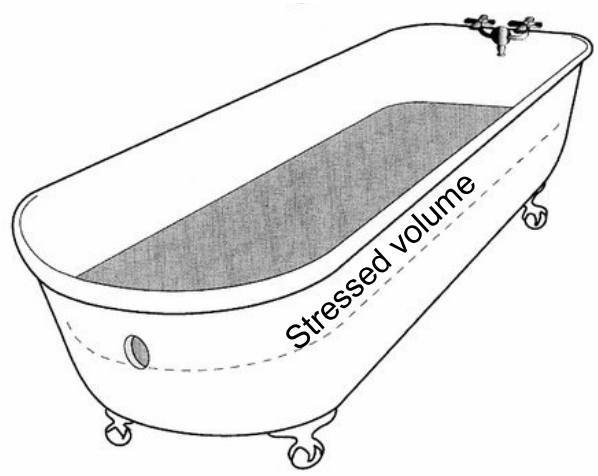

Pressure-volume relationship
of the right ventricle
Pressure
Volume
Pressure-volume relationship
of the left ventricle
Pressure
Volume

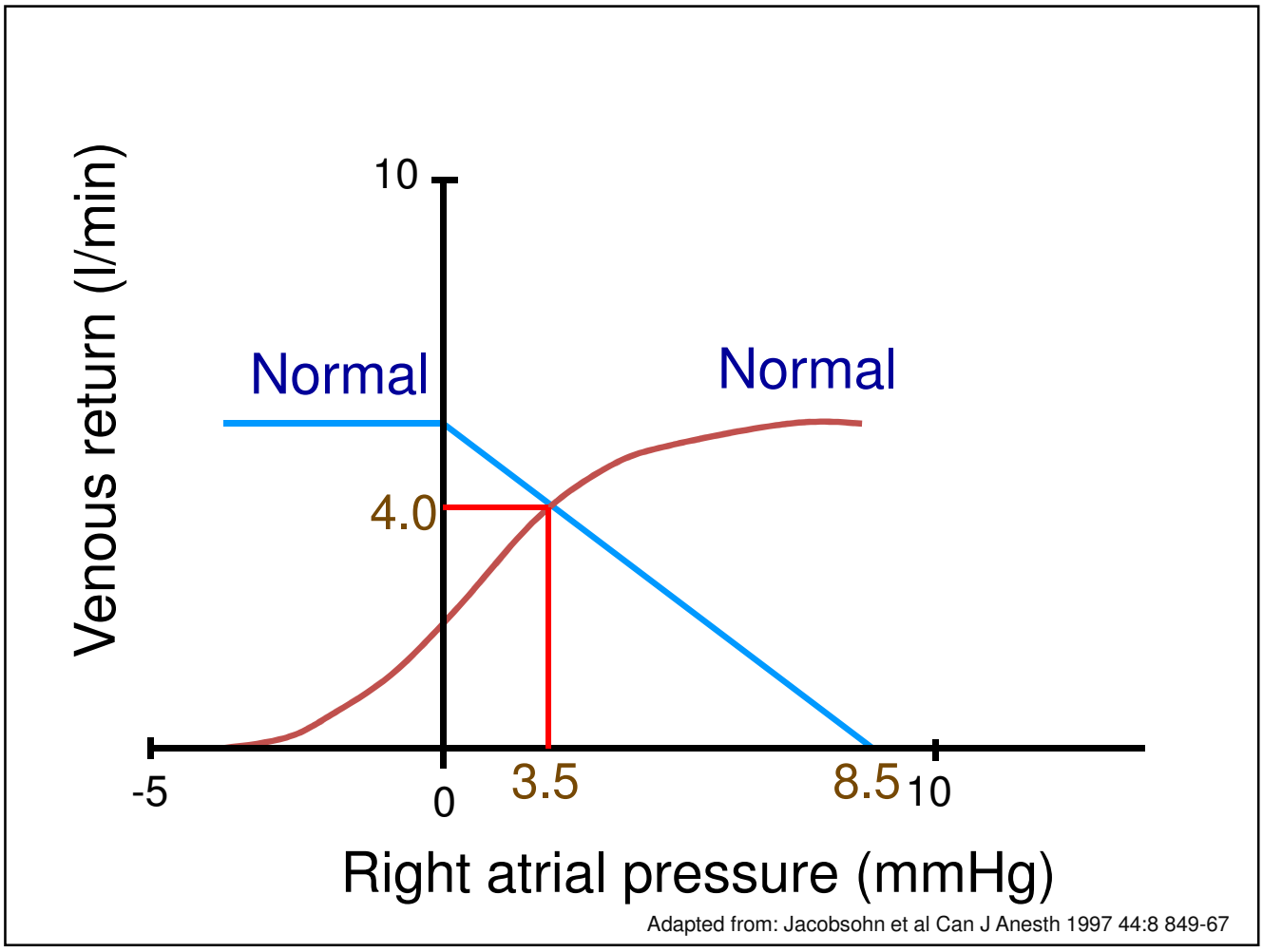
Intensive Care Med (1998) 24: 651–653

EDITORIAL

S. Magder

More respect for the CVP





Adapted from: Jacobsohn et al Can J Anesth 1997 44:8 849-67

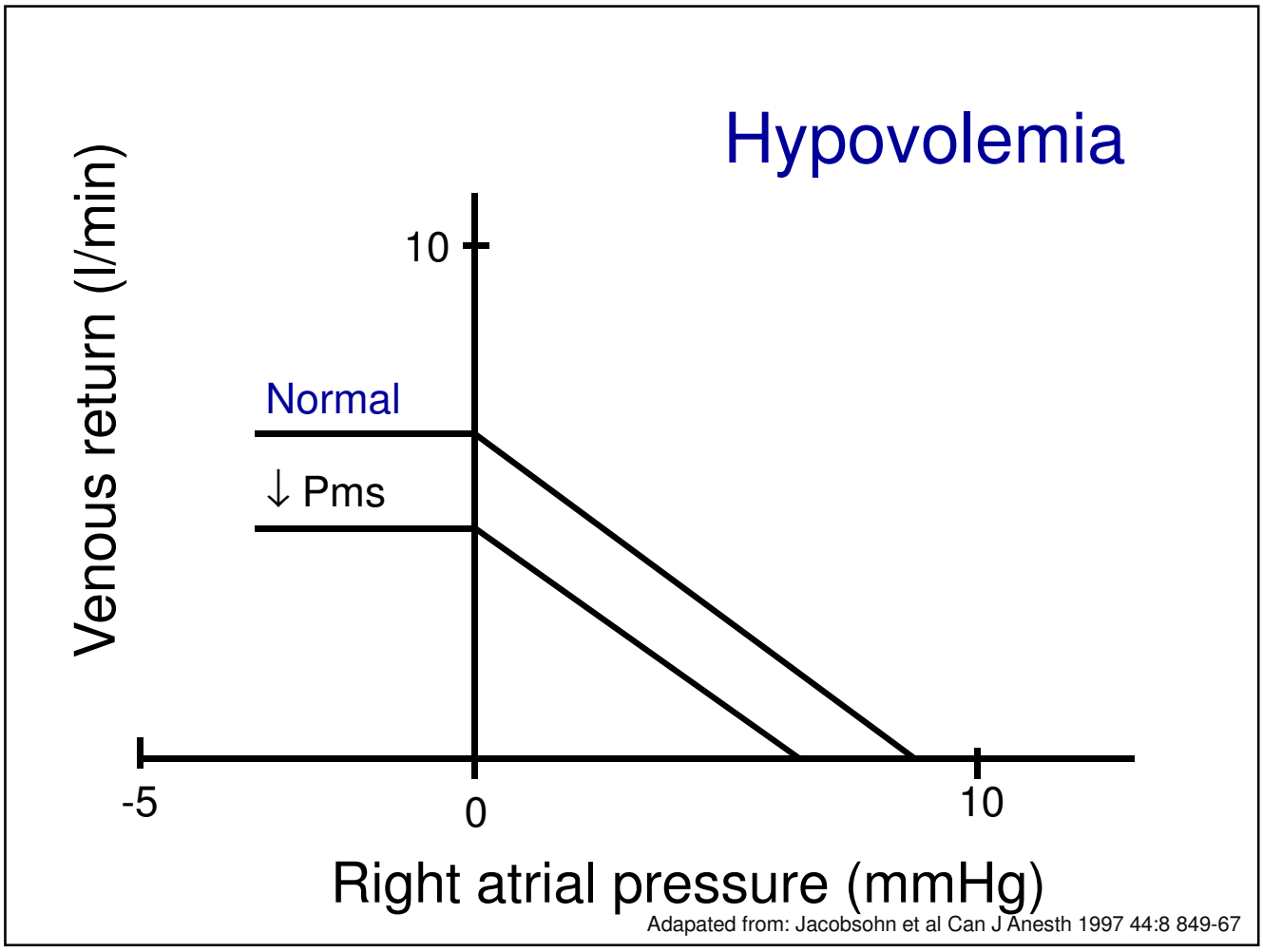
Déterminants du retour veineux

$$RV = \frac{\text{Gradient de pression}}{\text{Résistance au RV}} = \frac{Pvs - Pod}{Rrv}$$

1-↓ Pms: hypovolemia, vasodilatation

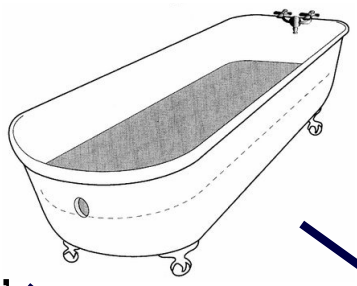
2-↑ Pra: Left and right systolic dysfunction
Left and right diastolic dysfunction
Left and right outflow tract obstruction
Pulmonary emboli
Hypoxia and hypercapnia

3-↑ Rrv: intrinsic obstruction and compartment syndrome (pericardial, mediastinal, thoracic, abdominal)



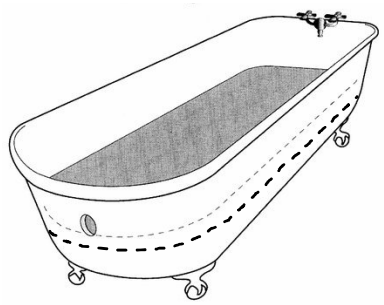
Adapated from: Jacobsohn et al Can J Anesth 1997 44:8 849-67

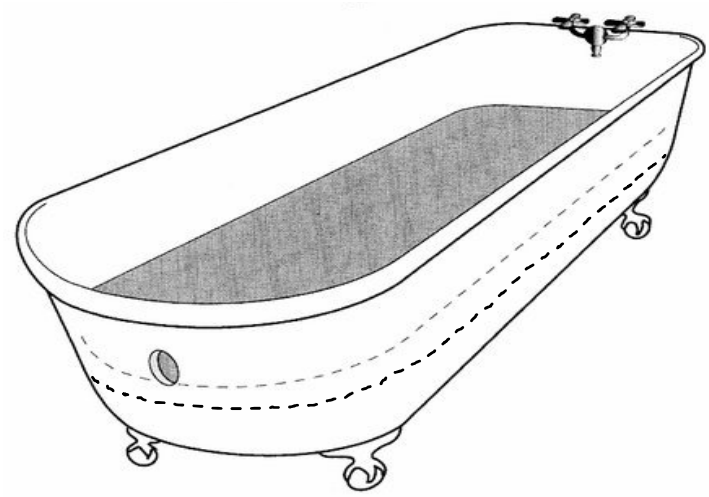
Pms = Stress volume / Compliance



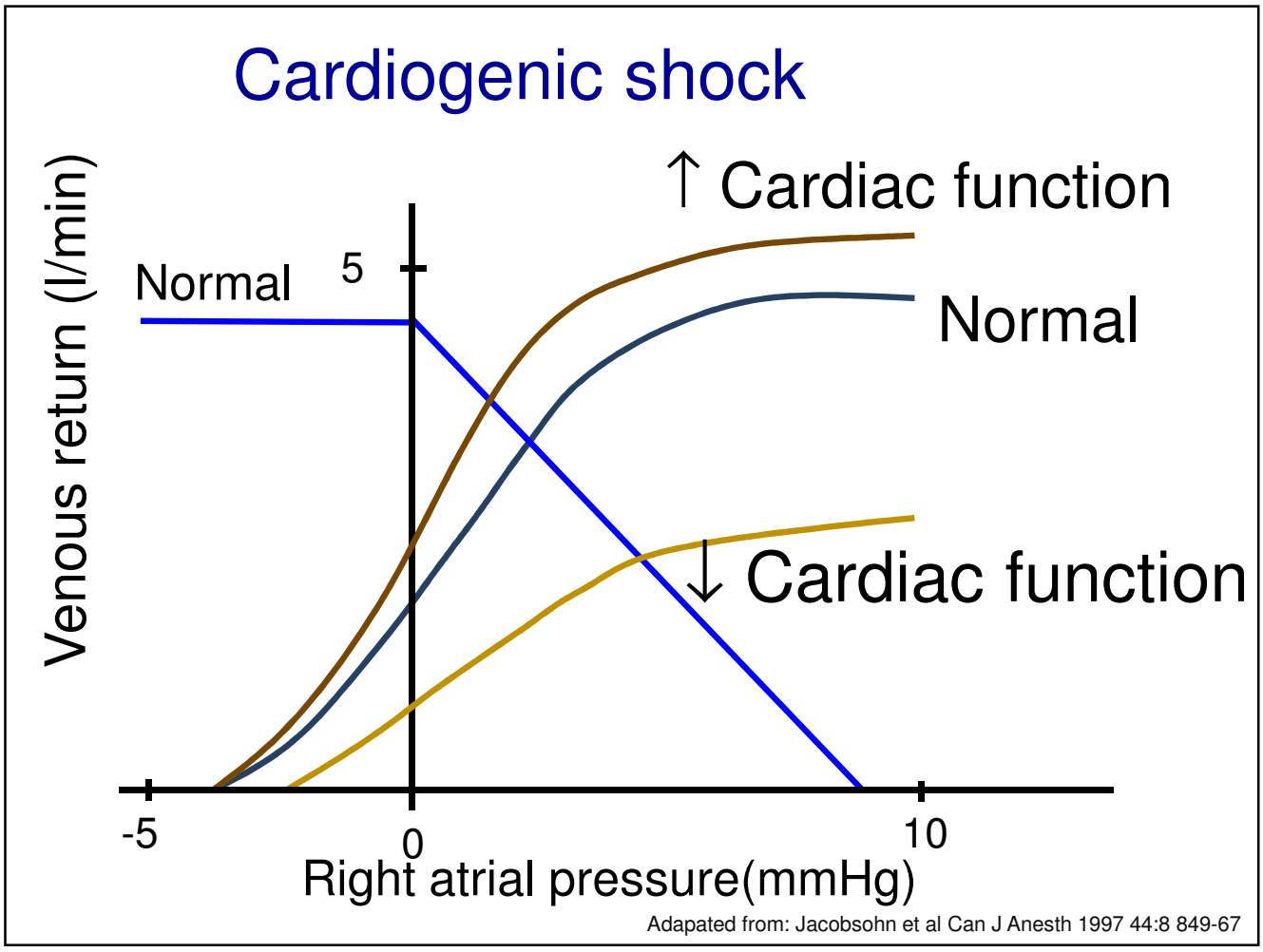
Loss of "stress volume"

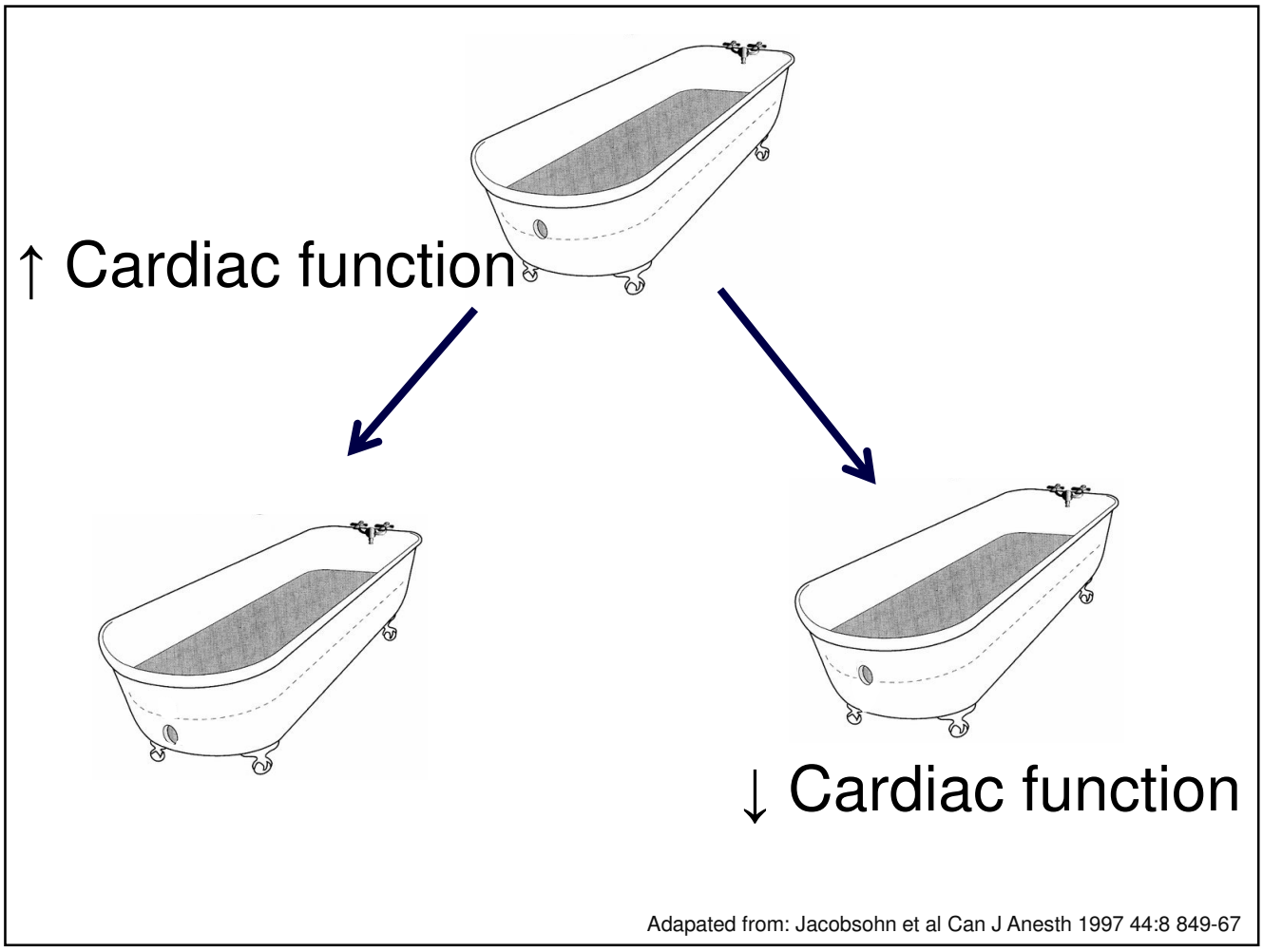
Increase in "unstress volume" or compliance





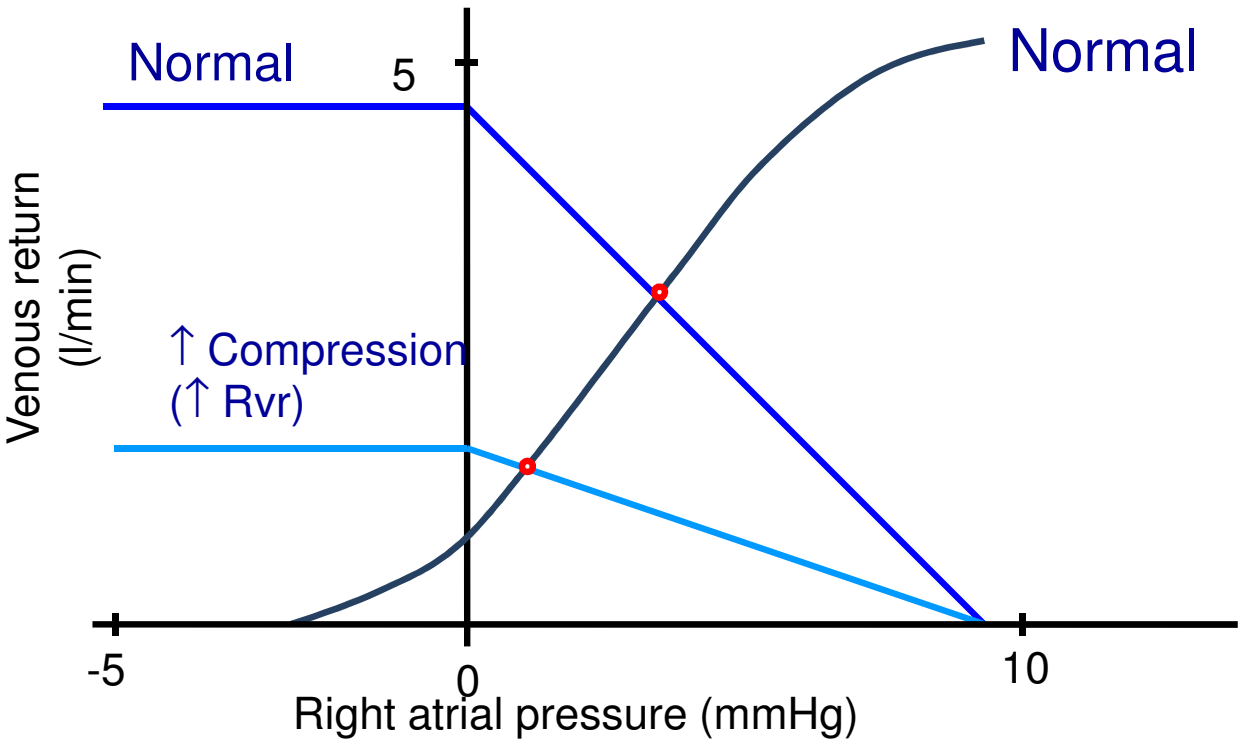
Adapated from: Jacobsohn et al Can J Anesth 1997 44:8 849-67


Cardiogenic shock
↑ Cardiac function
Normal
Normal
↓ Cardiac function
Venous return (l/min)
5
-5
0
10
Right atrial pressure(mmHg)
Adapated from: Jacobsohn et al Can J Anesth 1997 44:8 849-67



Adapated from: Jacobsohn et al Can J Anesth 1997 44:8 849-67

Obstructive shock: IVC compression



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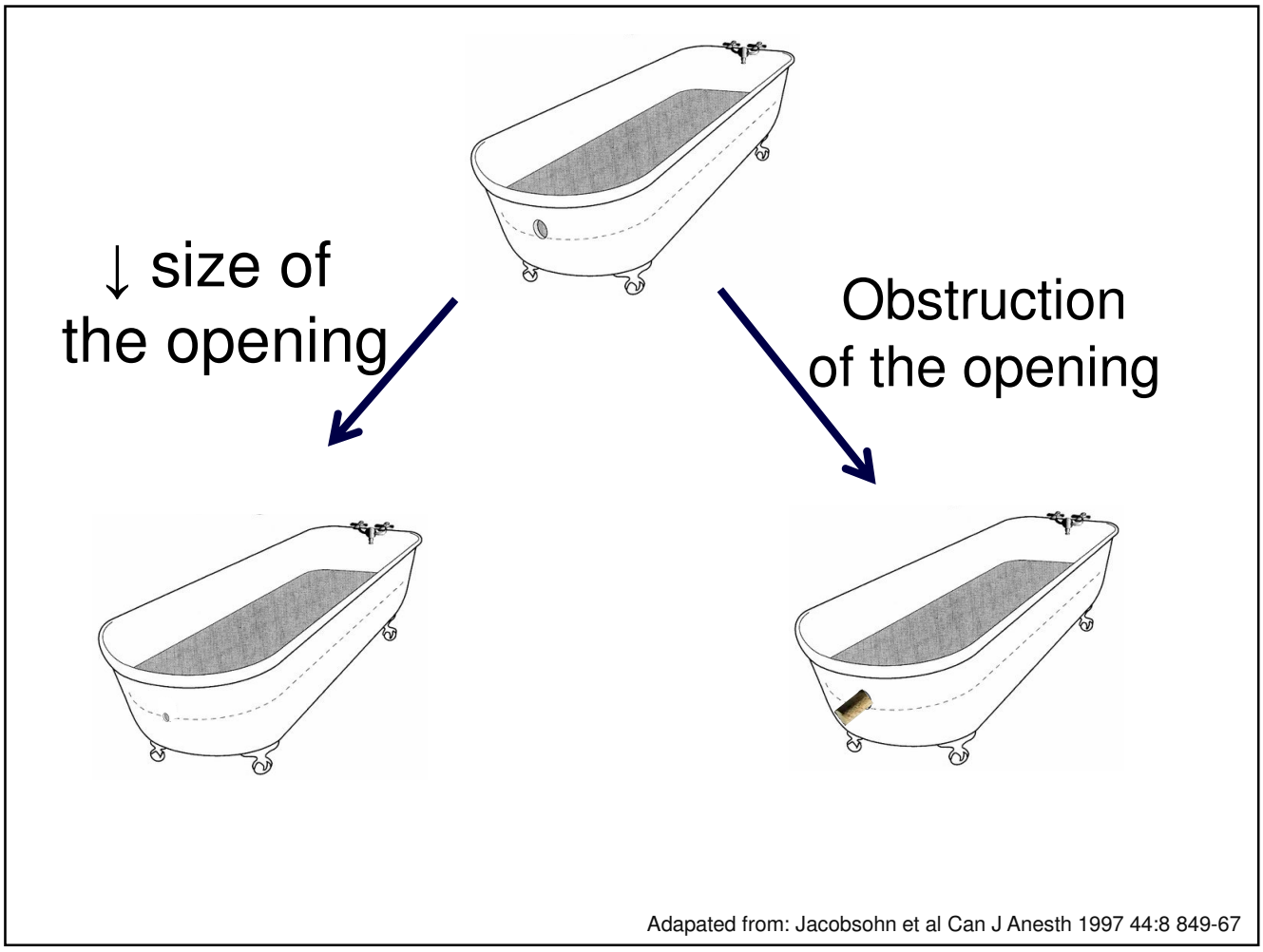

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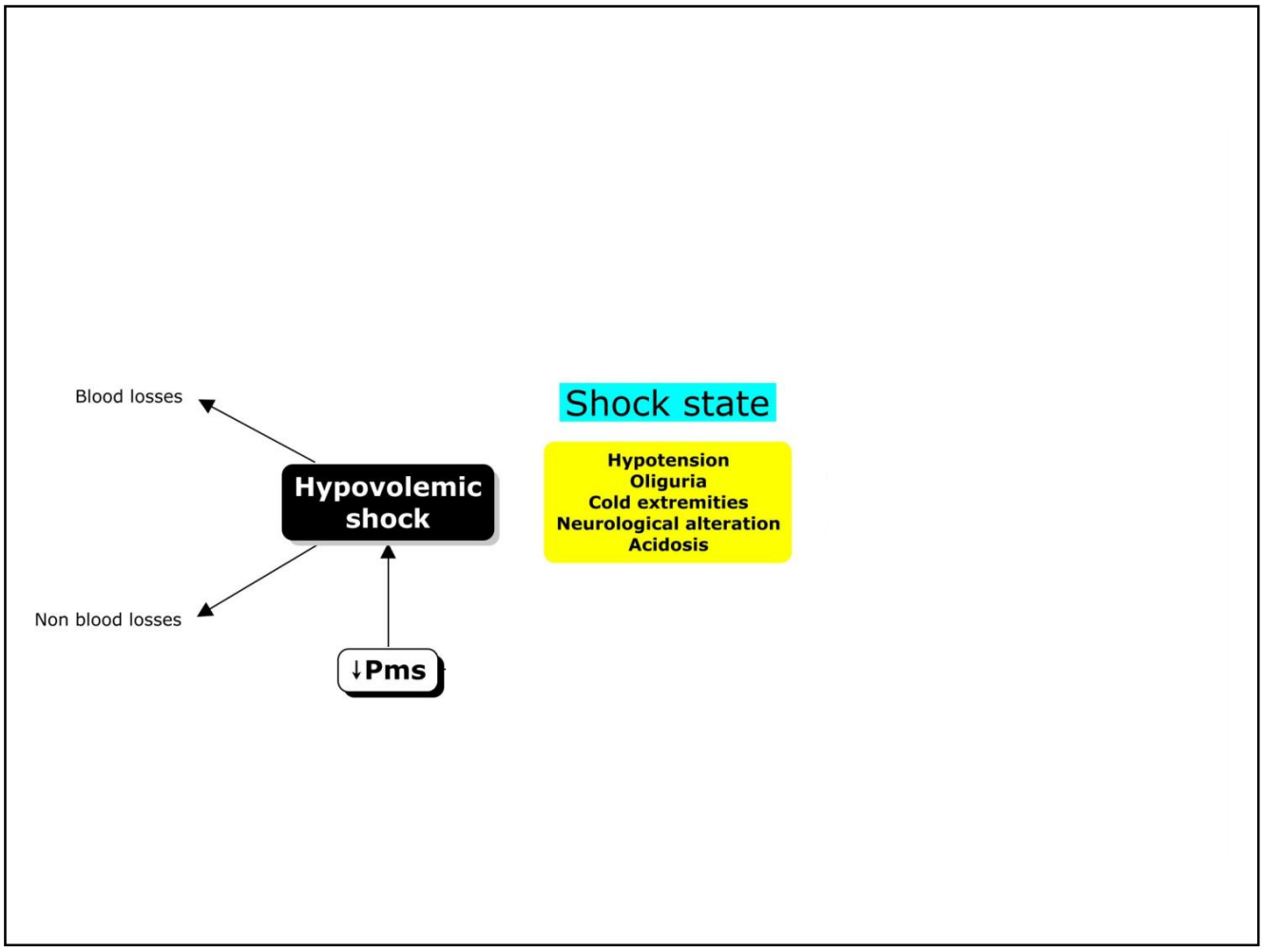
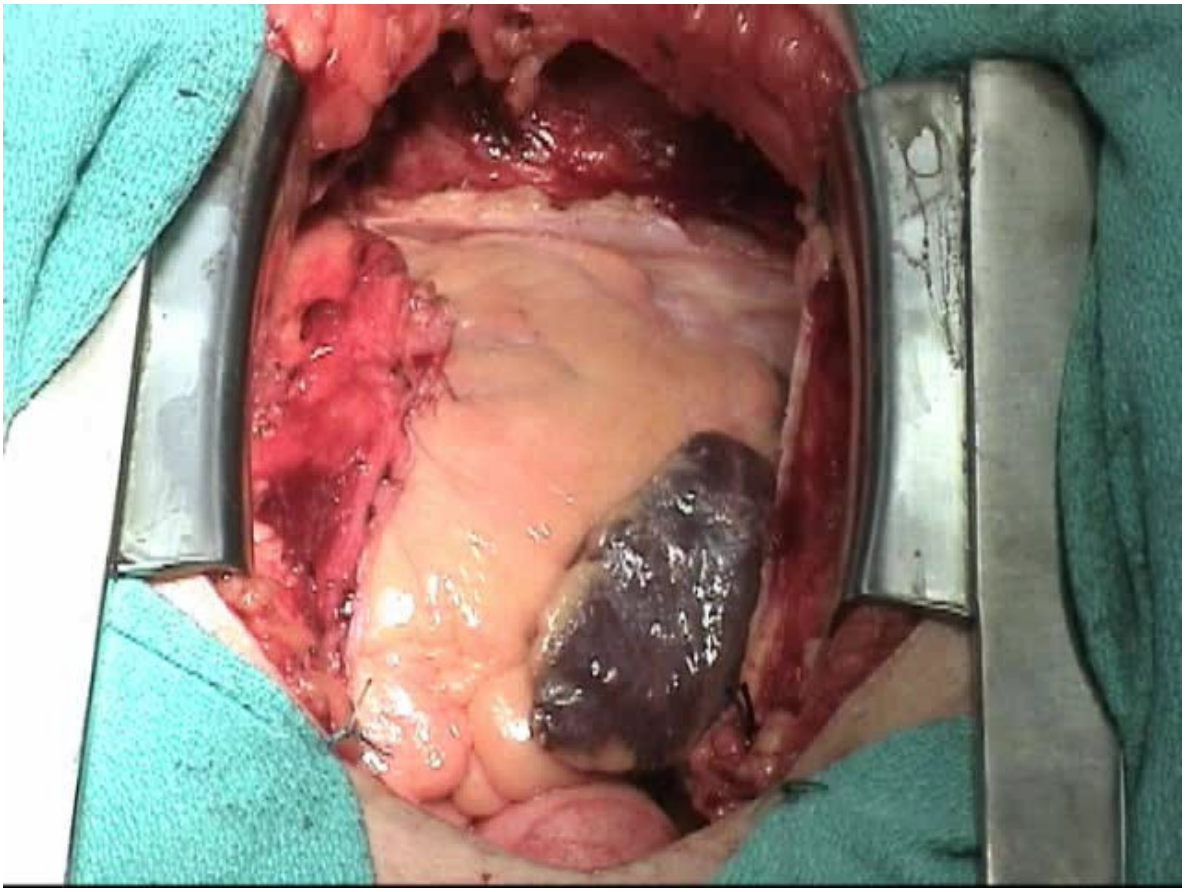
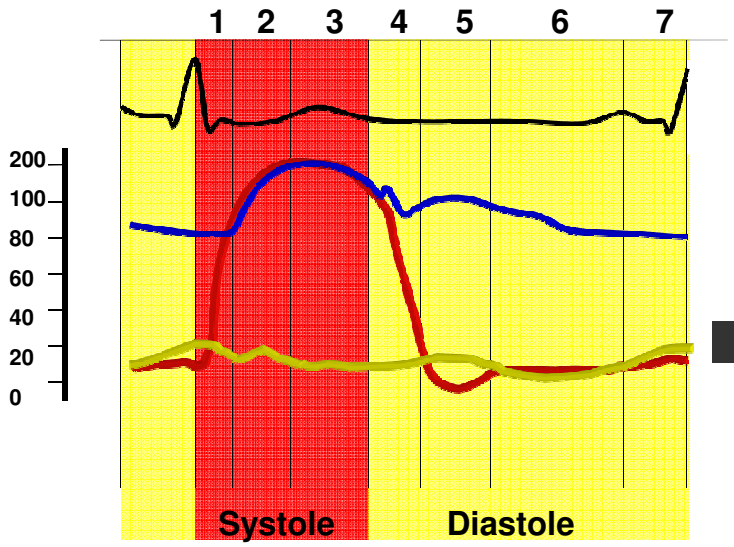
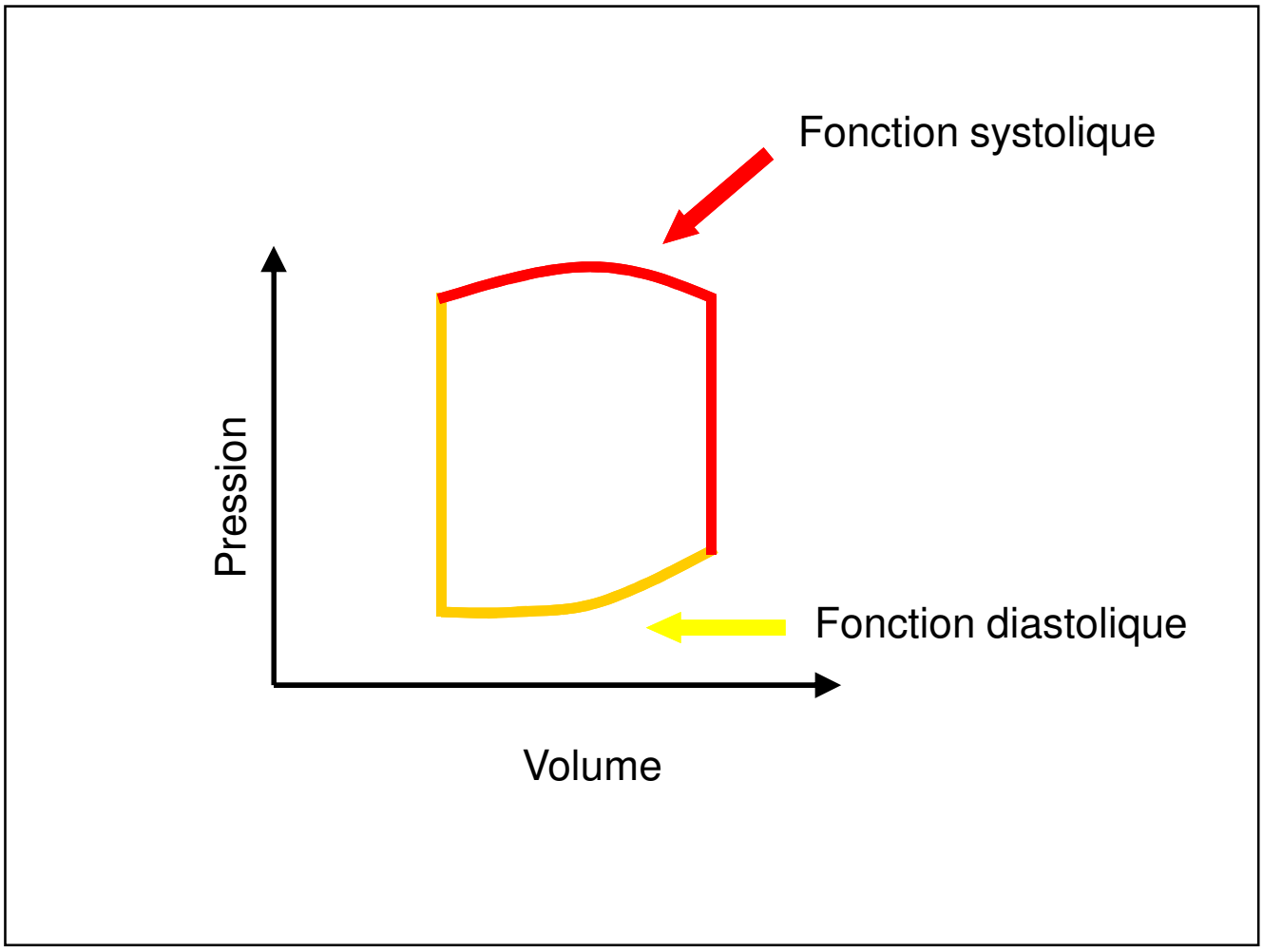

Blood losses
Hypovolemic shock
Non blood losses
↓Pms
Shock state
Hypotension
Oliguria
Cold extremities
Neurological alteration
Acidosis

If Guyton would have done peri-operative echocardiography, what would have been his observations?

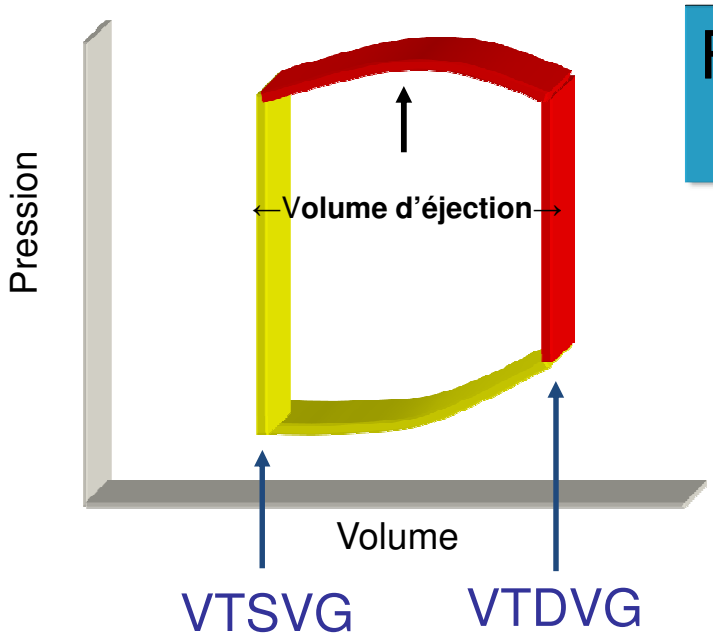




Adapted from Bettex D. Échocardiographie transoesophagienne en anesthésie-réanimation 1997


Fonction systolique
Pression
Fonction diastolique
Volume

Courbe pression-volume



$$FEVG = \frac{VE}{VTDVG}$$

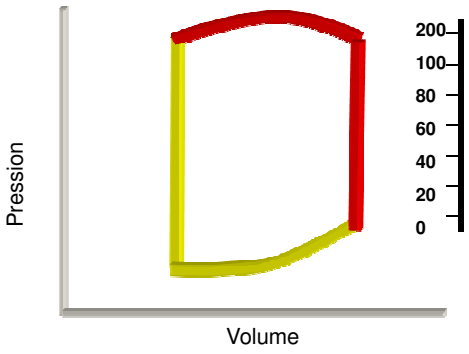
$$FEVG = \frac{VE}{VTDVG}$$

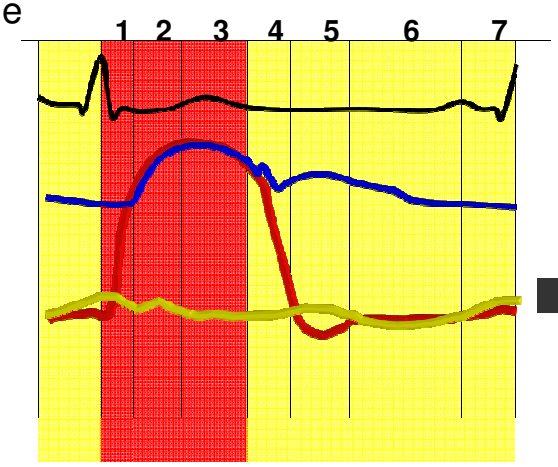
$$VE = FEVG \times VTDVG$$

Performance cardiaque → Fonction systolique

Remplissage → Fonction diastolique

Courbe pression-volume



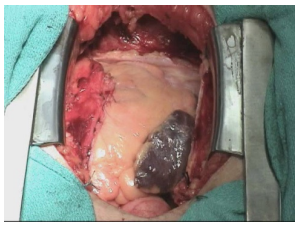


ECG

Pression artérielle

Pression OG

Pression VG



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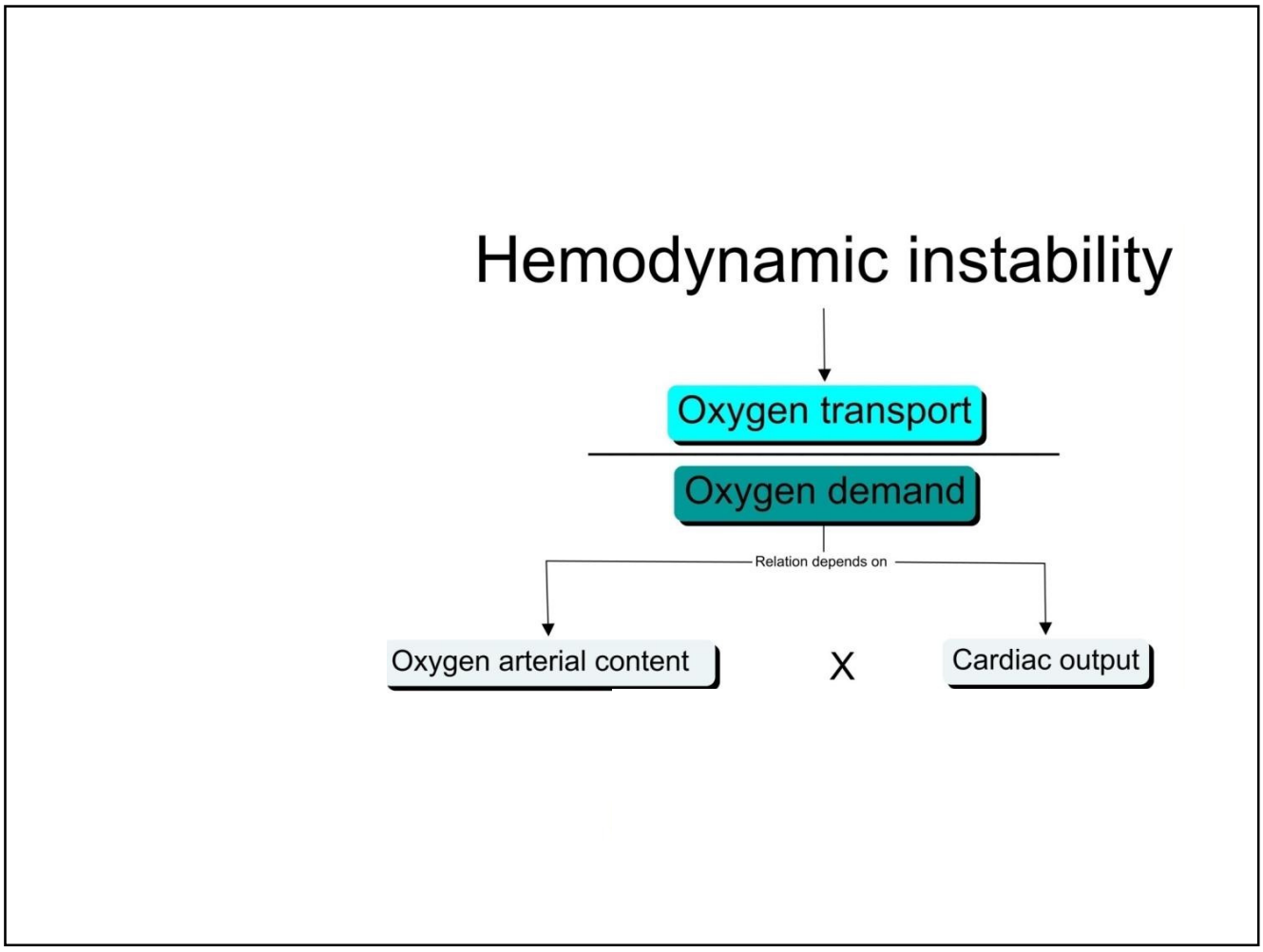
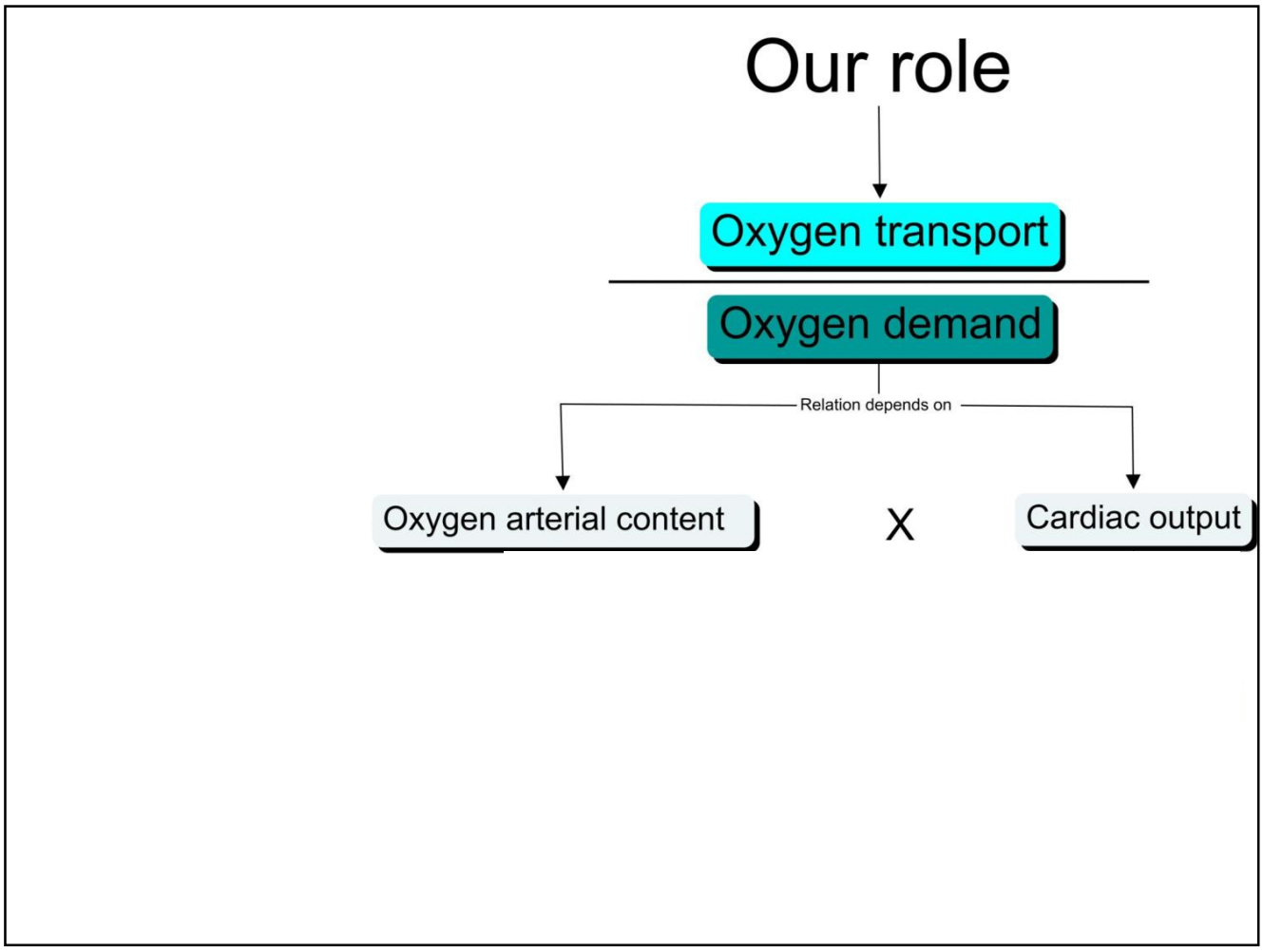
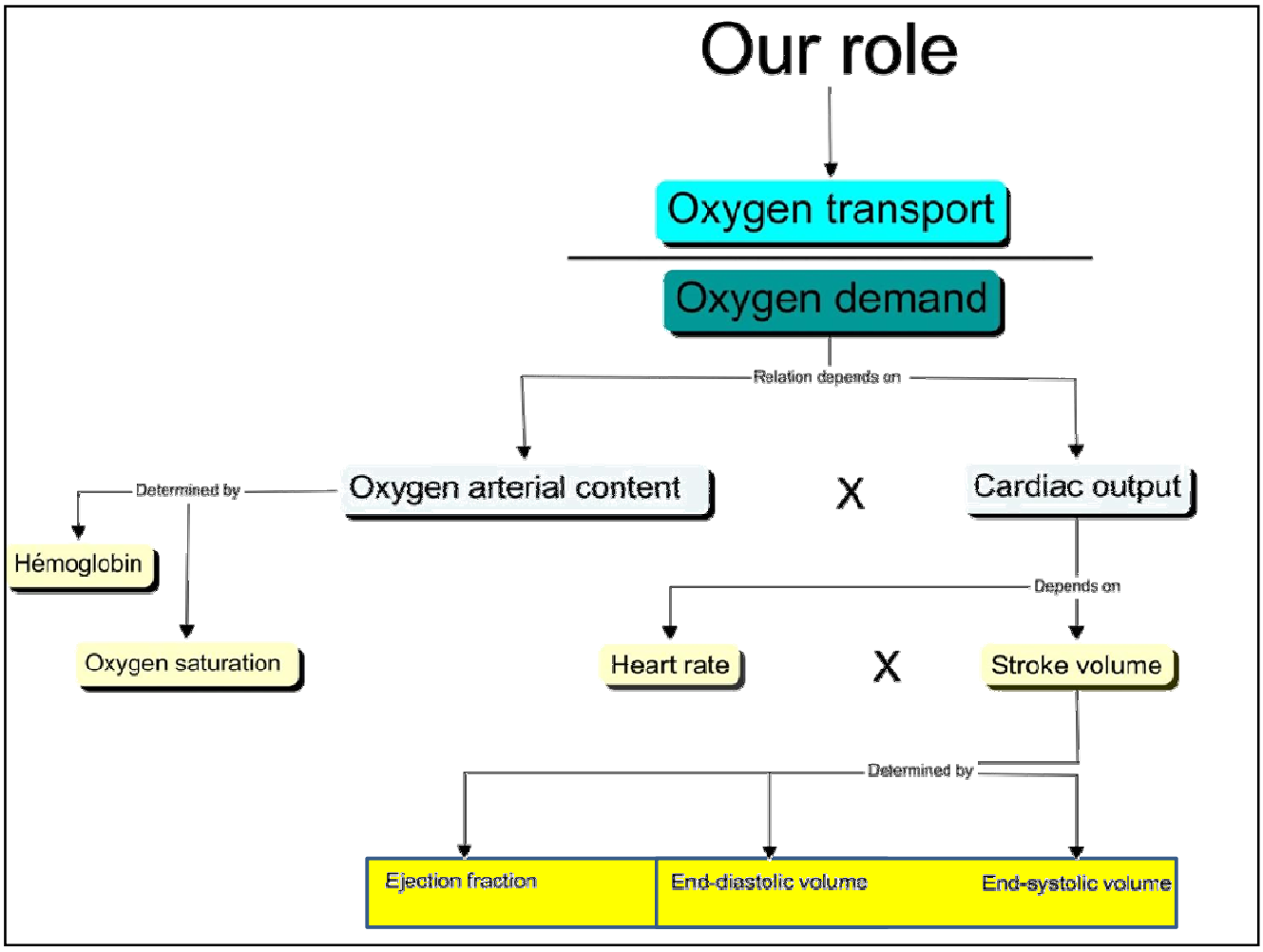
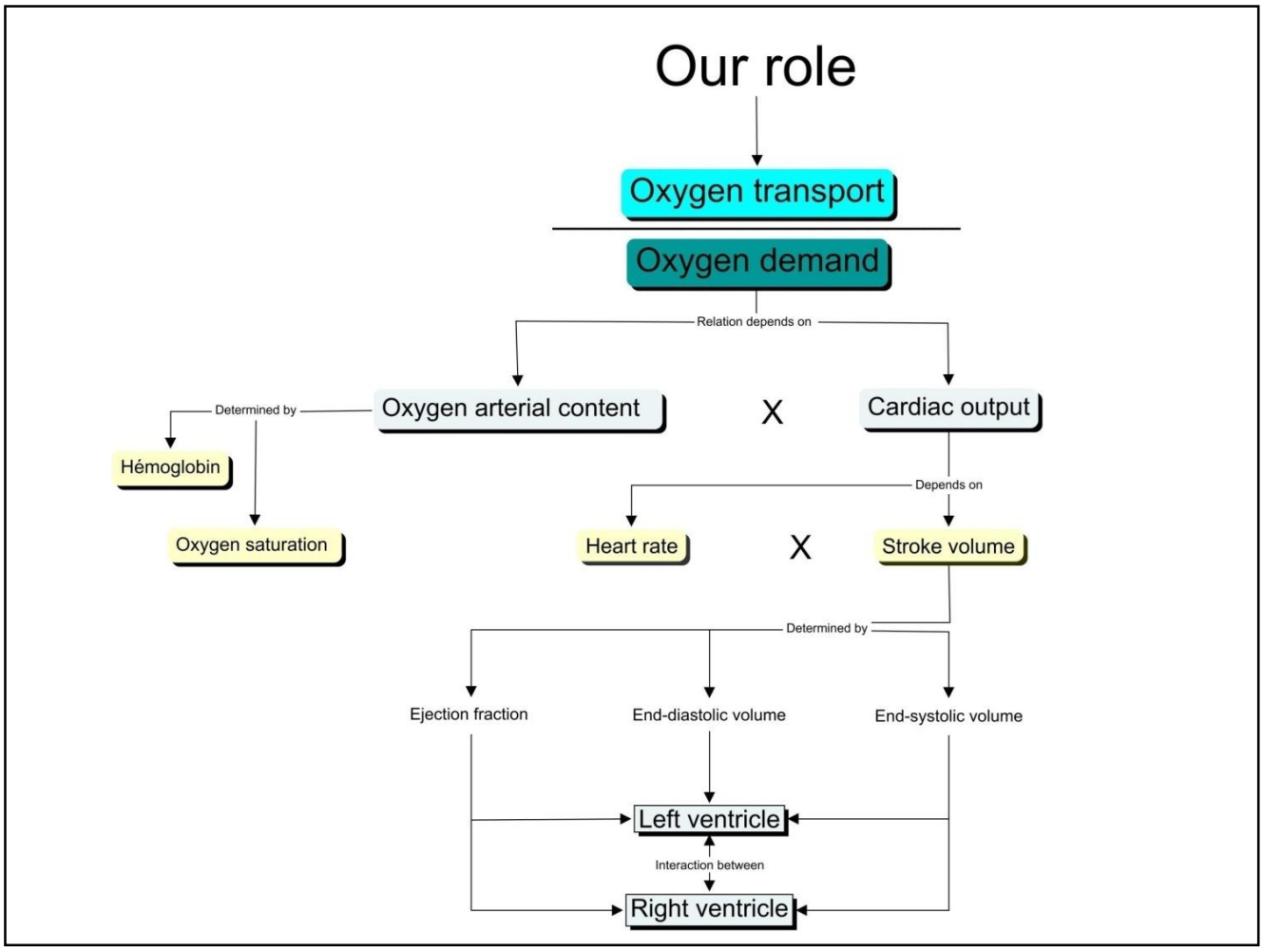

Hemodynamic instability
Oxygen transport
Oxygen demand
Relation depends on
Oxygen arterial content
X
Cardiac output


Our role
Oxygen transport
Oxygen demand
Relation depends on
Oxygen arterial content
X
Cardiac output


Our role
Oxygen transport
Oxygen demand
Relation depends on
Oxygen arterial content
X
Cardiac output
Determined by
Hémoglobin
Oxygen saturation
Depends on
Heart rate
X
Stroke volume
Determined by
Ejection fraction
End-diastolic volume
End-systolic volume


Our role
Oxygen transport
Oxygen demand
Relation depends on
Oxygen arterial content
X
Cardiac output
Determined by
Hémoglobin
Oxygen saturation
Depends on
Heart rate
X
Stroke volume
Determined by
Ejection fraction
End-diastolic volume
End-systolic volume
Left ventricle
Interaction between
Right ventricle