Extracardiac TEE to assess venous stasis

Georges Desjardins MD FRCPC FASE
Associate Professor
University of Montreal
Department of Anesthesiology
Montreal Heart Institute
Montreal, Canada

Peter Munk Cardiac Centre

Advanced Perioperative Imaging Lab

OBJECTIVES FACULTY PROGRAM WORKSHOPS THE CITY REGISTRATION

Presented by

Department of Anesthesiology and Pain Management & Division of Cardiac Surgery

Peter Munk Cardiac Centre

Toronto General Hospital, University Health Network

Seventeenth Annual Toronto Perioperative TEE Symposium

November 2-3, 2019

MaRS Auditorium

101 College St.

Toronto, M5G 1L7

Sunday, November 3

7:00 **Registration and Breakfast**

Session 3

8:00 **Surgical approach to AI** - J. Chung

8:20 **TEE evaluation of AI** - F. Mahmood

8:40 **AI case panel** - A. Mashari, F. Mahmood, J. Chung, A. Omran

9:00 Q&A

9:15 **Diastolic dysfunction assessment in my daily practice** - A. Nicoara

9:35 **Strain in my daily practice** - K. Rehfeldt

9:55 **Extra cardiac TEE to assess venous stasis and visceral perfusion** - G. Desjardins

10:15 Q&A

10:30 **Coffee Break**

11:00 **Congenital heart disease nomenclature** - E. Oechslin

11:30 **TEE in ACHD made simple** - A. Vegas

12:00 Q&A

12:15 **Lunch**

Sunday, November 3

7:00 **Registration and Breakfast**

Session 3

8:00 **Surgical approach to AI** - J. Chung

8:20 **TEE evaluation of AI** - F. Mahmood

8:40 **AI case panel** - A. Mashari, F. Mahmood, J. Chung, A. Omran

9:00 Q&A

9:15 **Diastolic dysfunction assessment in my daily practice** - A. Nicoara

9:35 **Strain in my daily practice** - K. Rehfeldt

9:55 **Extra cardiac TEE to assess venous stasis and visceral perfusion** - G. Desjardins

10:15 Q&A

10:30 **Coffee Break**

11:00 **Congenital heart disease nomenclature** - E. Oechslin

11:30 **TEE in ACHD made simple** - A. Vegas

12:00 Q&A

12:15 **Lunch**

Advanced Perioperative Imaging Lab

Sunda

7:00 **Registrat**

Session 3

8:00 **Surgical a**

8:20 **TEE evalu**

8:40 **AI case p** hung, A. Omran

9:00 Q&A

9:15 **Diastolic dysfunction assessment in my daily practice** - A. Nicoara

9:35 **Strain in my daily practice** - K. Rehfeldt

9:55 **Extra cardiac TEE to assess venous stasis and visceral perfusion** - G. Desjardins

10:15 Q&A

10:30 **Coffee Break**

11:00 **Congenital heart disease nomenclature** - E. Oechslin

11:30 **TEE in ACHD made simple** - A. Vegas

12:00 Q&A

12:15 **Lunch**

OBJECTIVES FACULTY PROGRAM WORKSHOPS THE CITY REGISTRATION

Sunda

7:00 **Registrat**

Session 3

8:00 **Surgical a**

8:20 **TEE evalu**

8:40 **AI case p** hung, A. Omran

9:00 Q&A

9:15 **Diastolic dysfunction assessment in my daily practice** - A. Nicoara

9:35 **Strain in my daily practice** - K. Rehfeldt

9:55 **Extra cardiac TEE to assess venous stasis and visceral perfusion** - G. Desjardins

10:15 Q&A

10:30 **Coffee Break**

11:00 **Congenital heart disease nomenclature** - E. Oechslin

11:30 **TEE in ACHD made simple** - A. Vegas

12:00 Q&A

12:15 **Lunch**

Financial Disclosures

None

Extracardiac TEE to assess venous stasis and visceral perfusion

Should we include extracardiac echo to assess venous congestion in our perioperative examination ?

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

RV Dysfunction after cardiac surgery

Common

Often not properly anticipated

Often not appreciated until late presentation and/or severe dysfunction

Not easy to detect with standard 2D TEE

RV Dysfunction after cardiac surgery

Systolic Dysfunction

Diastolic Dysfunction

RV Dysfunction after cardiac surgery

↓ RV CO

↑ CVP

Venous Congestion

Venous Congestion

Is it a problem ?

Is fluid overload a problem ?

Is interstitial edema a problem ?

Assessing Venous Congestion

Physical Examination

CVP

Hepatic veins Flow patterns

Portal vein Flow patterns

Splenic vein Flow patterns

Renal veins Flow patterns

Canadian Journal of Cardiology 35 (2019) 1088–1090

Editorial

Portal Vein Pulsatility After Cardiac Surgery—Who Cares?

Varinder K. Randhawa, MD, PhD, Michael Zhen-Yu Tong, MD, MBA, and Edward G. Soltesz, MD, MPH

Department of Cardiovascular Medicine, Kaufman Center for Heart Failure, Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio, USA

See article by Benkreira et al., pages 1134–1141 of this issue.

—Who Cares?

Portal Vein I —Who Cares?

Varinder K and

Edward G. Soltesz, MD, MPH

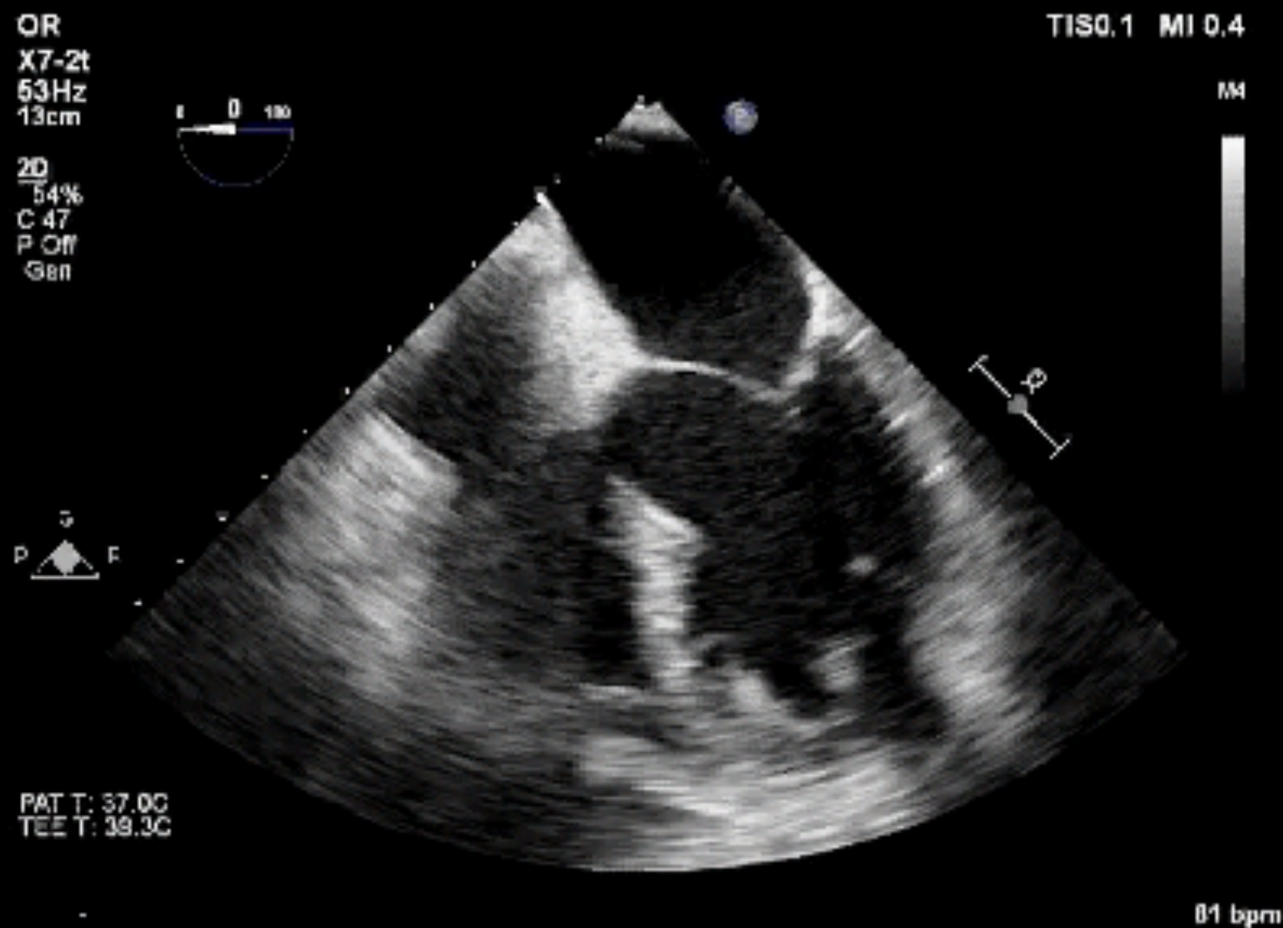
Department of Cardiovascular Medicine, Kaufman Center for Heart Failure, Heart and Vascular Institute, Cleveland Clinic, Cleveland, Ohio, USA

See article by Benkreira et al., pages 1134–1141 of this issue.

Importance of venous stasis and visceral perfusion

Understanding the problem

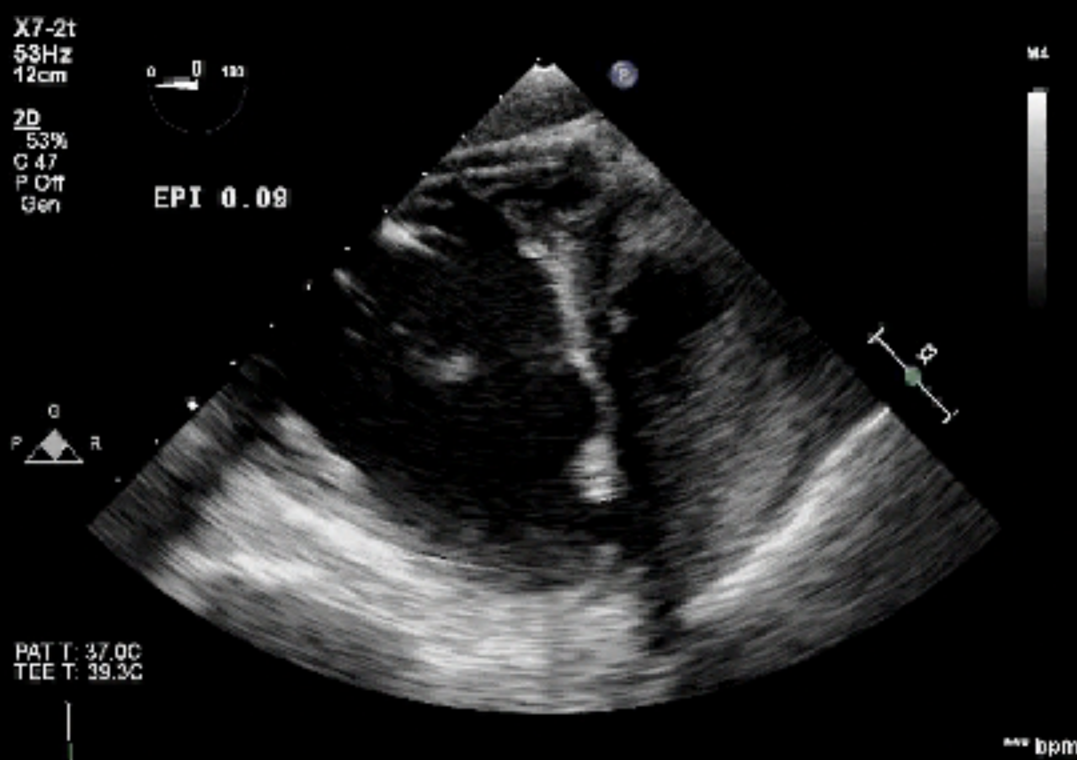
Our usual focus



INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

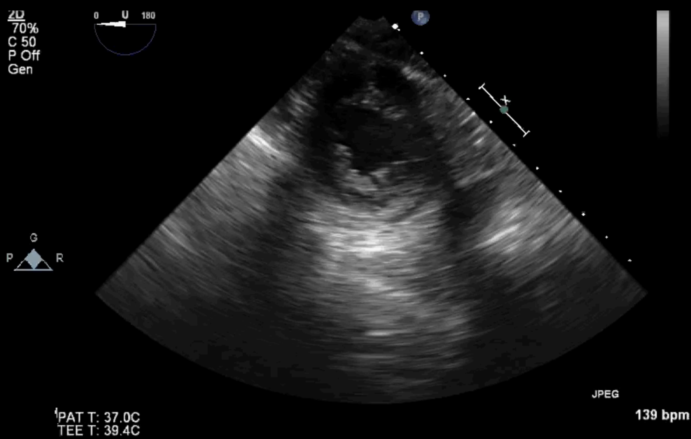
Volume Status and Ventricular Function

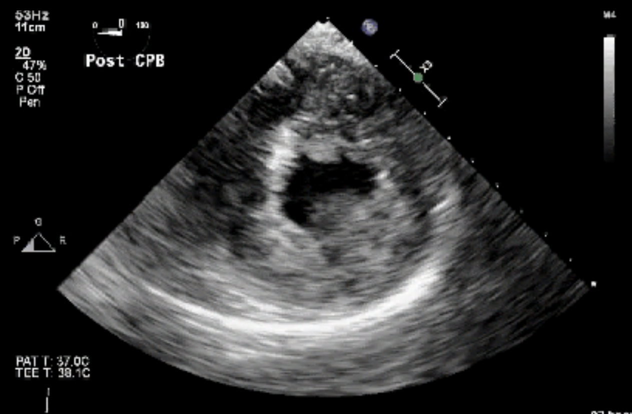


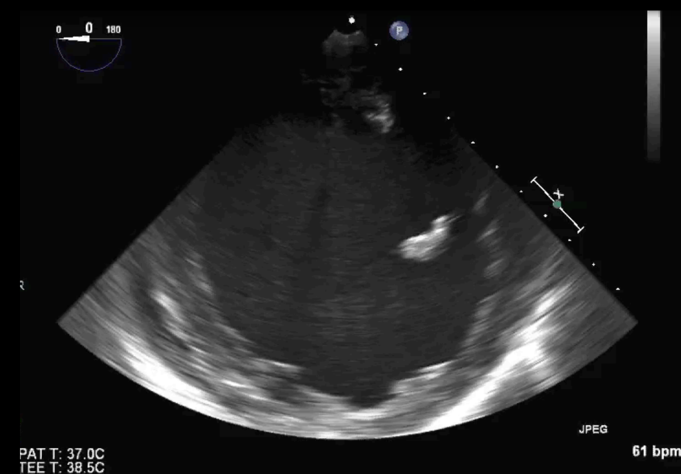
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

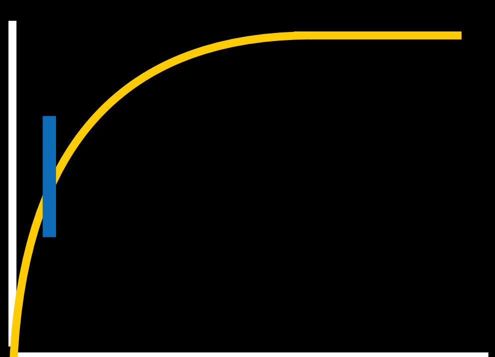
Volume Status on the Left

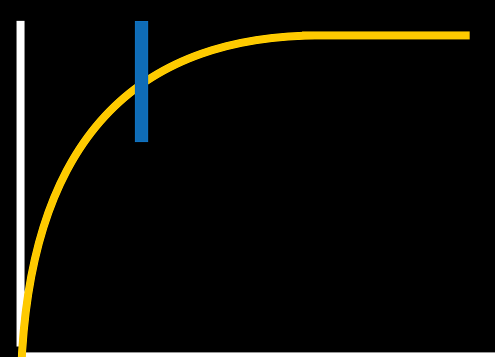
ANESTHÉSIOLOGIE • ICM

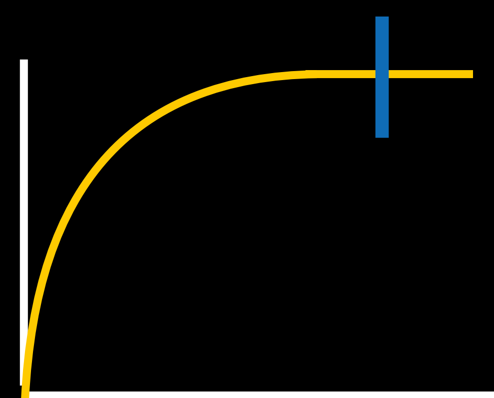








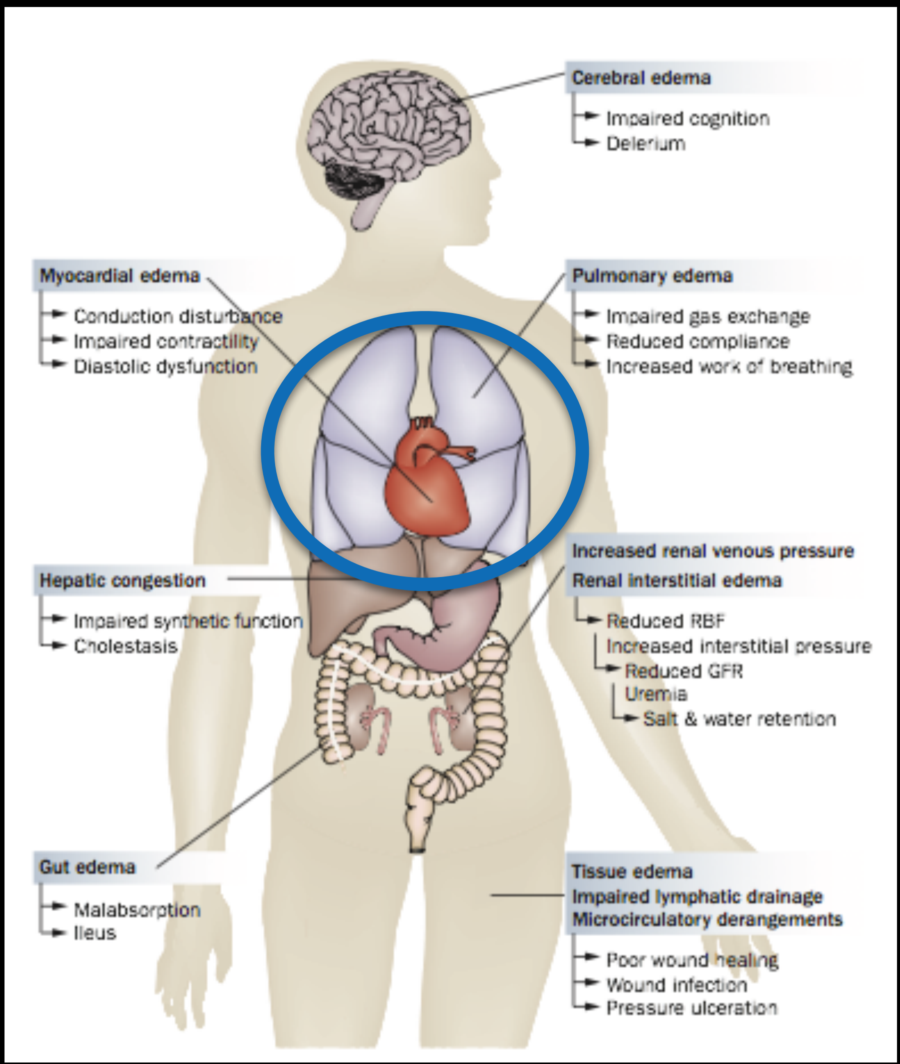


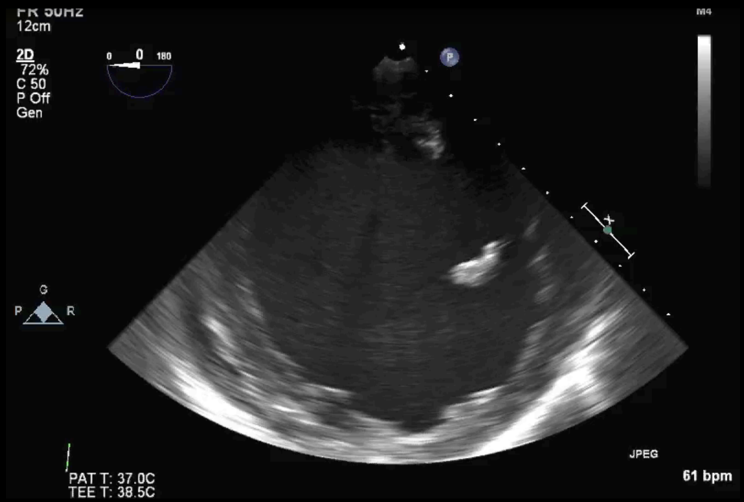


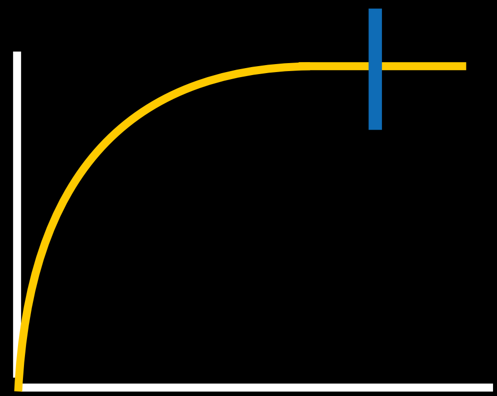
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

Fluid overload of the Left Side







Prowle et al. Nat Rev. Nephrol. 2010;6:107-115

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

REVIEWS

Fluid balance and acute kidney injury

John R. Prowle, Jorge E. Echeverri, E. Valentina Ligabo, Claudio Ronco and Rinaldo Bellomo

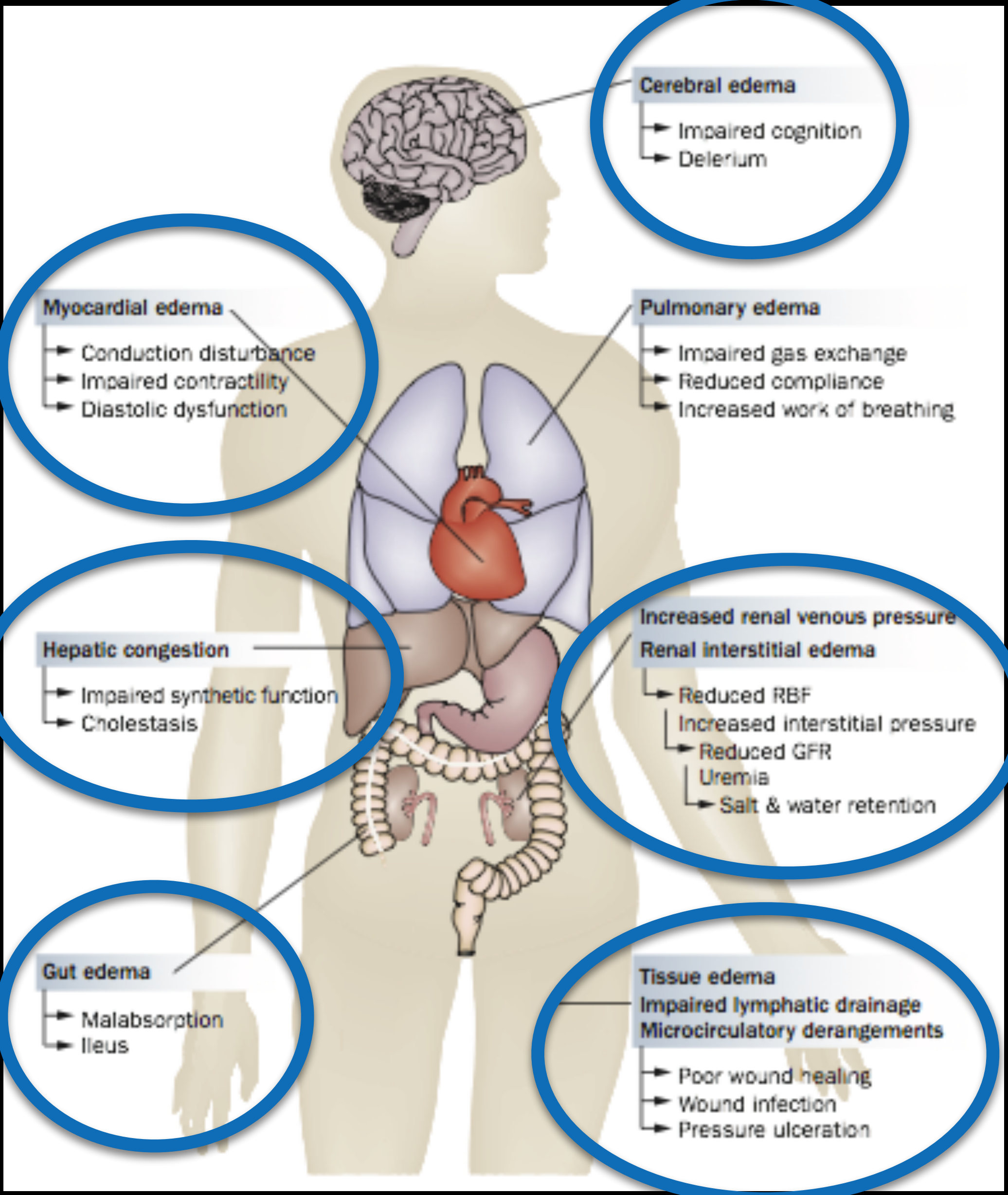
Abstract | Intravenous fluids are widely administered to patients who have, or are at risk of, acute kidney injury (AKI). However, deleterious consequences of overzealous fluid therapy are increasingly being recognized. Salt and water overload can predispose to organ dysfunction, impaired wound healing and nosocomial infection, particularly in patients with AKI, in whom fluid challenges are frequent and excretion is impaired. In this Review article, we discuss how interstitial edema can further delay renal recovery and why conservative fluid strategies are now being advocated. Applying these strategies in critical illness is challenging. Although volume resuscitation is needed to restore cardiac output, it often leads to tissue edema, thereby contributing to ongoing organ dysfunction. Conservative strategies of fluid management mandate a switch towards neutral balance and then negative balance once hemodynamic stabilization is achieved. In patients with AKI, this strategy might require renal replacement therapy to be given earlier than when more-liberal fluid management is used. However, hypovolemia and renal hypoperfusion can occur in patients with AKI if excessive fluid removal is pursued with diuretics or extracorporeal therapy. Thus, accurate assessment of fluid status and careful definition of targets are needed at all stages to improve clinical outcomes. A conservative strategy of fluid management was recently tested and found to be effective in a large, randomized, controlled trial in patients with acute lung injury. Similar randomized, controlled studies in patients with AKI now seem justified.

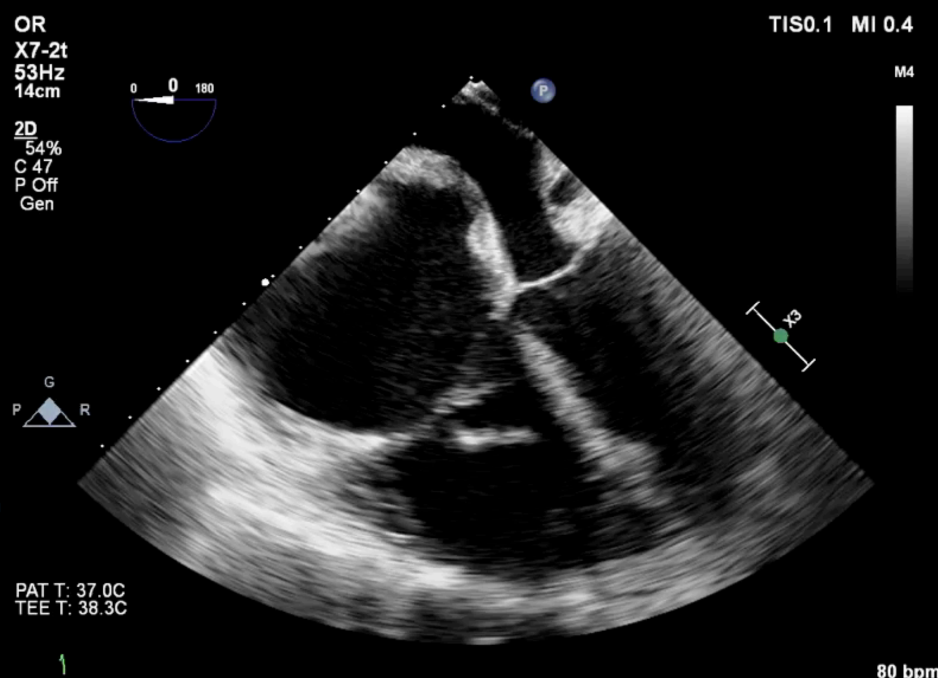
Prowle, J. R. *et al. Nat. Rev. Nephrol.* **6**, 107–115 (2010); published online 22 December 2009; doi:10.1038/nrneph.2009.213

Importance of venous stasis and visceral perfusion

Effects of Fluid Overload on the Right Side

Venous stasis on Right Side





Prowle et al. Nat Rev. Nephrol. 2010;6:107-115

Importance of venous stasis on visceral perfusion

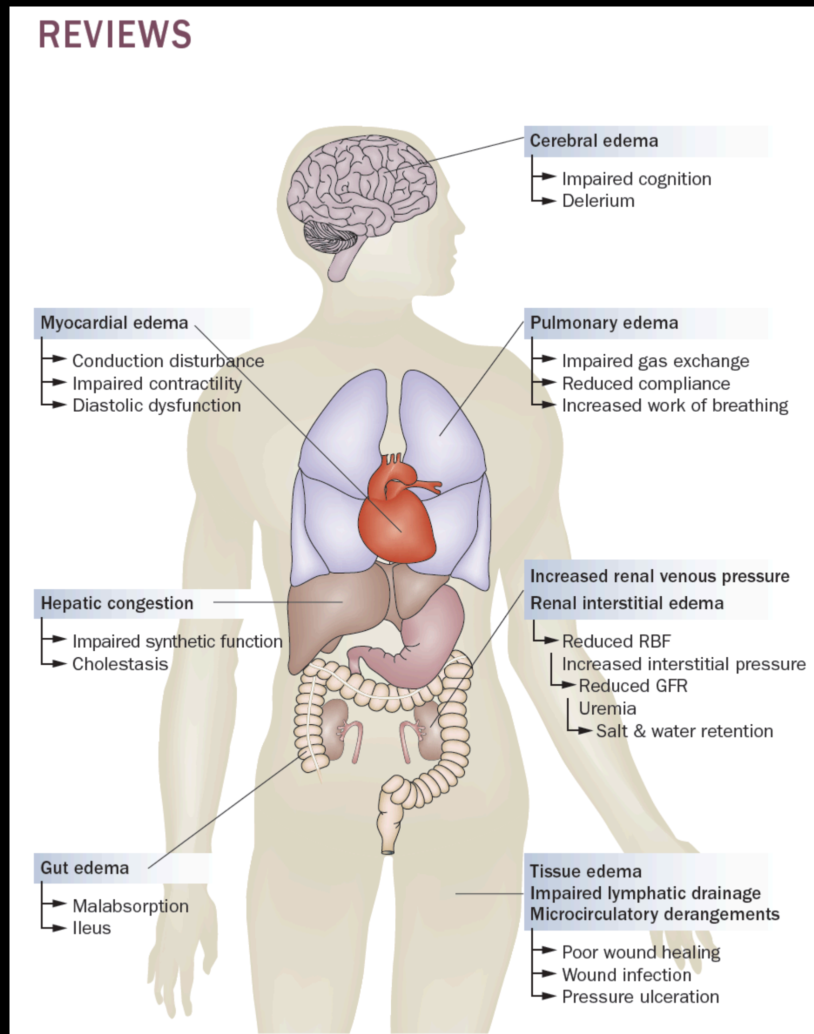


Figure 2 | Pathological sequelae of fluid overload in organ systems. Abbreviations: GFR, glomerular filtration rate; RBF, renal blood flow.

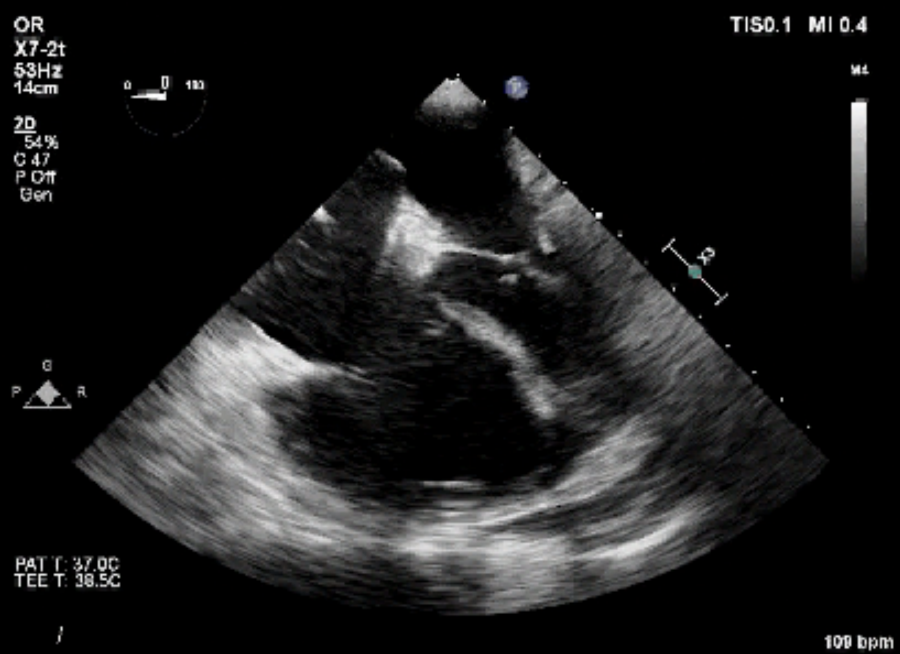
Prowle et al. Nat Rev. Nephrol. 2010;6:107-115

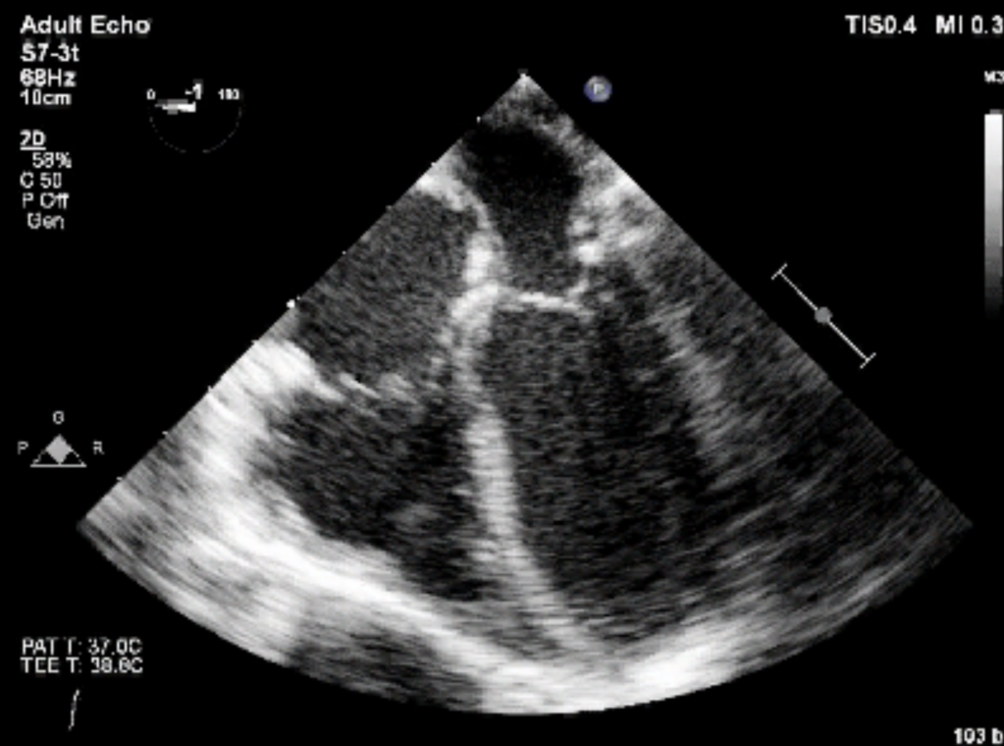
Venous stasis is a dangerous problem

Venous stasis is a dangerous problem

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

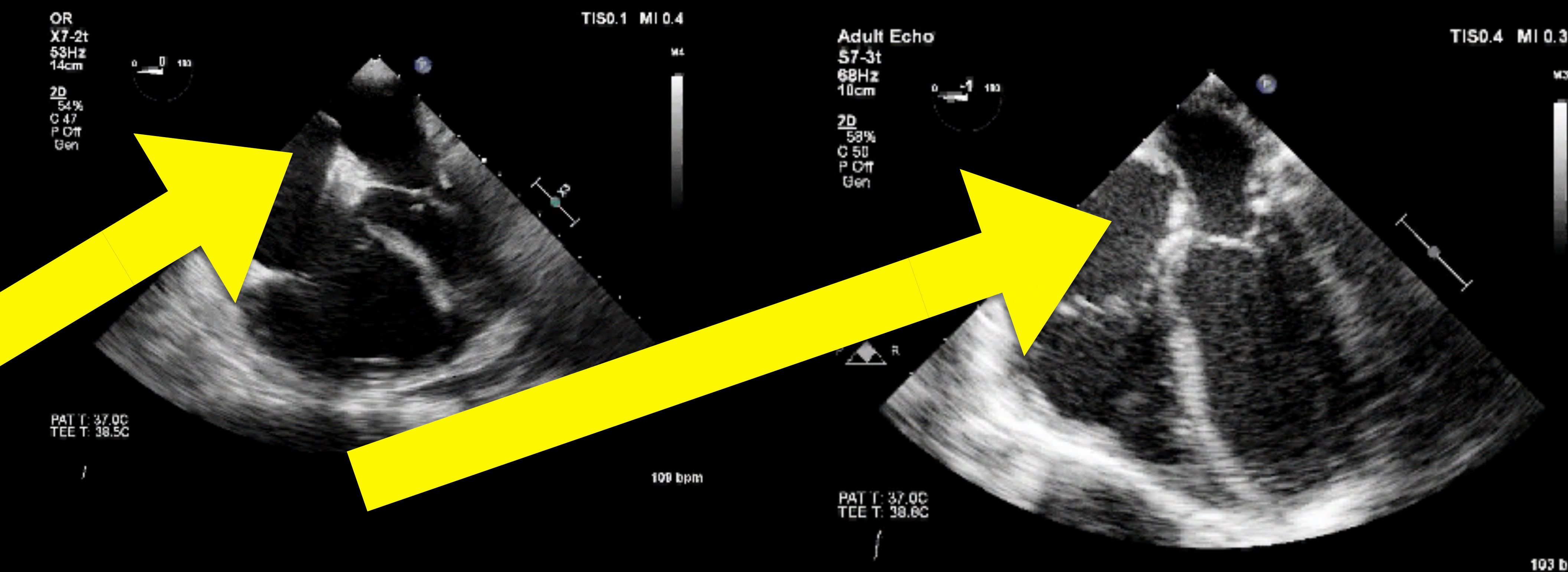
ANESTHÉSIOLOGIE • ICM





INSTITUT DE CARDIOLOGIE DE MONTRÉAL

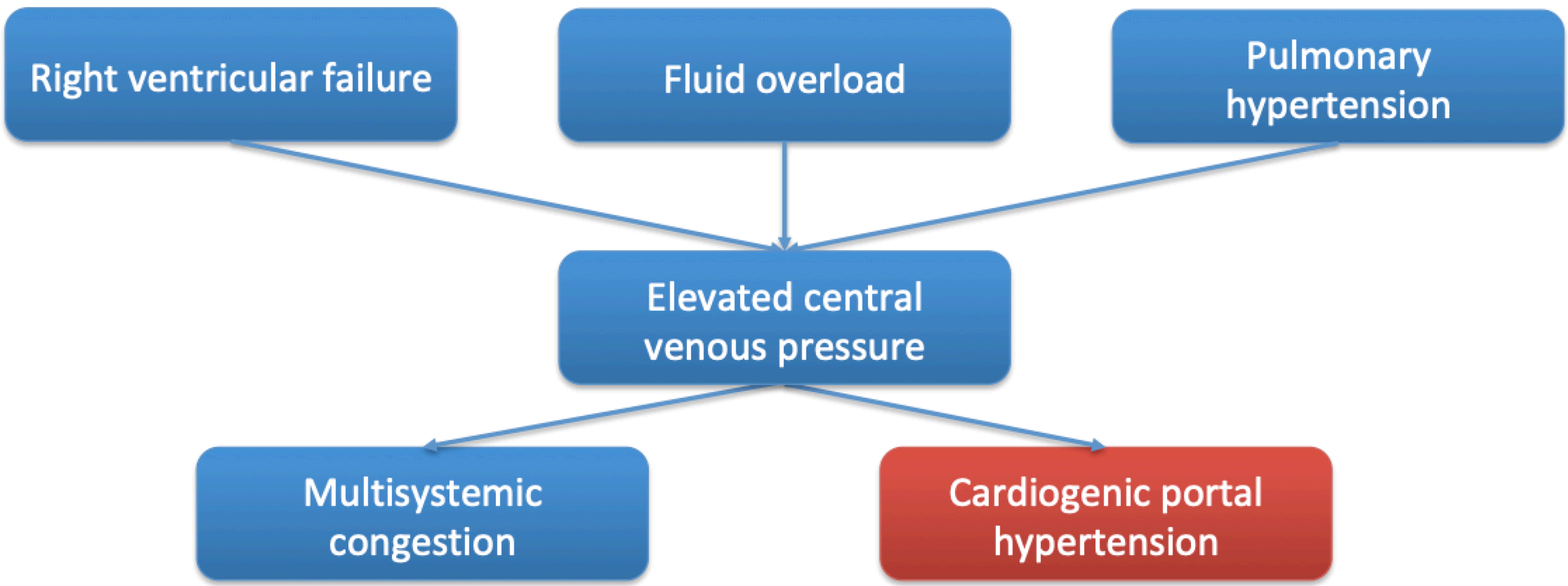
ANESTHÉSIOLOGIE • ICM



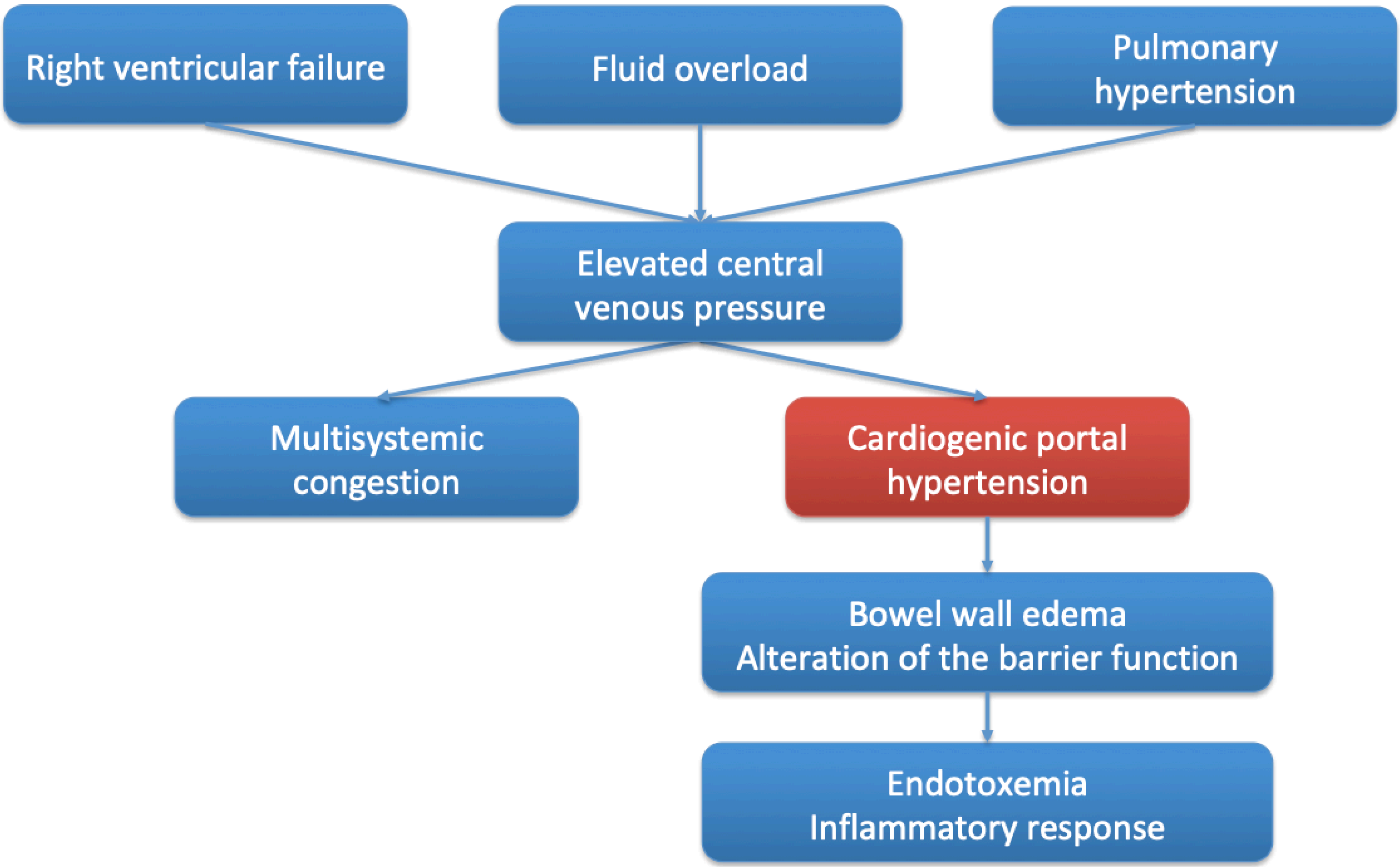
PROBLEMS IN ♥ SURGERY

- Right ventricular failure
- Fluid overload
- Pulmonary hypertension

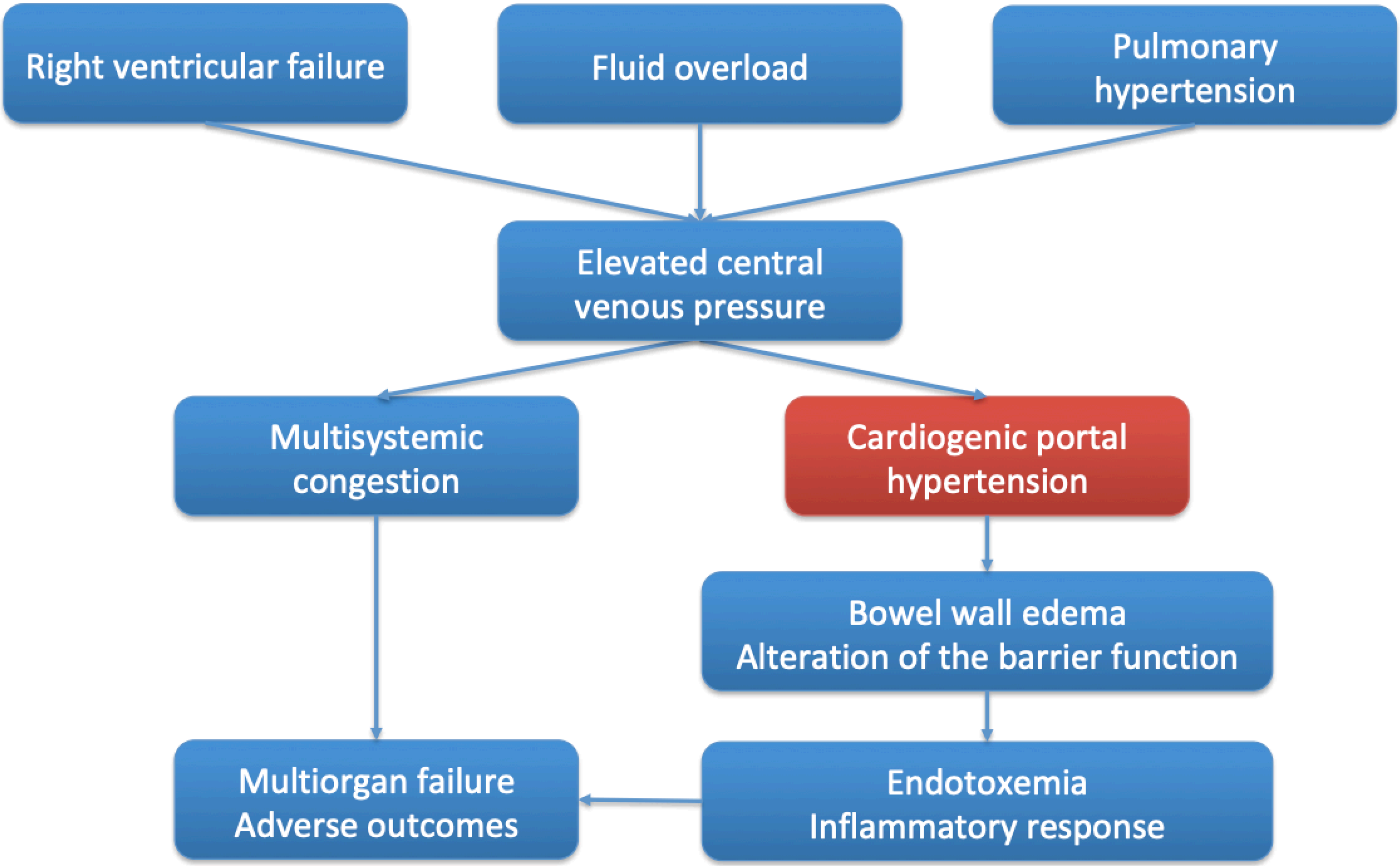
PROBLEMS IN ♥ SURGERY



PROBLEMS IN ♥ SURGERY



PROBLEMS IN ♥ SURGERY



Contemporary Reviews in Cardiovascular Medicine

Gastrointestinal and Liver Issues in Heart Failure

Varun Sundaram, MD; James C. Fang, MD

Circulation.2016;133:1696-1703.

Pathophysiology of cardio-intestinal syndrome

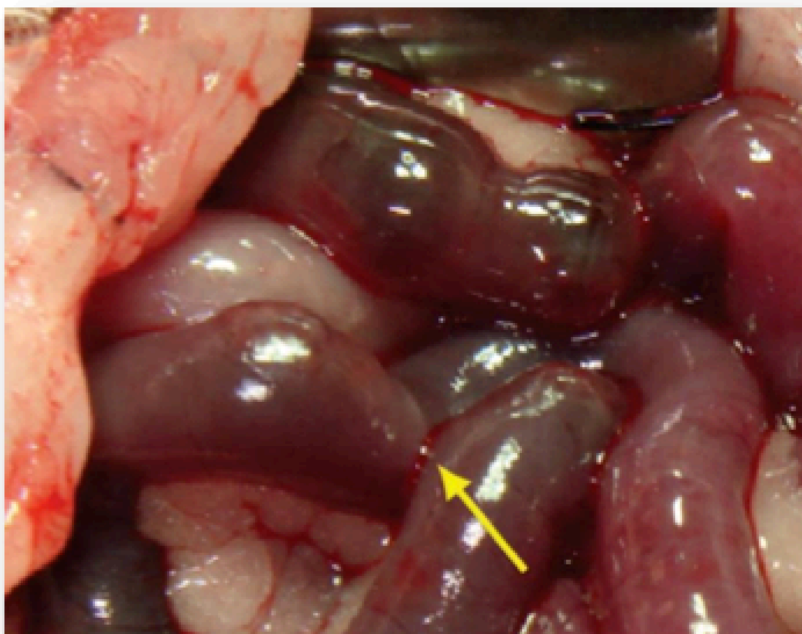
Heart failure

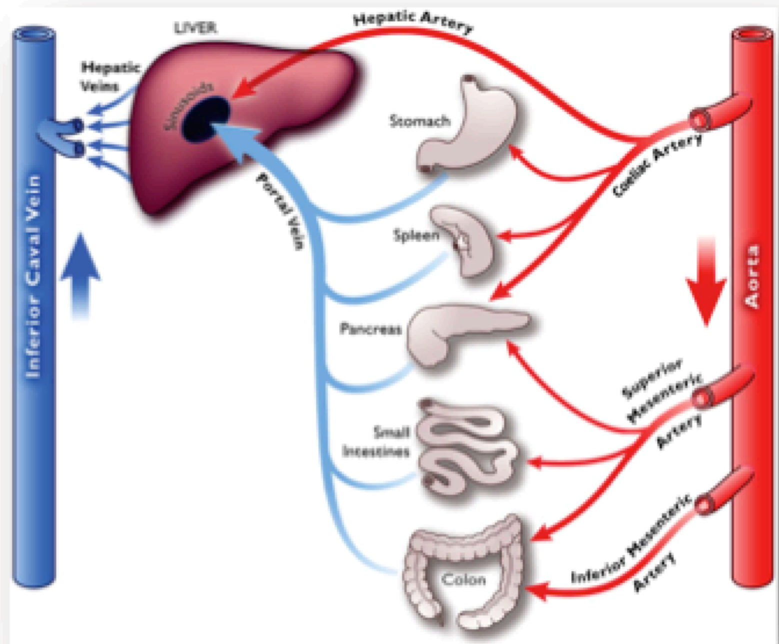
Gut

Gut edema

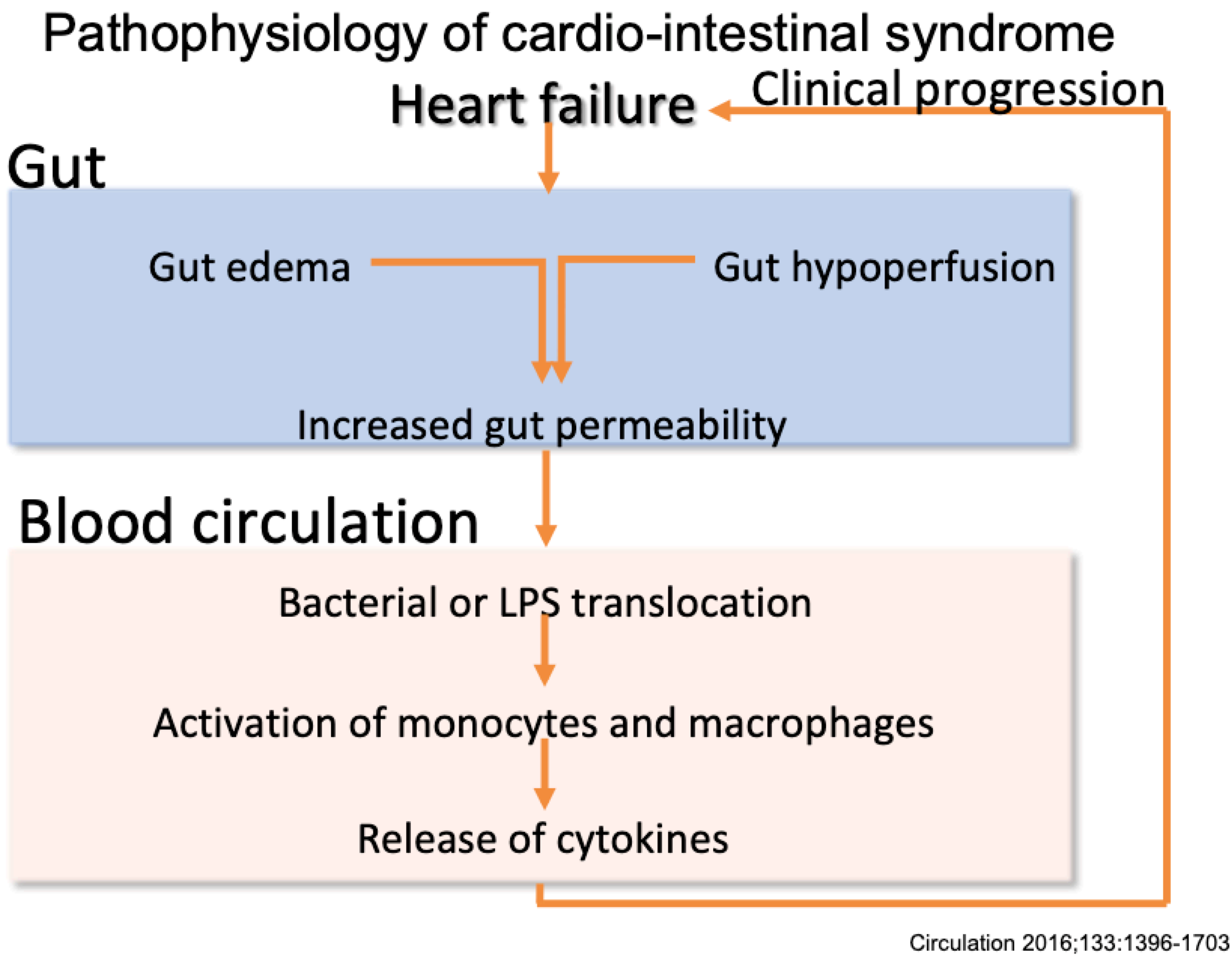
Gut hypoperfusion

Increased gut permeability



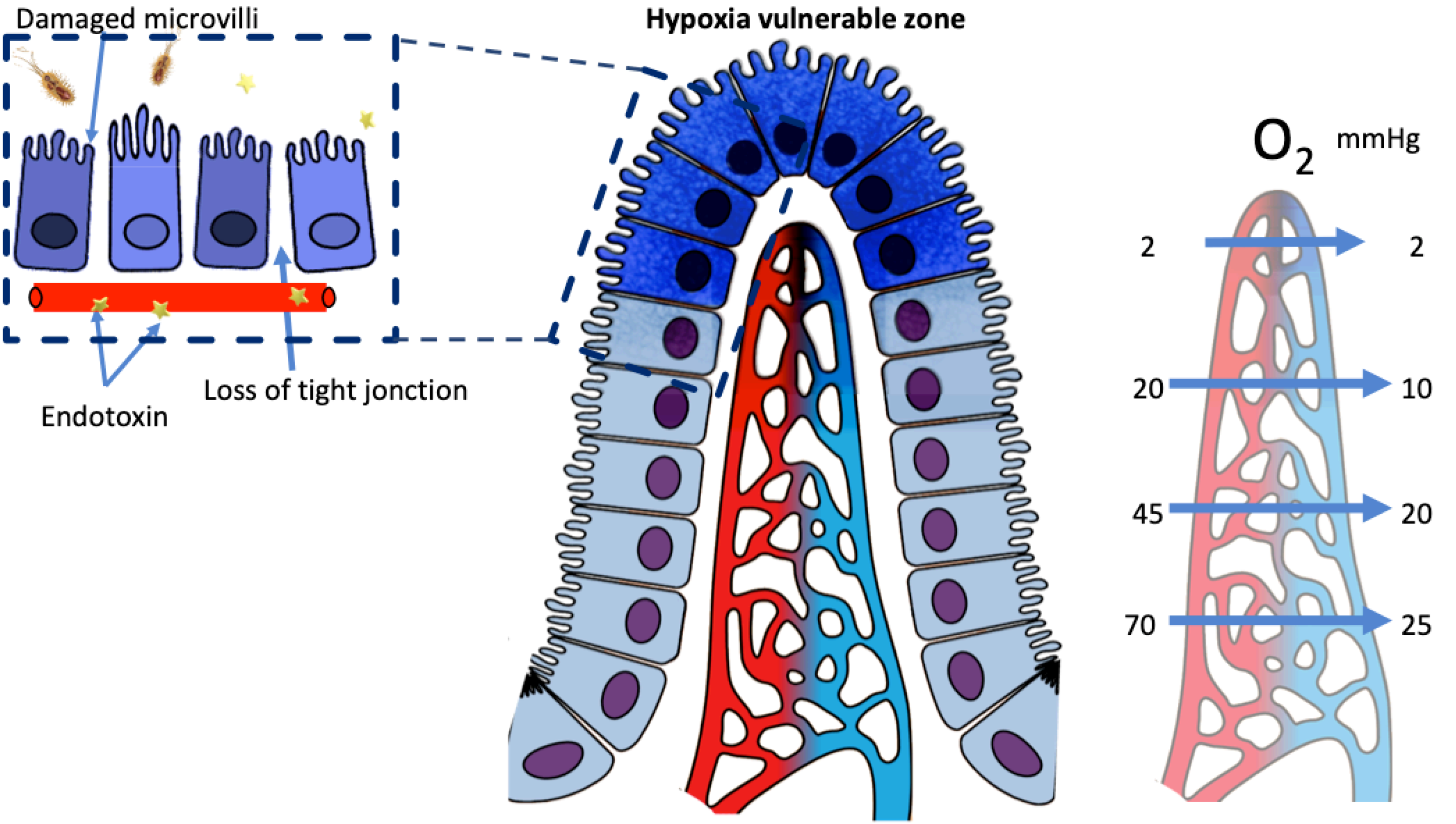


Circulation 2016;133:1396-1703

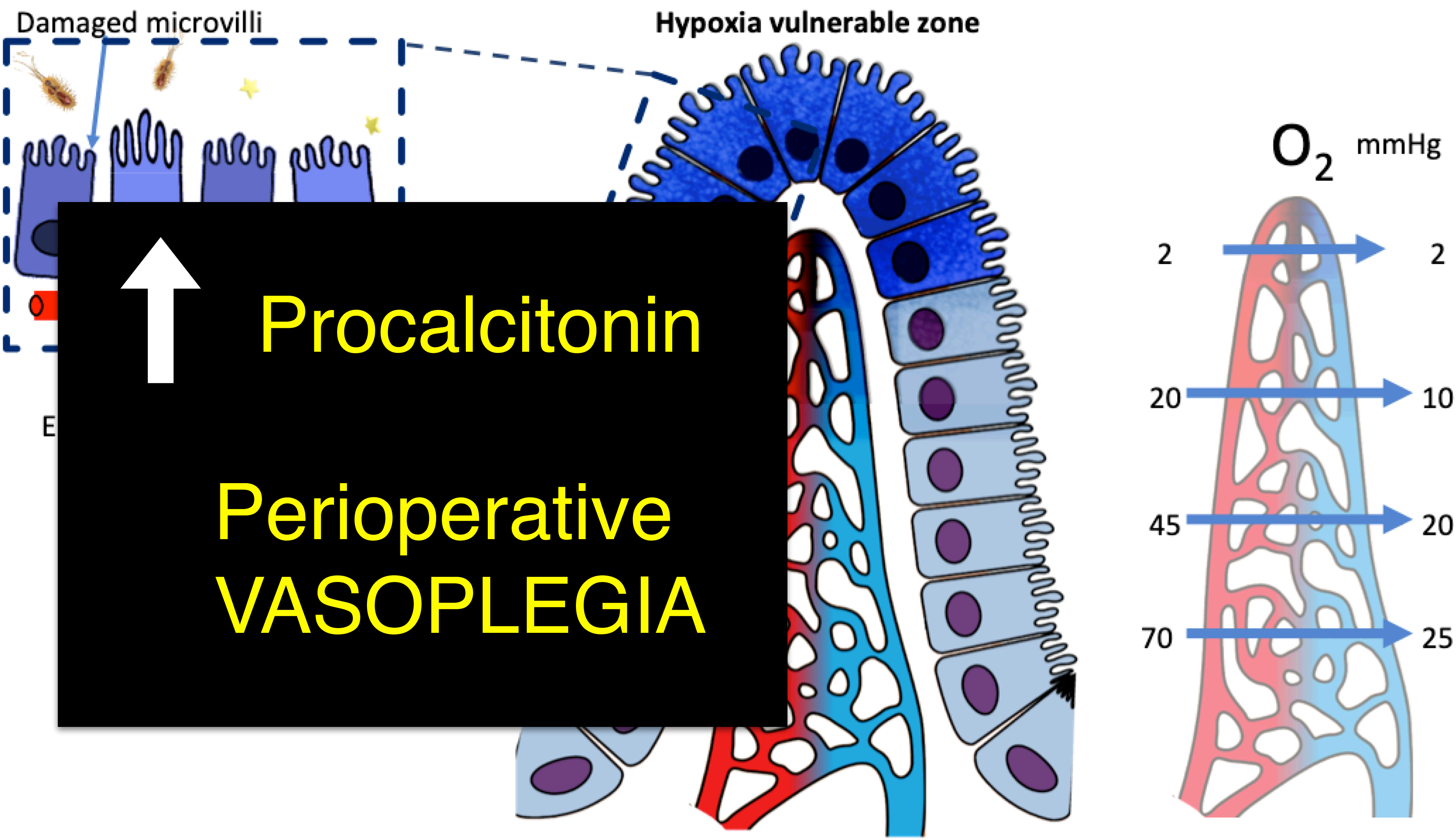

Pathophysiology of cardio-intestinal syndrome
Heart failure
Clinical progression
Gut
Gut edema
Gut hypoperfusion
Increased gut permeability
Blood circulation
Bacterial or LPS translocation
Activation of monocytes and macrophages
Release of cytokines
Circulation 2016;133:1396-1703

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM



INSTITUT DE CARDIOLOGIE



↑ Procalcitonin

Perioperative VASOPLEGIA

Clinical Challenge

Identification fluid status

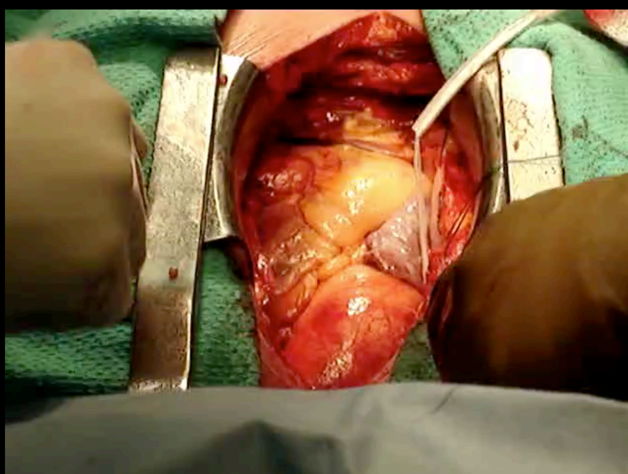
Individualize fluid administration

Identify fluid non responsiveness

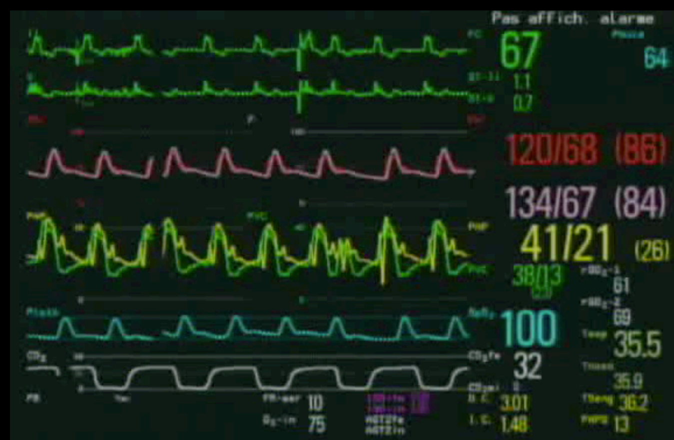
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

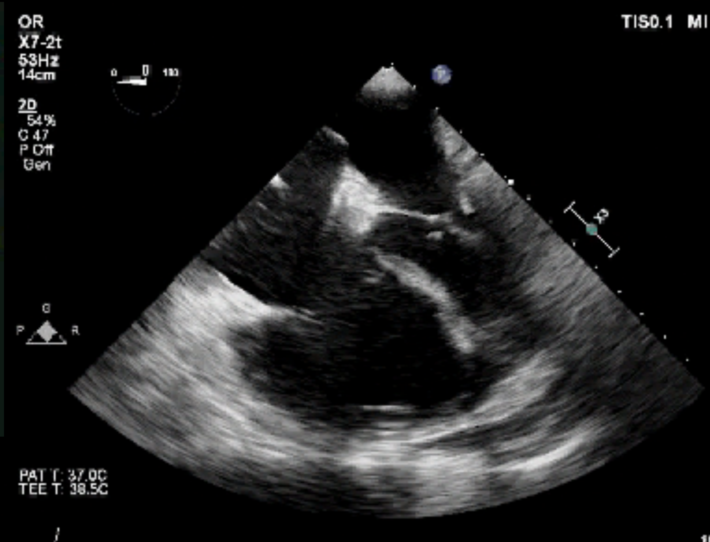
Assessing RV Function



Direct Visual Assessment



RV Pressure & Waveform Analysis



Echo

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

Journal of Cardiothoracic and Vascular Anesthesia 33 (2019) 1090–1104

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

ELSEVIER

Review Article

Perioperative Right Ventricular Pressure Monitoring in Cardiac Surgery

Check for updates

Meggie Raymond, MD[*], Lars Grønlykke, MD[†], Etienne J. Couture, MD[‡], Georges Desjardins, MD[*], Jennifer Cogan, MD[*], Jennifer Cloutier, MD[§], Yoan Lamarche, MD[||], Philippe L. L'Allier, MD[¶], Hanne Berg Ravn, MD, PhD[†], Pierre Couture, MD[*], Alain Deschamps, MD, PhD[*], Marie-Eve Chamberland, MD[*], Christian Ayoub, MD[*], Jean-Sébastien Lebon, MD[*], Marco Julien, MD[*], Jean Taillefer, MD[*], Antoine Rochon, MD[*], André Y. Denault, MD, PhD[#,1]

*Department of Anesthesiology, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada

†Department of Cardiothoracic Anaesthesia, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark

‡Intensive Care Program, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada

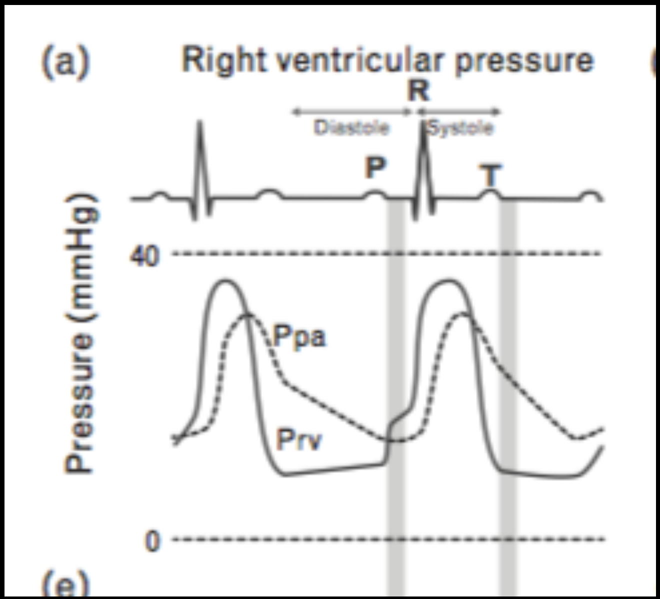
§Department of Anesthesiology, Saint John Regional Hospital, Saint John, New Brunswick, Canada

||Department of Cardiac Surgery, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada

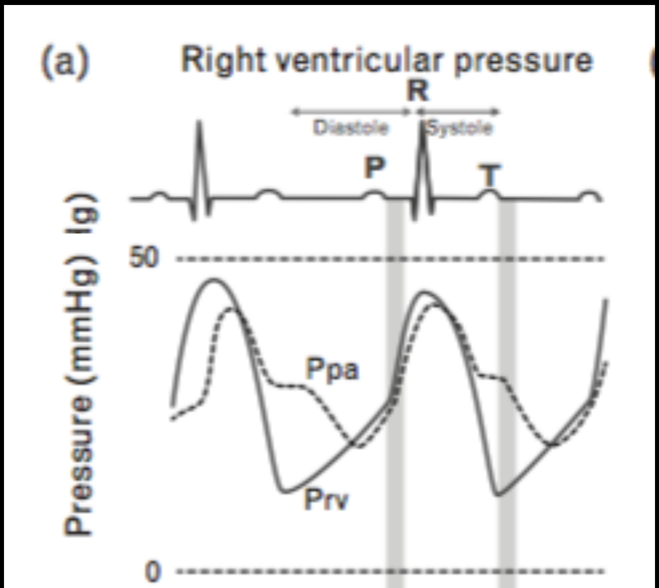
¶Department of Cardiology, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada

#Department of Anesthesiology and Cardiac Surgical Intensive Care Department, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada

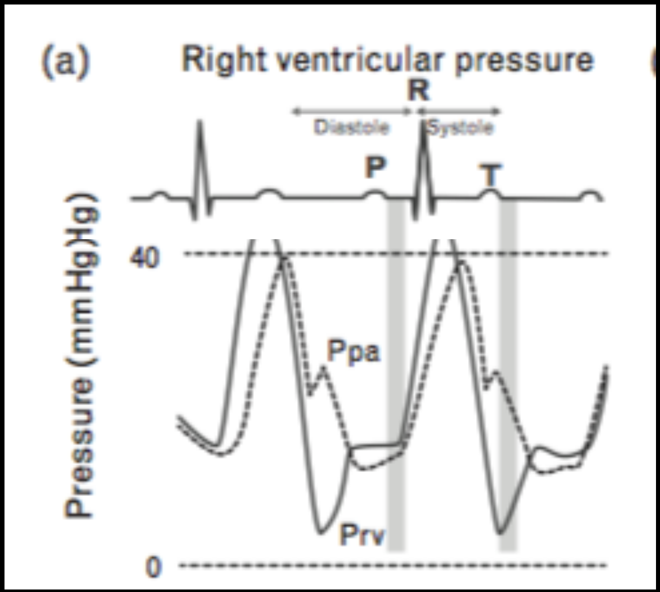
Why Look at RV Pressure?



Normal



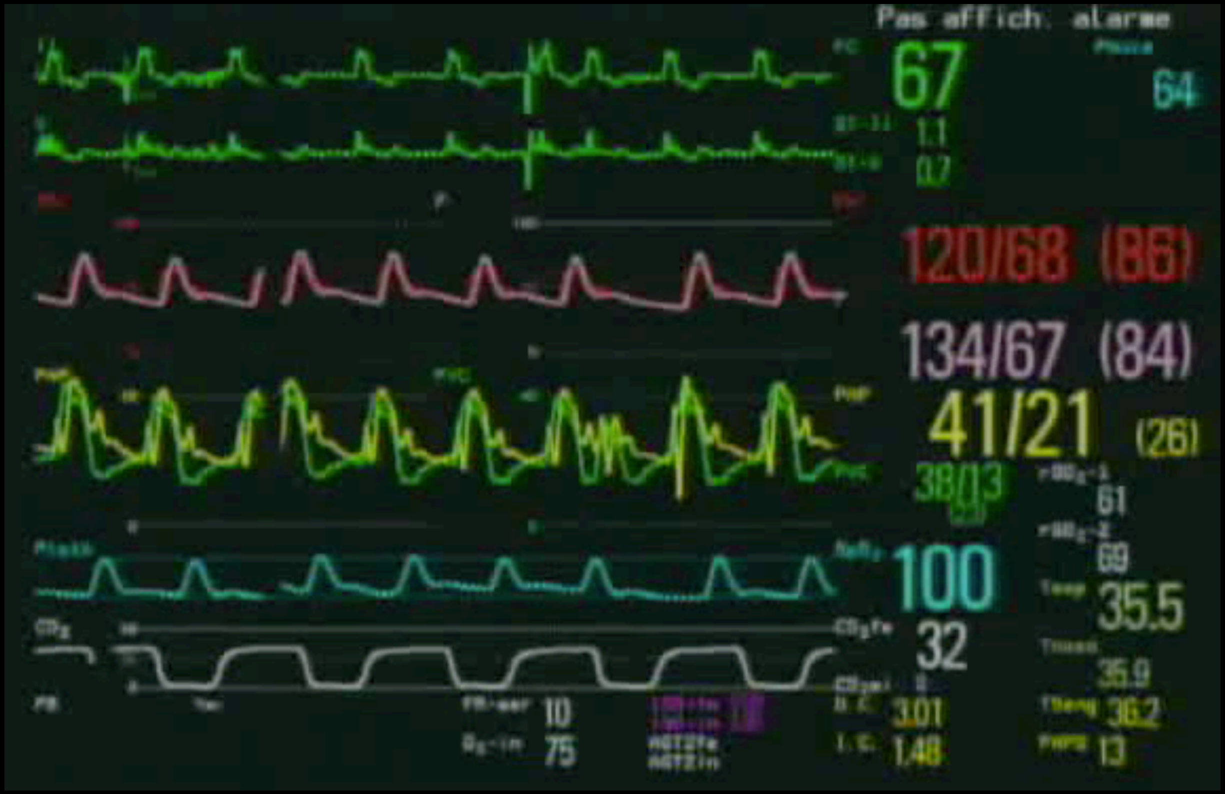
Elevated RVEDP



RV Failure

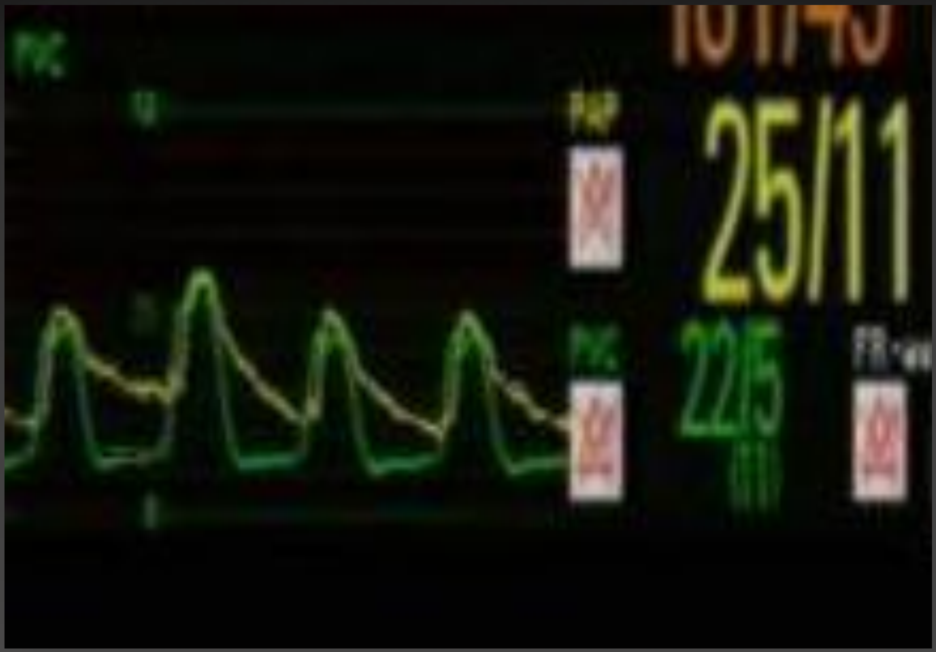
Haddad et al. Curr Opin Anaesthesiol. 2016;29(1):68-79

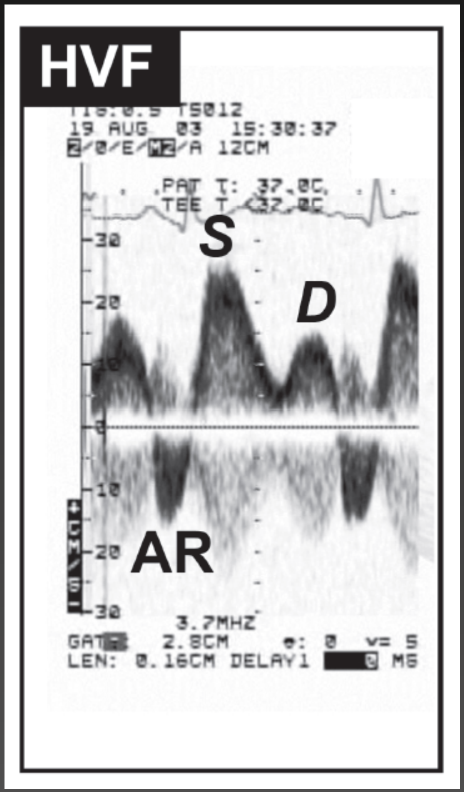
Pressure & Waveform Analysis



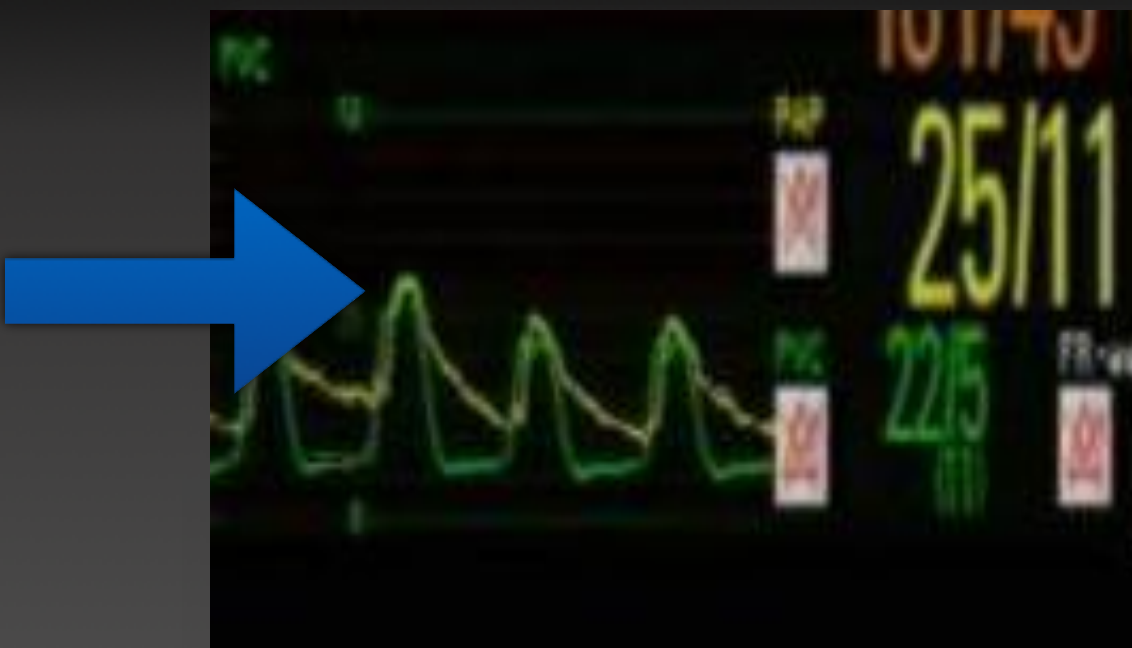
A Normal RVEDP < 5 mmHg

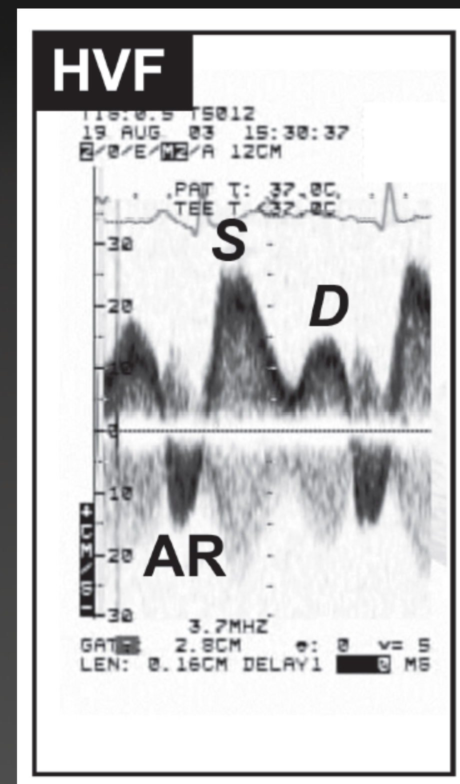
Importance of RV Failure





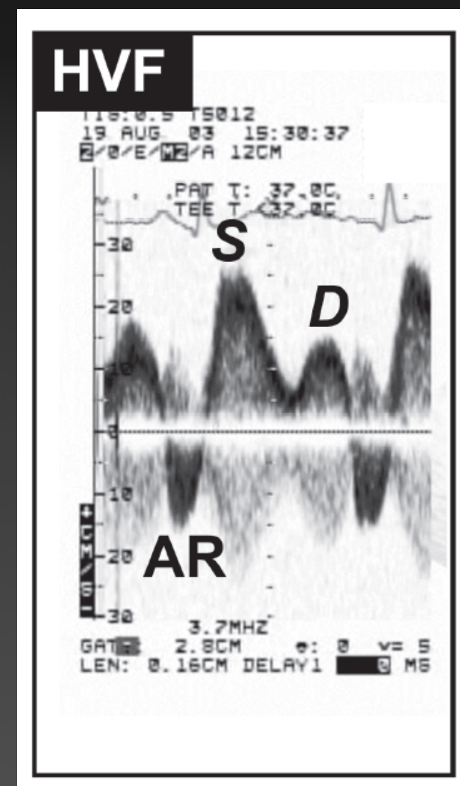
Importance of RV Failure





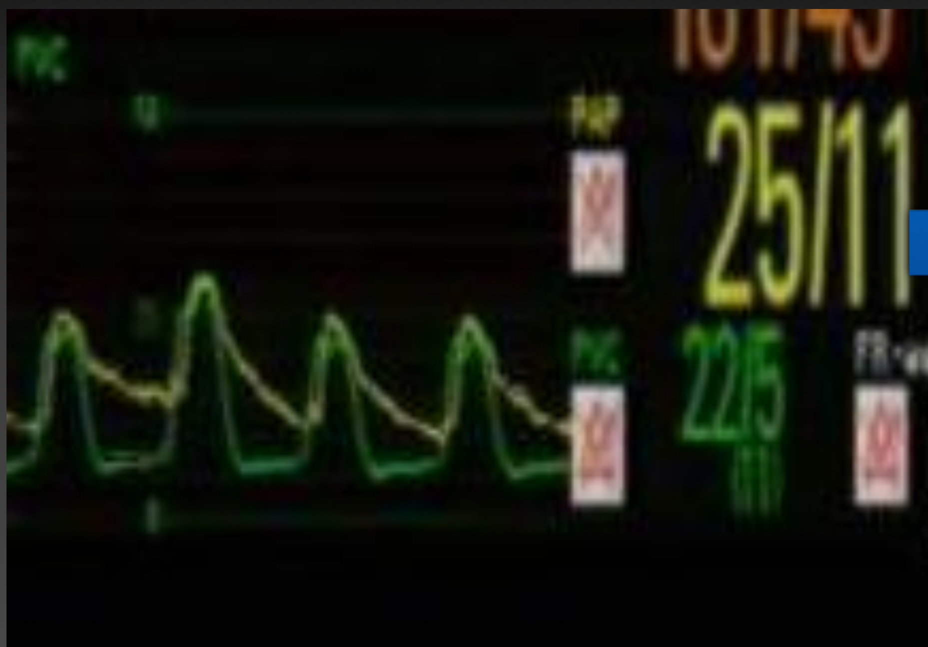
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

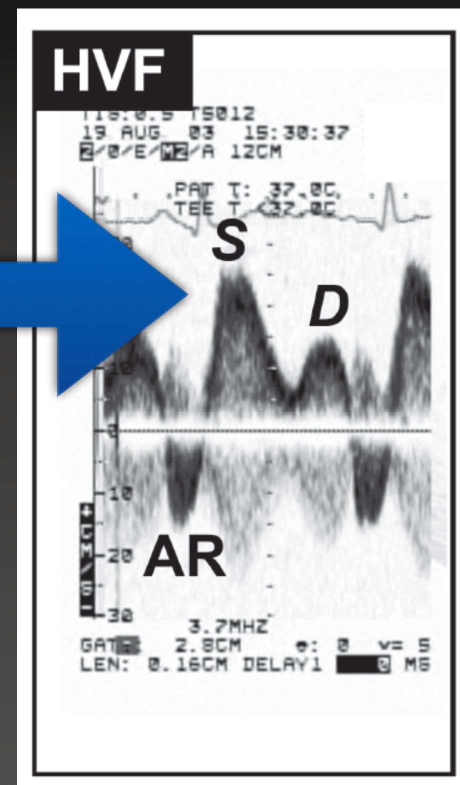
Importance of RV Failure



INSTITUT DE CARDIOLOGIE DE MONTRÉAL

Importance of RV Failure





INSTITUT DE CARDIOLOGIE DE MONTRÉAL

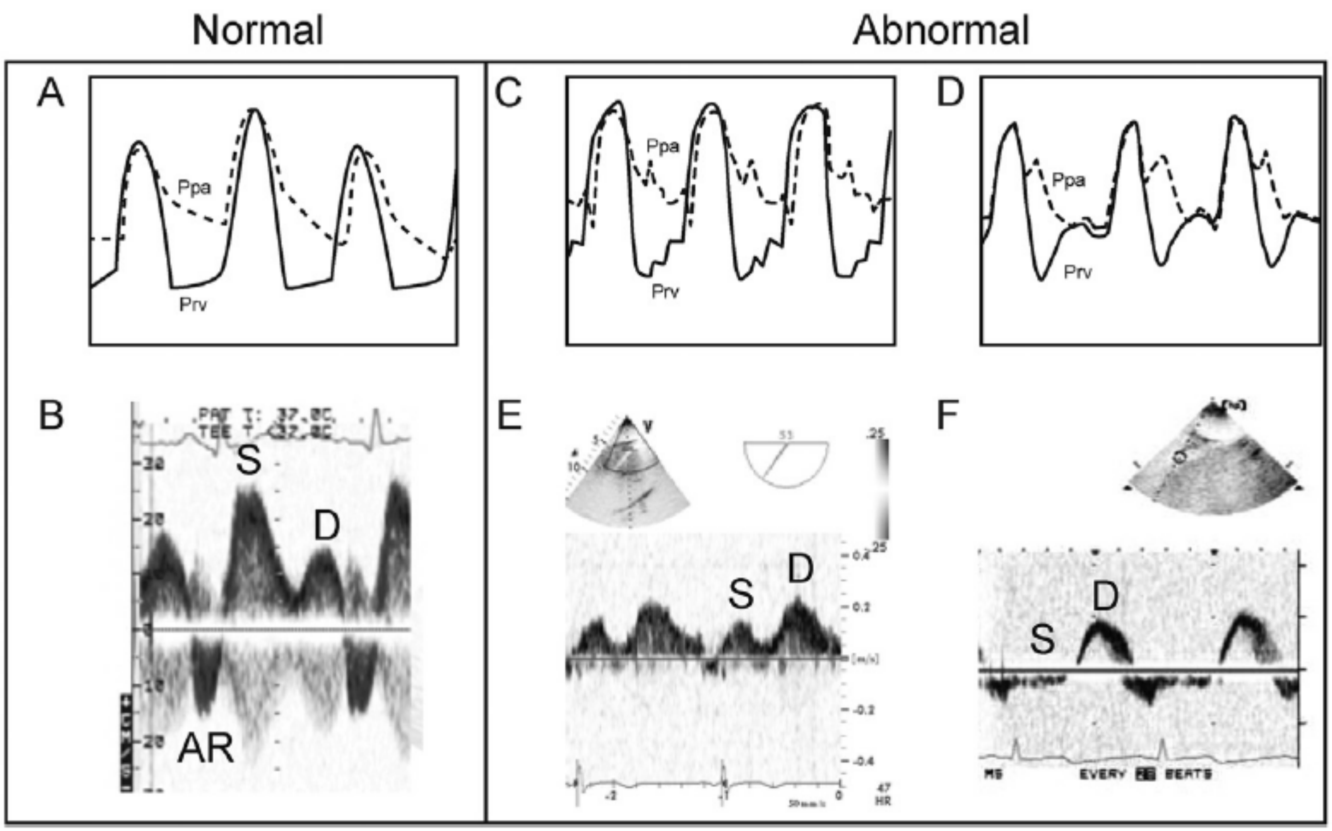
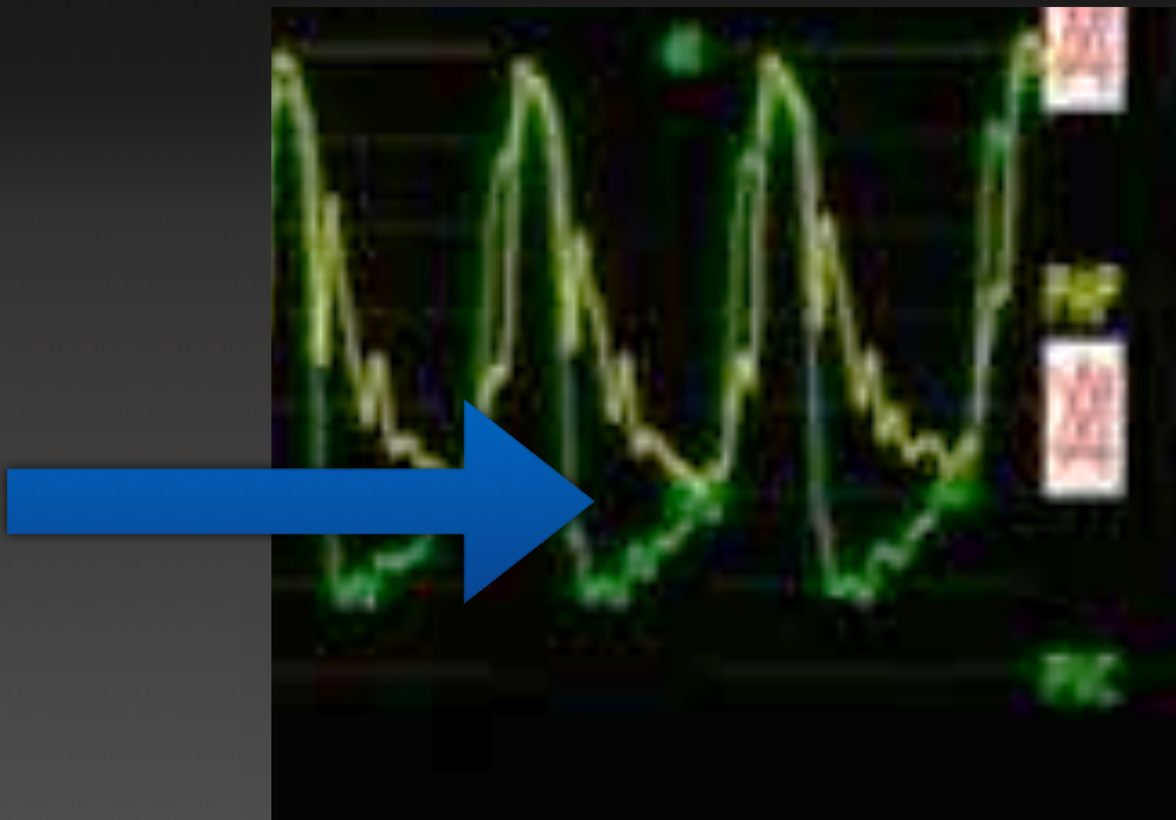


Fig 1. (A,B) Echocardiographic and hemodynamic definition for normal and abnormal (C-F) right ventricular function using hepatic venous flow (HVF) variables, right ventricular pressure (Prv), and pulmonary artery pressure (Ppa) (dotted line) waveforms. Note that as right ventricular function deteriorates, the Prv waveform changes from a (A) normal horizontal to an (C) oblique and then a (D) square root waveform. The latter is associated with Ppa diastolic equalization. Note also that as right ventricular function deteriorates, the S/D ratio > 1 (B) becomes < 1 (E) and the S wave flattens or can even become inverted (F) (AR, HVF atrial reversal; D, diastolic component of the HVF; S, systolic component of the HVF). (Adapted from Denault 2013[20]).

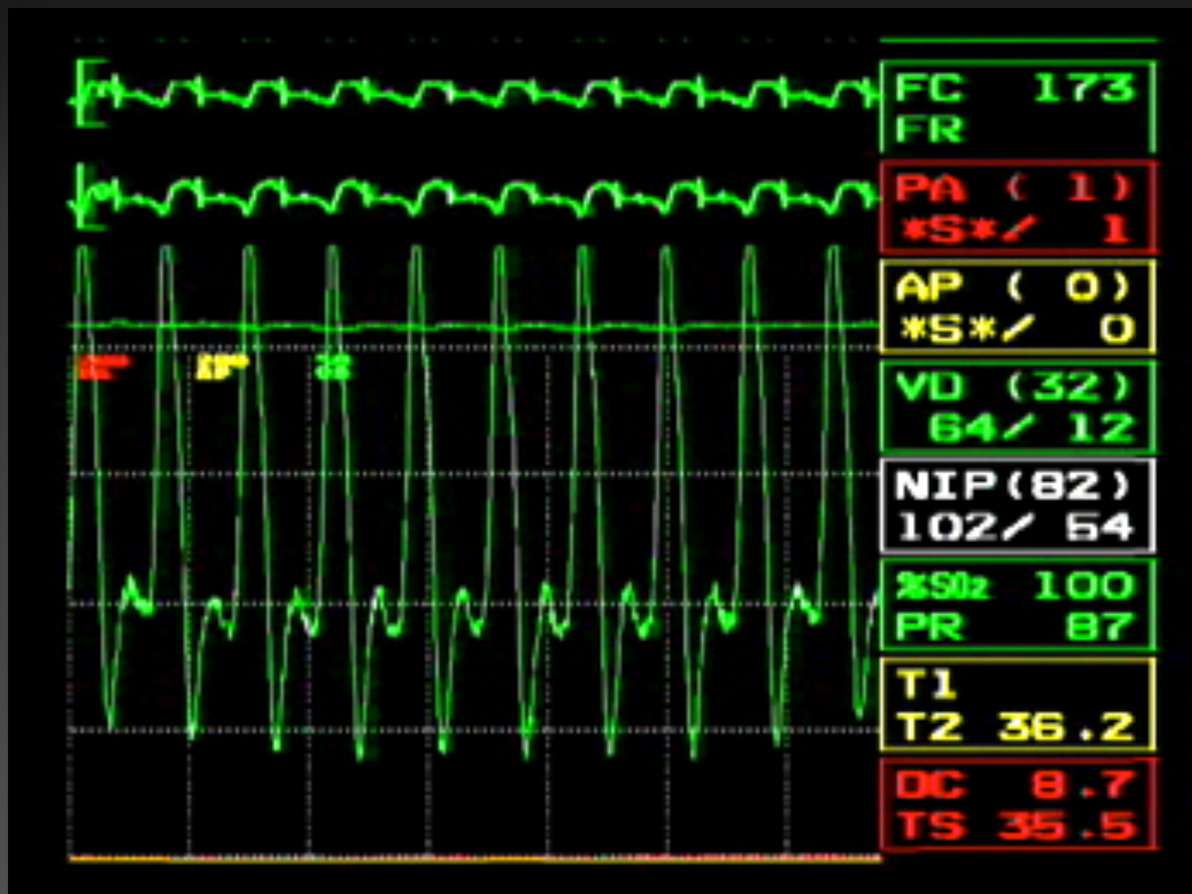
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

RV Pressures in RV Failure

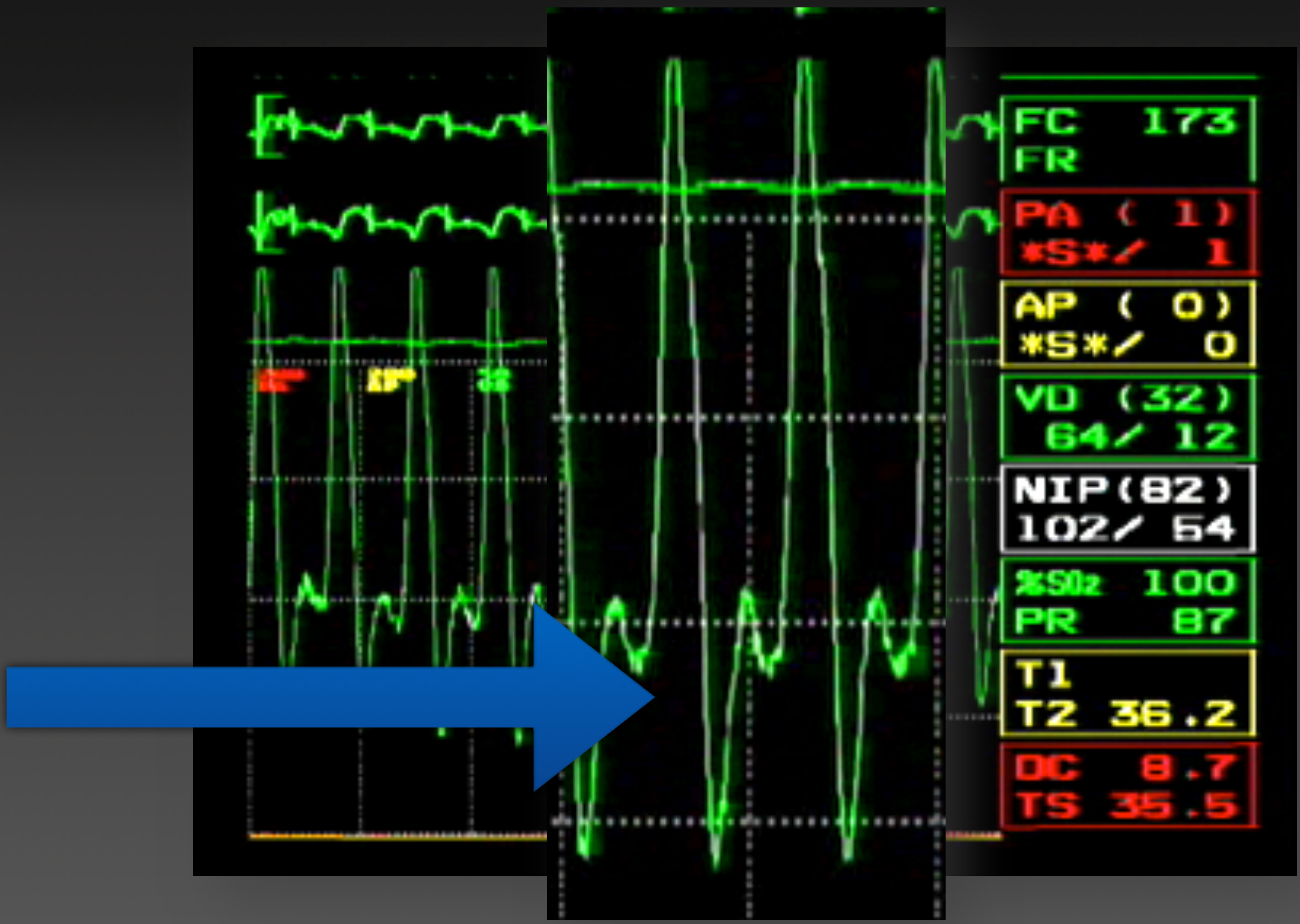


INSTITUT DE CARDIOLOGIE DE MONTRÉAL

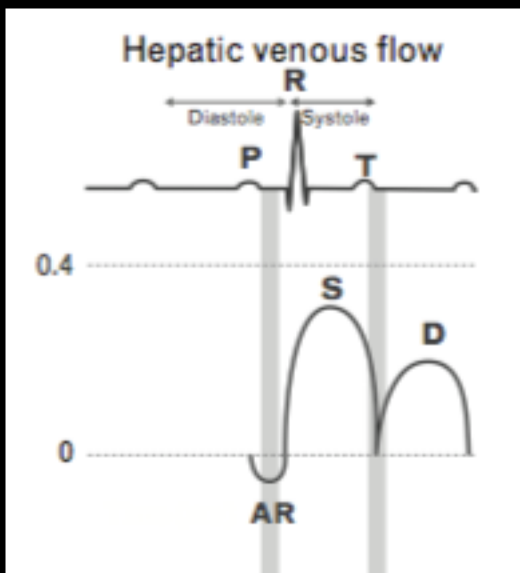
Importance of RV Failure



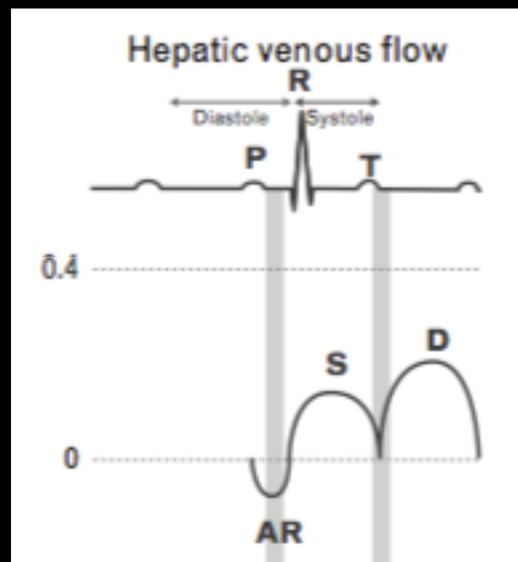
Severe RV Failure



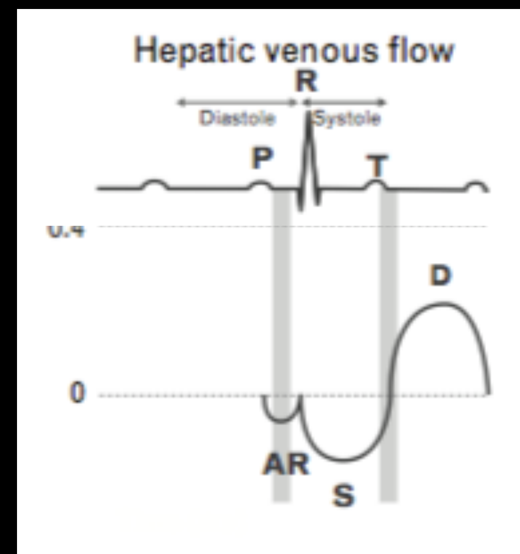
Hepatic Vein



Normal



Elevated RVEDP



RV Failure

Haddad et al. Curr Opin Anaesthesiol. 2016;29(1):68-79

Assessing Venous Congestion

Physical Examination

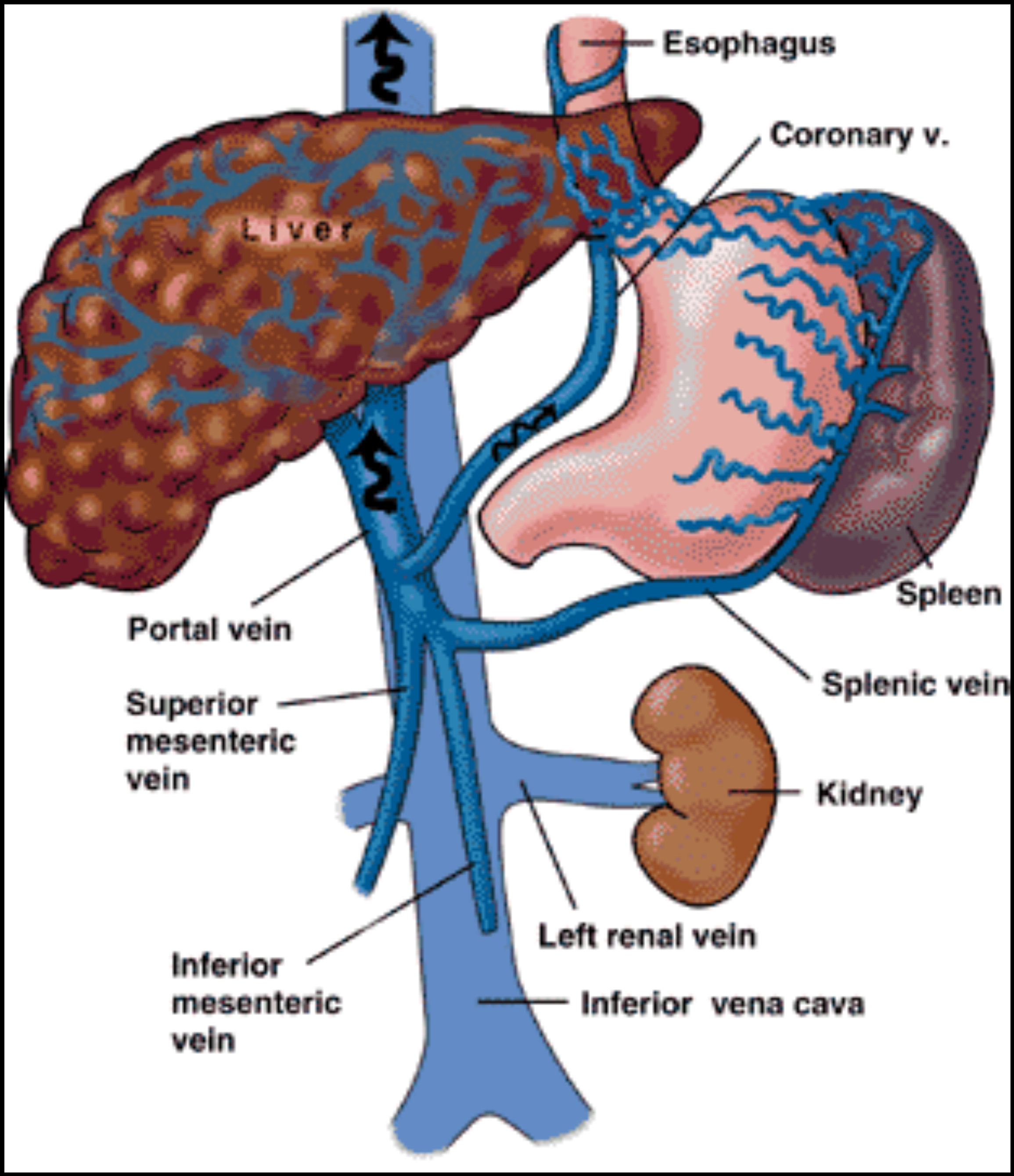
CVP

Hepatic veins Flow patterns

Portal vein Flow patterns

Splenic vein Flow patterns

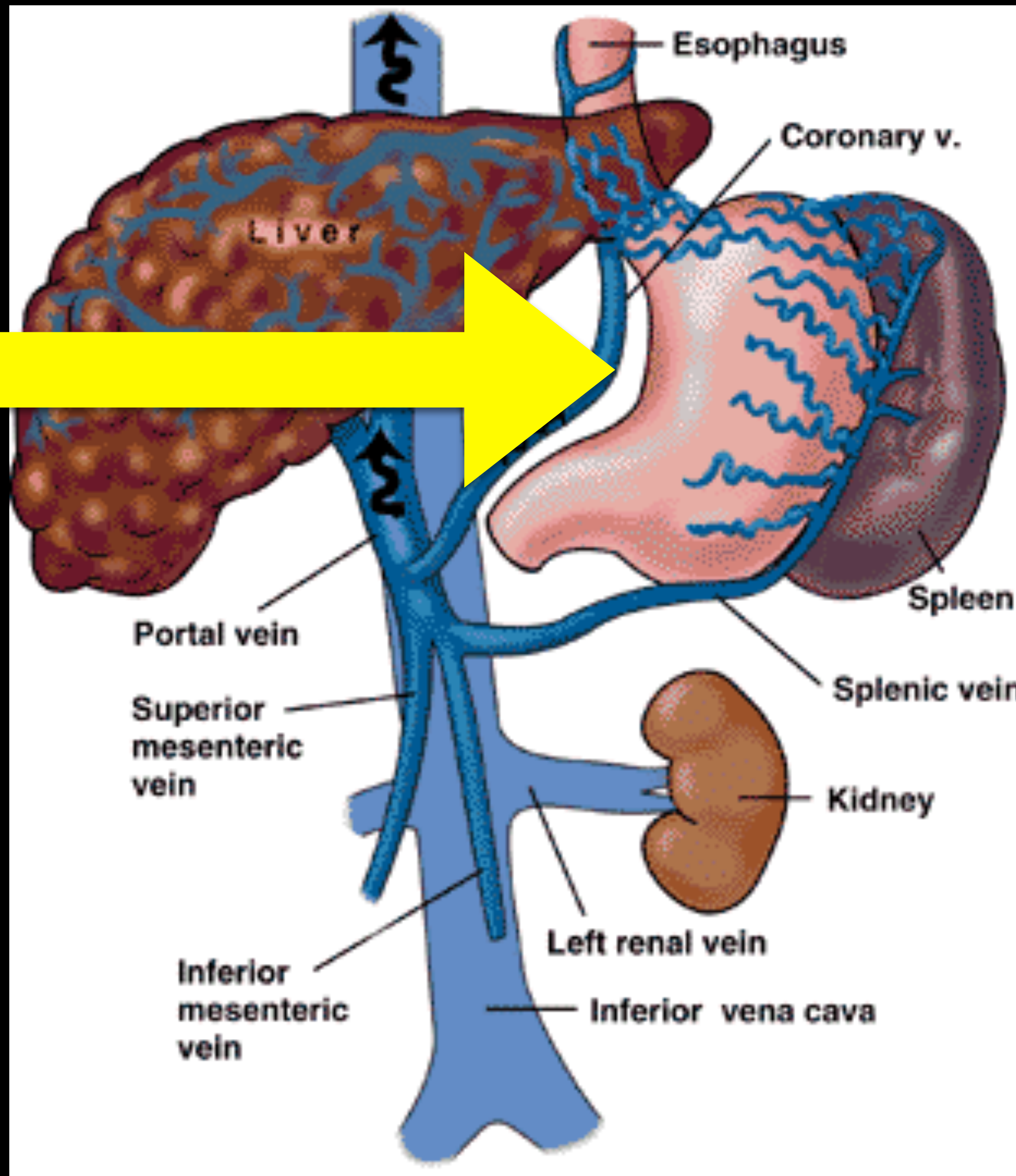
Renal veins Flow patterns

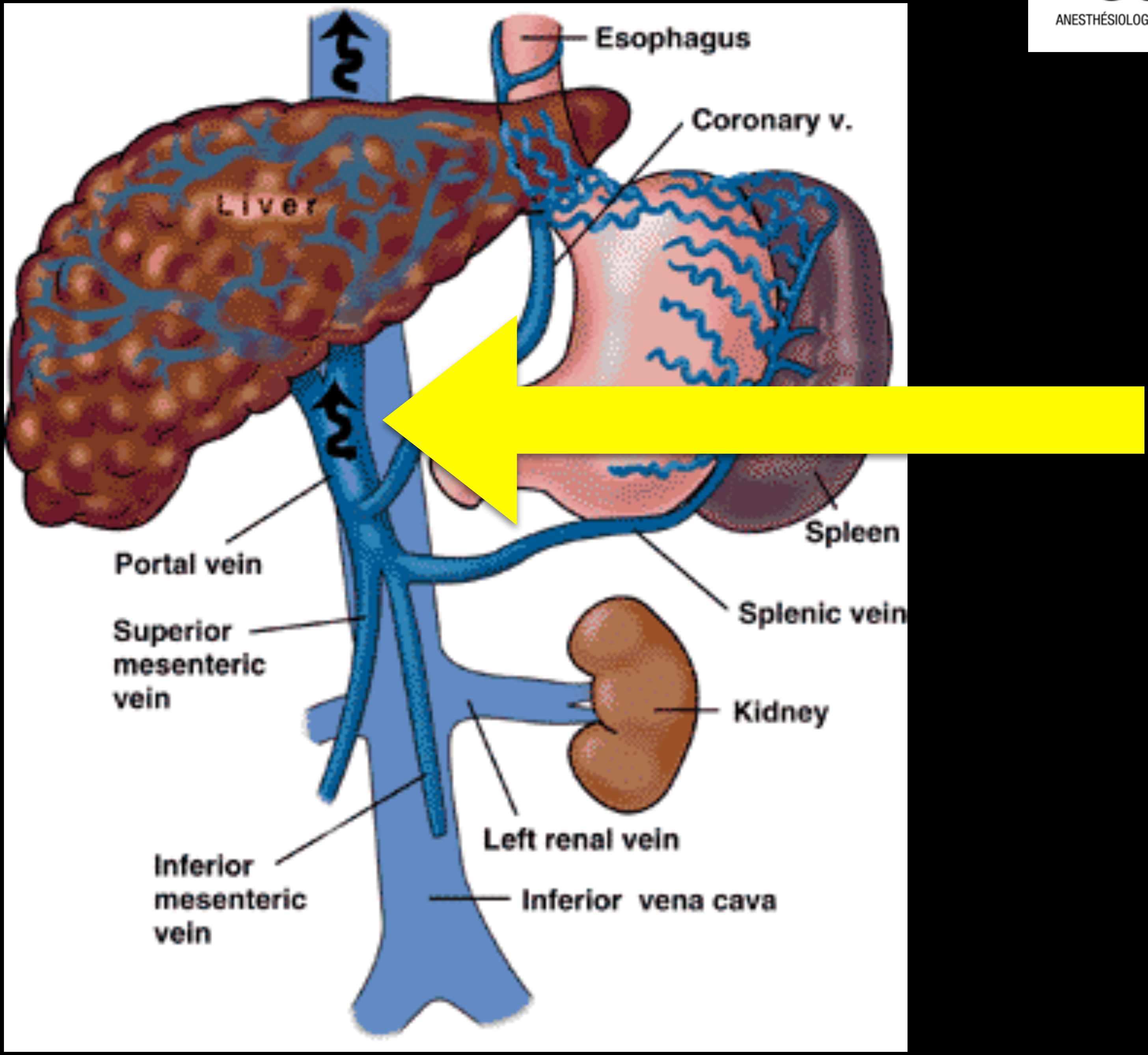


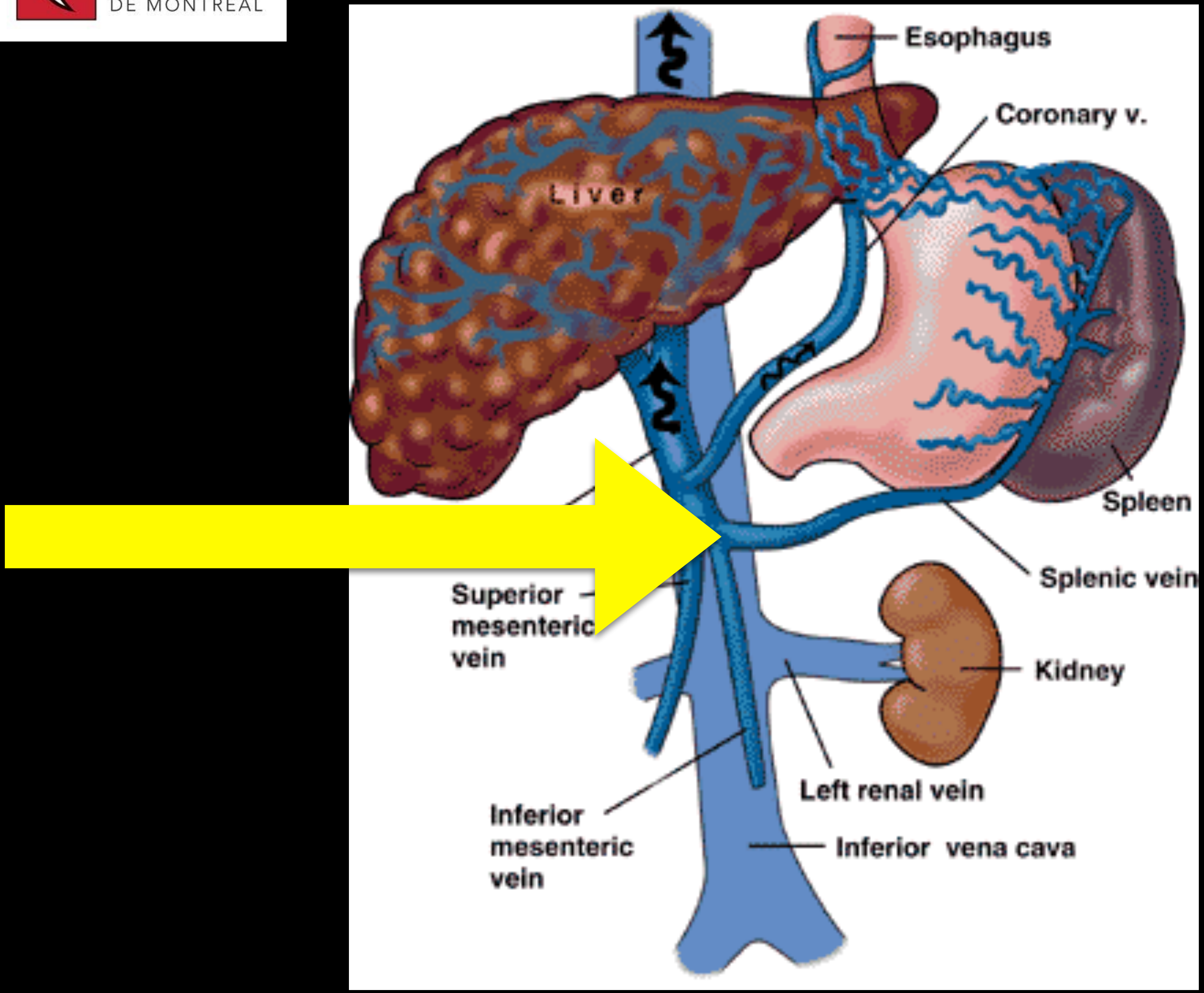
Esophagus
Coronary v.
Liver
Spleen
Portal vein
Splenic vein
Superior mesenteric vein
Kidney
Left renal vein
Inferior mesenteric vein
Inferior vena cava

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM



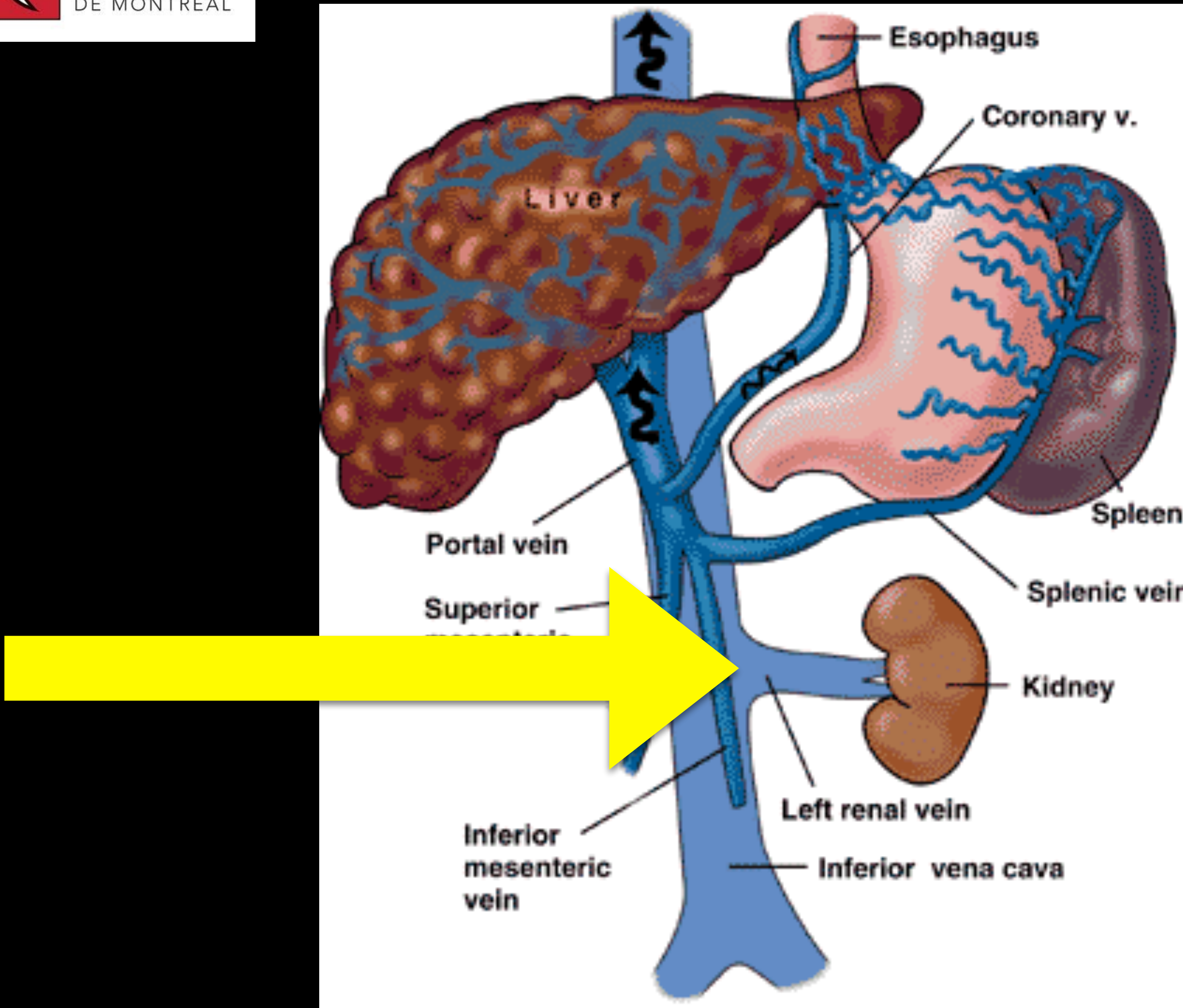

Esophagus
Coronary v.
Liver
Spleen
Portal vein
Splenic vein
Superior mesenteric vein
Kidney
Left renal vein
Inferior mesenteric vein
Inferior vena cava



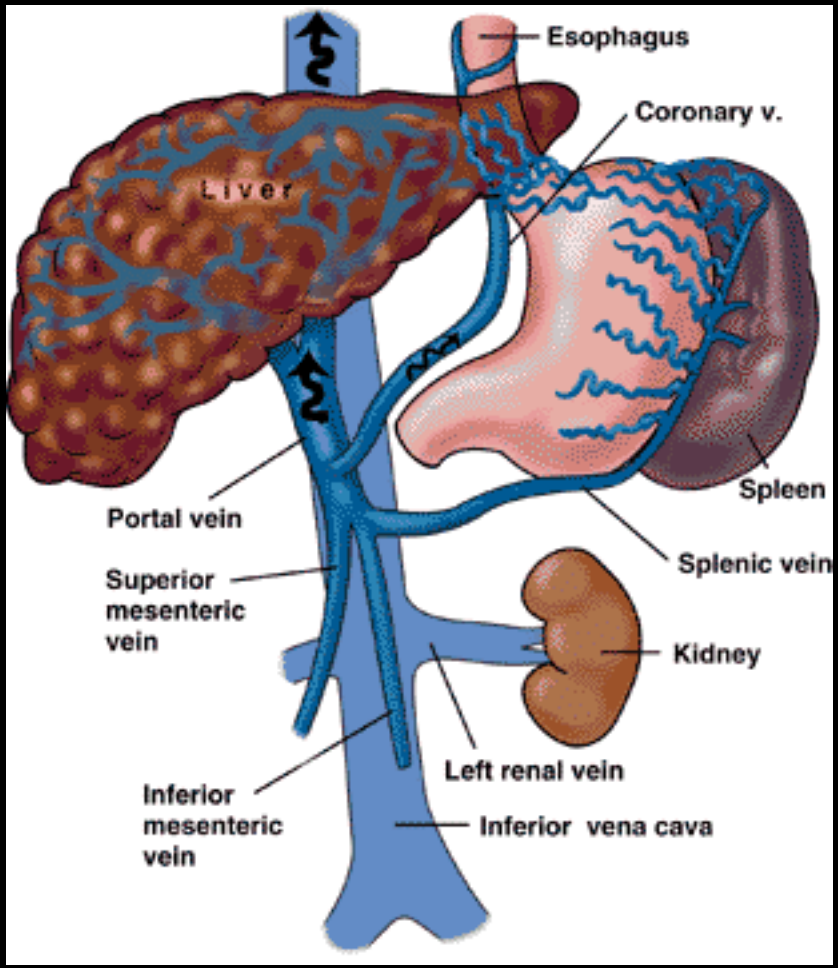
Esophagus
Coronary v.
Liver
Spleen
Splenic vein
Superior mesenteric vein
Kidney
Left renal vein
Inferior mesenteric vein
Inferior vena cava

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

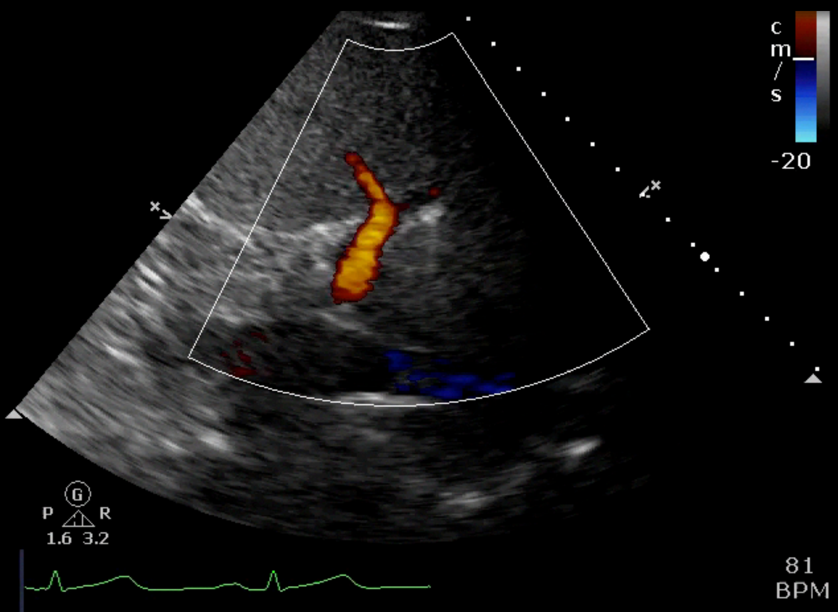
ANESTHÉSIOLOGIE • ICM

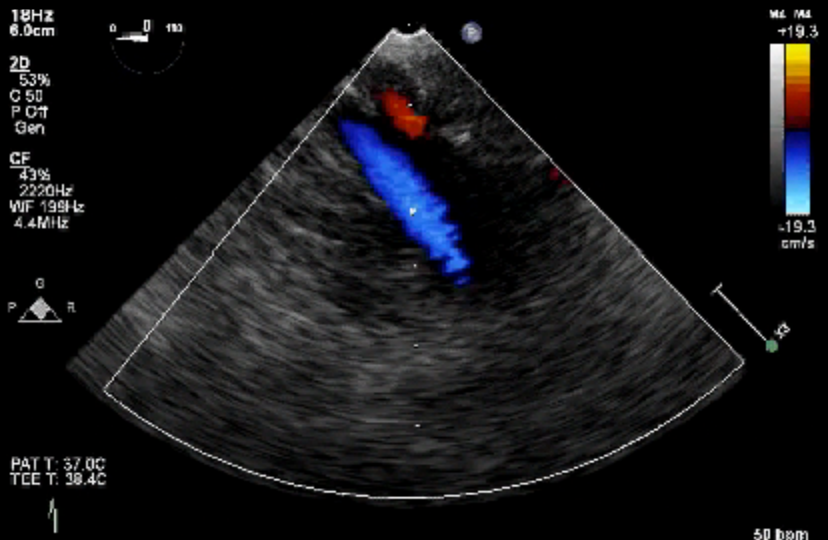


Anatomy



Portal Vein TTE



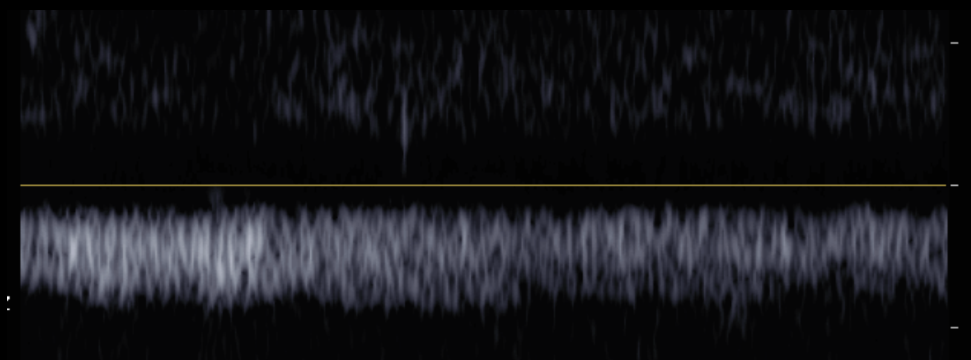


Splenic Vein TEE

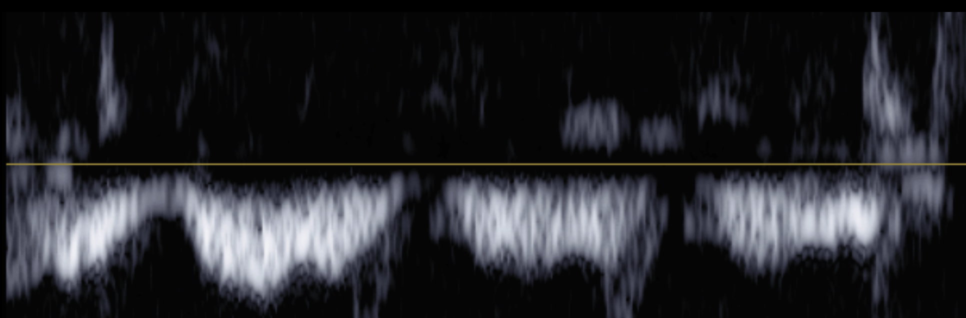
Portal vein Flow Patterns

Can be interrogated with TTE and TEE

Cirrhosis Literature…



Normal Portal Vein Flow

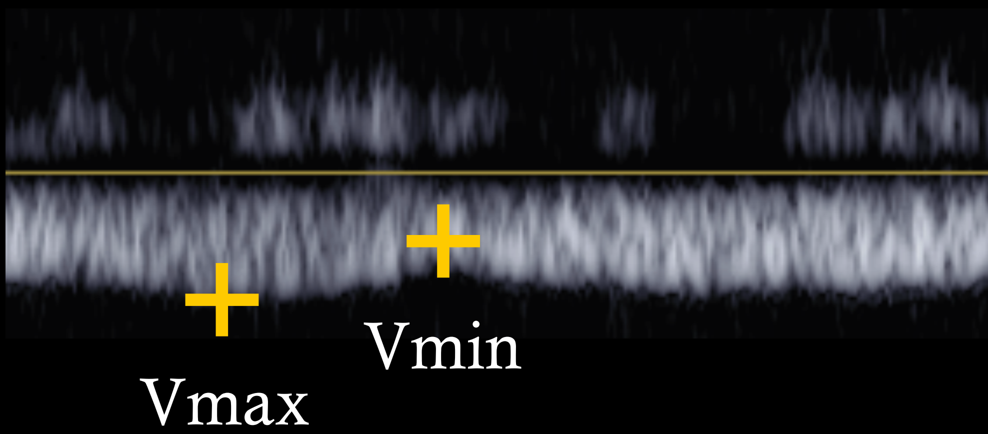


Pulsatile Portal Vein Flow

- Cirrhosis —> Port HTN
- Right Heart Failure —> Venous and Hepatic Congestion

Kok et al. Scand J Gastroenterol Suppl 1999;230:82-8

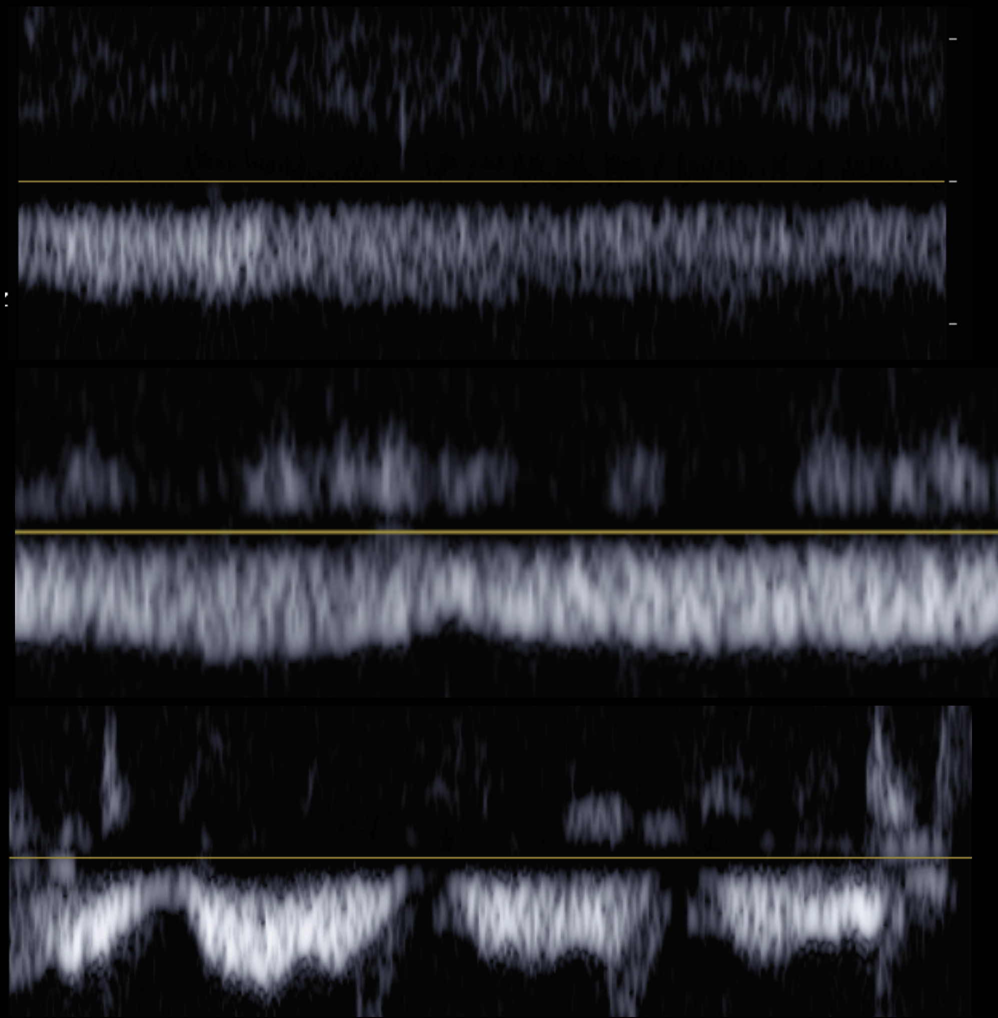
Portal Vein Pulsatility Index



PV PI = (Vmax - Vmin)/Vmax

Westra et al. AJR 1995;165:167-72

Portal Vein Pulsatility Index



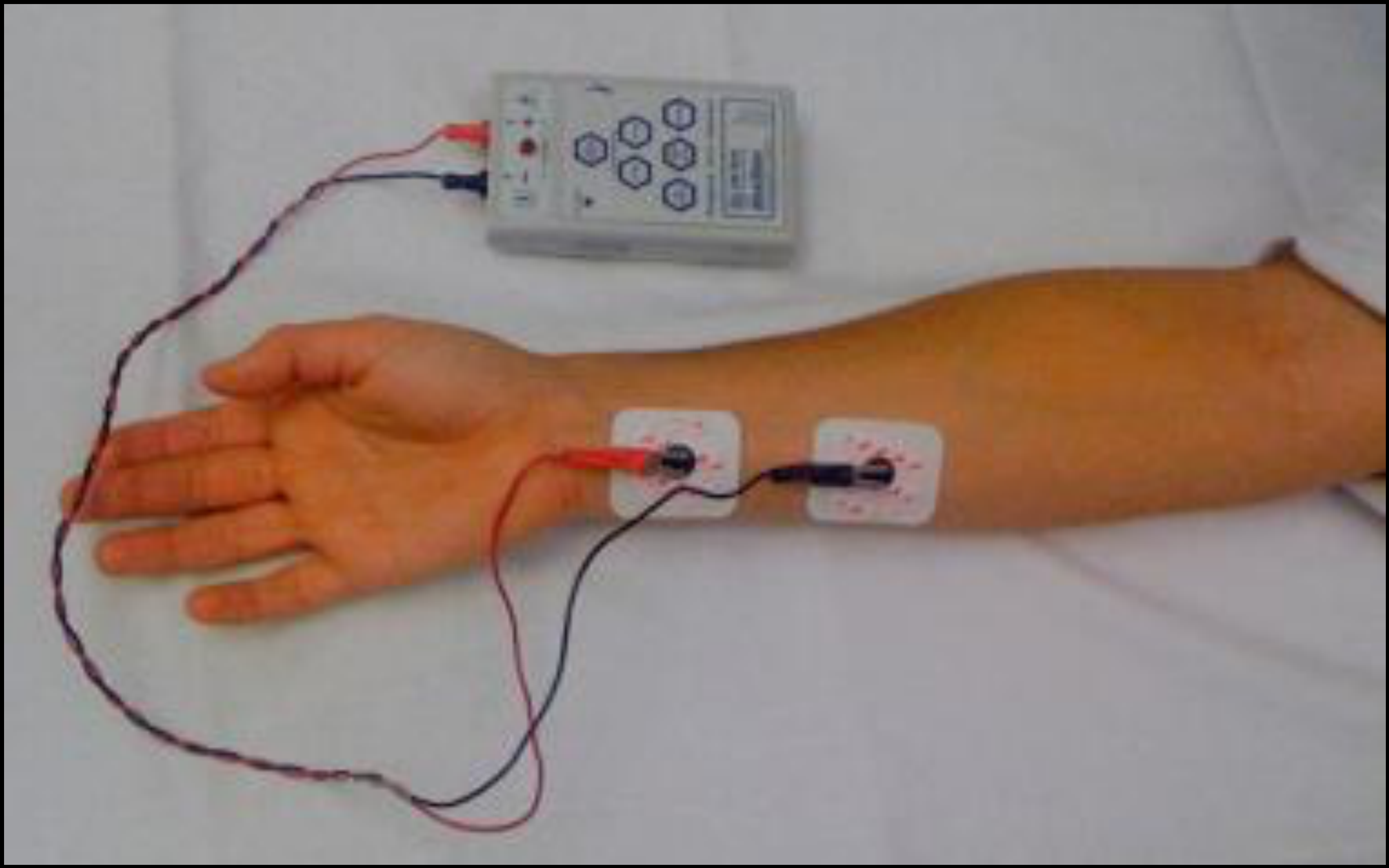
Normal Controls:
PV PI = 0

Cirrhosis but no PHT
PV PI = .35

Cirrhosis with PHT
PV PI = .60

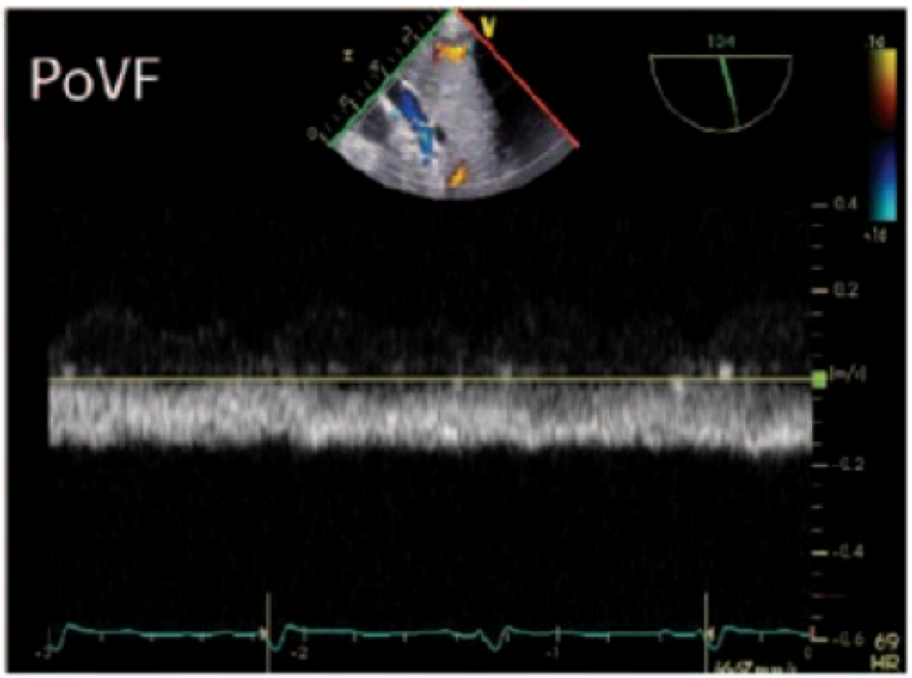
Westra et al. AJR 1995;165:167-72

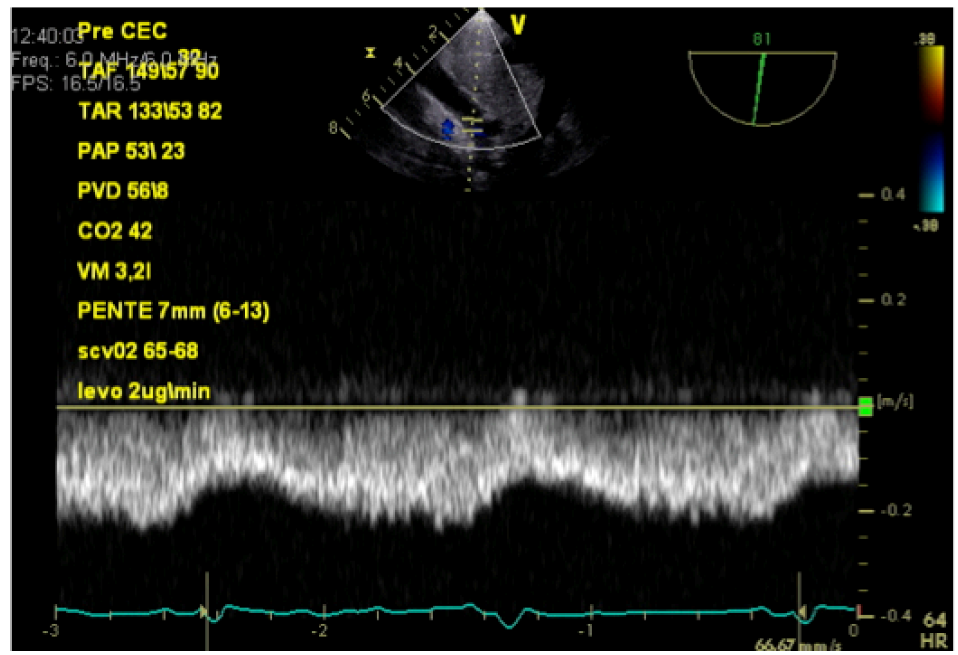
RV Twitch Monitor



Portal hypertension in ♥ surgery

- Portal hypertension = an ultrasound biomarker resulting from right heart dysfunction (Abnormal right ventricular-arterial coupling)



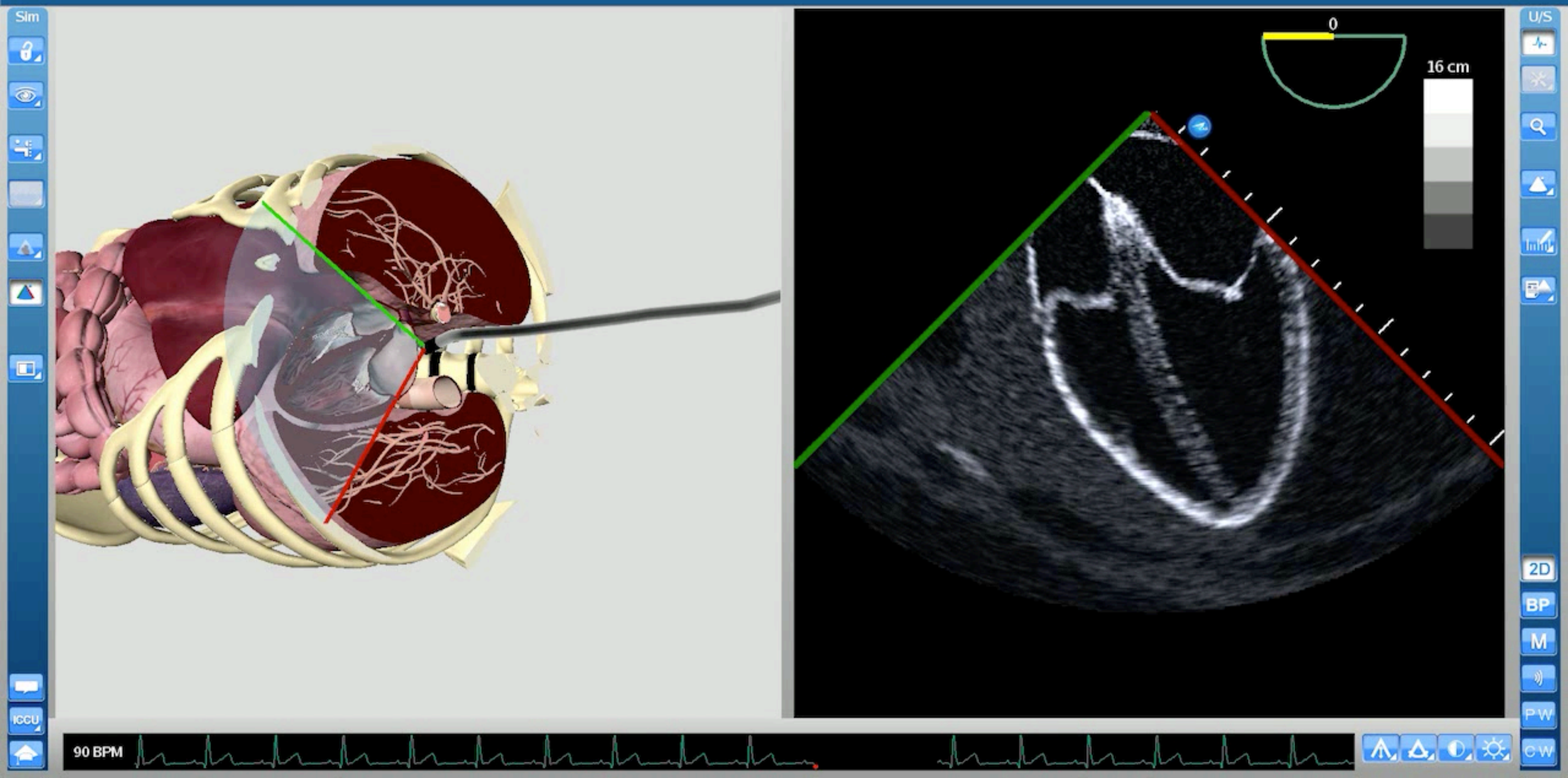


INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

How to find the Portal Vein - TEE

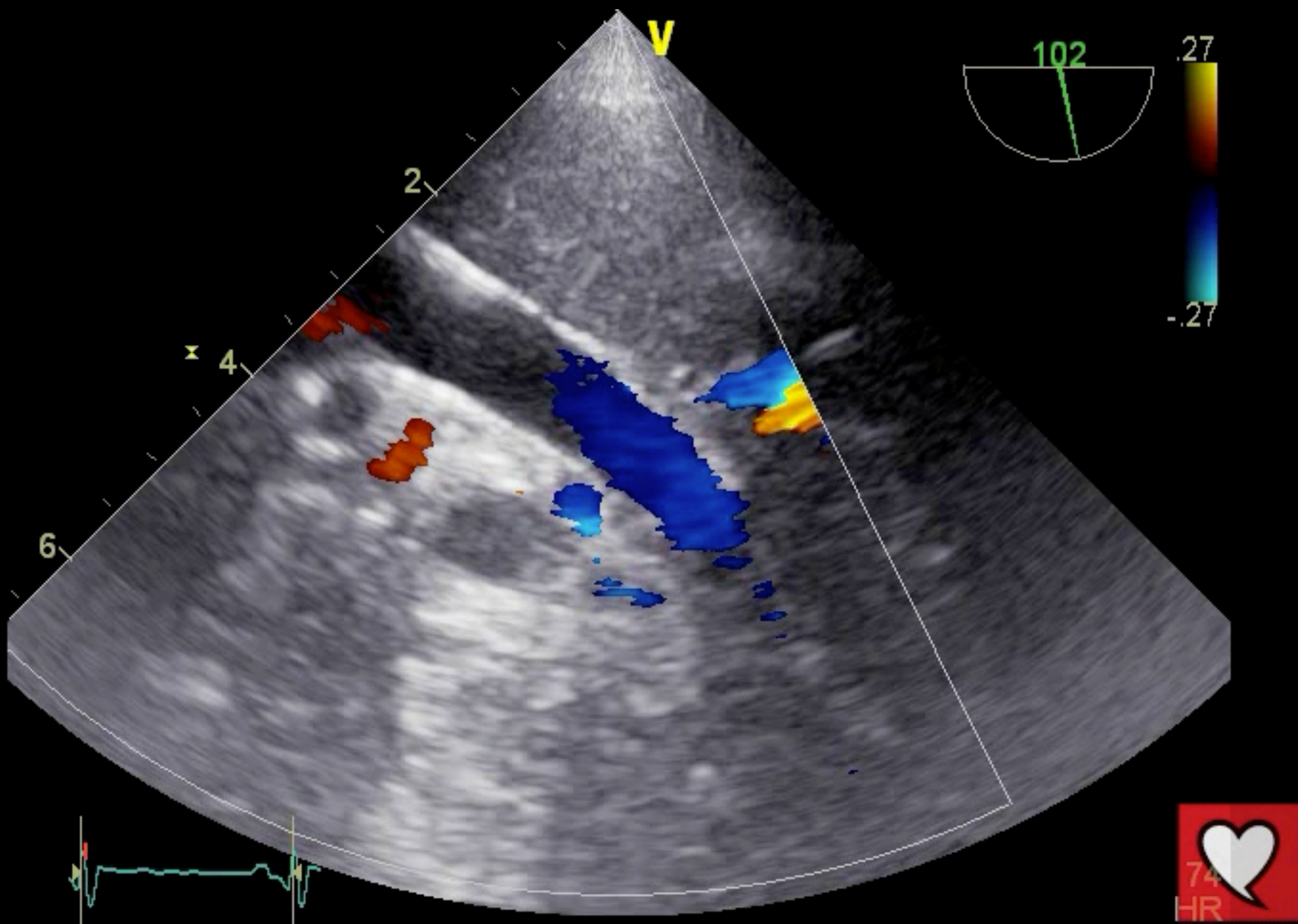
Start with a mid-esophageal four-chamber view



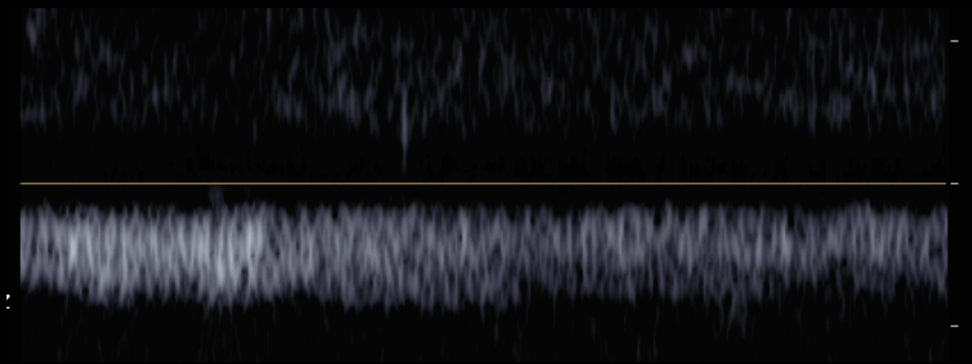
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

How to find the Portal Vein - TEE



Portal Vein Flow Pattern

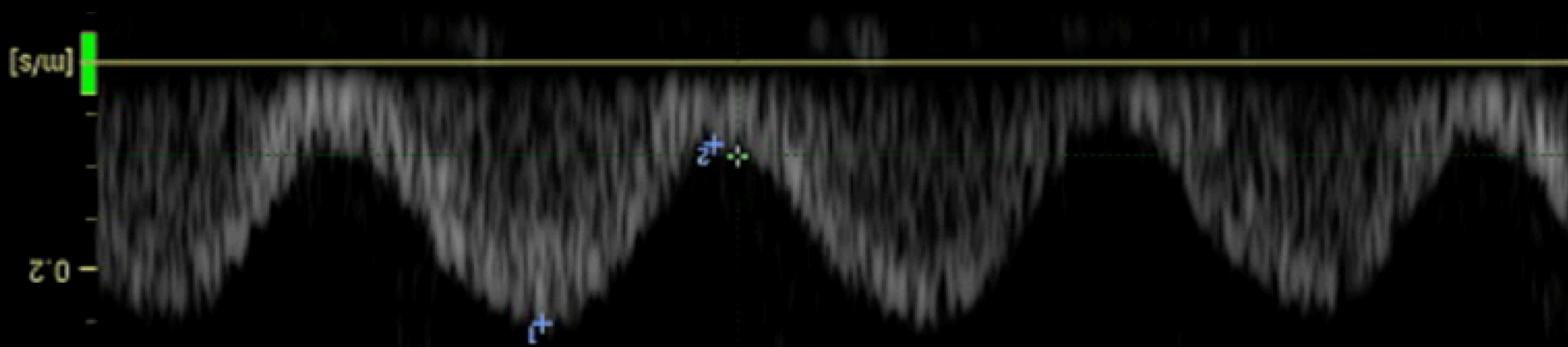


Normal Portal Vein Flow

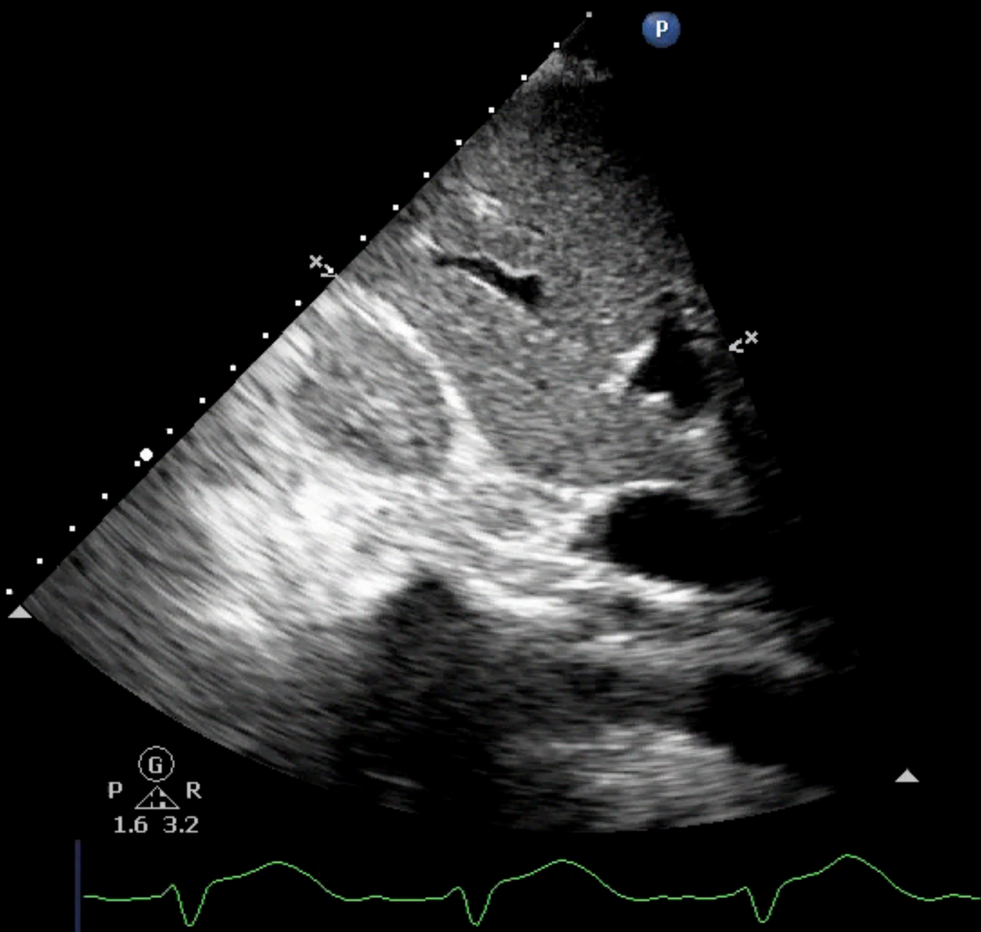
INSTITUT DE CARDIOLOGIE DE MONTRÉAL

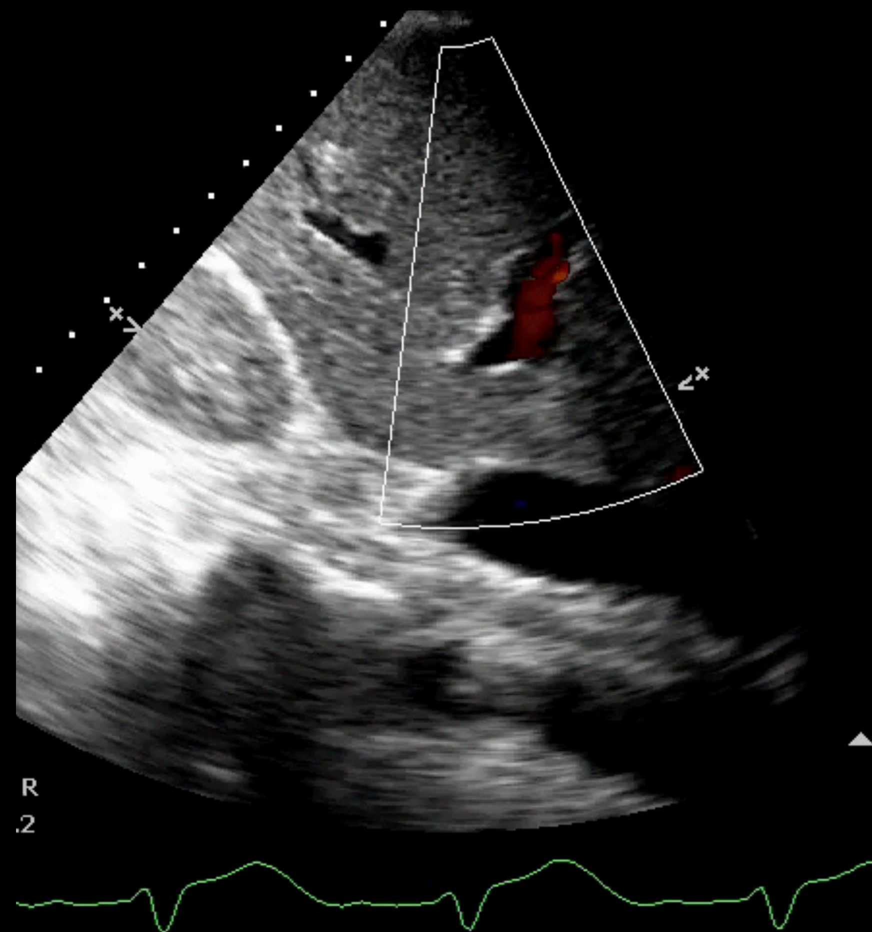
ANESTHÉSIOLOGIE • ICM

Abnormal Portal Vein Flow



How to find the Portal Vein - TTE





Monitoring Portal Vein Flow Patterns for detection of venous stasis and abnormal visceral perfusion

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

Journal of Cardiothoracic and Vascular Anesthesia 32 (2018) 1780–1787

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Original Article

The Association Between Pulsatile Portal Flow and Acute Kidney Injury after Cardiac Surgery: A Retrospective Cohort Study

William Beaubien-Souligny, MD[*,1], Roberto Eljaiek, MD, MSc[*], Annik Fortier, MSc[†], Yoan Lamarche, MD, MSc[‡], Mark Liszkowski, MD[§], Josée Bouchard, MD[‖], André Y. Denault, MD, PhD[*]

[*]*Department of Anesthesiology and Intensive Care, Montreal Heart Institute, Montreal, Quebec, Canada*
[†]*Montreal Health Innovations Coordinating Center, Montreal Heart Institute, Montreal, Quebec, Canada*
[‡]*Department of Cardiac Surgery, Montreal Heart Institute, Montreal, Quebec, Canada*
[§]*Department of Cardiology, Montréal Heart Institute, Montreal, Quebec, Canada*
[‖]*Department of Nephrology, Hôpital Sacré-Coeur de Montréal, Montreal, Quebec, Canada*

Prevalence of Abnormal Pattern

Table 2
Assessment of Portal Vein Flow after Cardiac Surgery

	POD 0	POD 1	POD 2	POD 3	POD 4	POD 5	POD 6	POD 7
Patients examined	72 (71%)	63 (62%)	31 (30%)	17 (17%)	13 (13%)	11 (11%)	6 (5.9%)	3 (2.9%)
Median PF (IQR) (%)	30% (0-35)	15% (0-30)	30% (30-50)	30% (20-50)	30% (25-50)	30% (0-100)	30% (15-30)	30% (30-50)
PF $<30\%$	35 (49%)	37 (59%)	7 (23%)	5 (29%)	4 (31%)	4 (36%)	2 (33%)	0 (0%)
PF 30%-49%	20 (28%)	20 (32%)	10 (32%)	7 (41%)	5 (39%)	3 (27%)	4 (67%)	2 (67%)
PF 50%-99%	13 (18%)	4 (6.3%)	10 (32%)	2 (12%)	2 (15%)	1 (9.1%)	0 (0%)	1 (33%)
PF $\geq 100\%$	4 (5.6%)	2 (3.2%)	4 (13%)	3 (18%)	2 (15%)	3 (27%)	0 (0%)	0 (0%)

Abbreviations: CPB, cardiopulmonary bypass; IQR, interquartile range; PF, pulsatility fraction; POD, postoperative day.

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

Prevalence of Abnormal Pattern

Table 2
Assessment of Portal Vein Flow after Cardiac Surgery

	POD 0	POD 1	POD 2	POD 3	POD 4	POD 5	POD 6	POD 7
Patients examined	72 (71%)	63 (62%)	[redacted]	[redacted]	[redacted]	11 (11%)	6 (5.9%)	3 (2.9%)
Median PF (IQR) (%)	30% (0-35)	15% (0-30)	[redacted]	[redacted]	[redacted]	30% (0-100)	30% (15-30)	30% (30-50)
PF < 30%	35 (49%)	37 (59%)	[redacted]	[redacted]	[redacted]	4 (36%)	2 (33%)	0 (0%)
PF 30%-49%	20 (28%)	20 (32%)	[redacted]	[redacted]	[redacted]	3 (27%)	4 (67%)	2 (67%)
PF 50%-99%	13 (18%)	4 (6.3%)	[redacted]	[redacted]	[redacted]	1 (9.1%)	0 (0%)	1 (33%)
PF ≥ 100%	4 (5.6%)	2 (3.2%)	[redacted]	[redacted]	[redacted]	3 (27%)	0 (0%)	0 (0%)

24%

Abbreviations: CPB, cardiopulmonary bypass; IQR, interquar [redacted] rative day.

Prevalence of Abnormal Pattern

1784 W. Beaubien-Souligny et al. / Journal of Cardiothoracic and Vascular Anesthesia 32 (2018) 1780–1787

Table 2
Assessment of Portal Vein Flow after Cardiac Surgery

	POD 0	POD 1	POD 2	POD 3	POD 4	POD 5	POD 6	POD 7
Patients examined	72 (71%)	63 (62%)	31 (30%)	17 [redacted]	[redacted]	[redacted]	6 (5.9%)	3 (2.9%)
Median PF (IQR) (%)	30% (0-35)	15% (0-30)	30% (30-50)	30% [redacted]	[redacted]	[redacted]	[redacted]% (15-30)	30% (30-50)
PF <30%	35 (49%)	37 (59%)	7 (23%)	5 [redacted]	[redacted]	[redacted]	[redacted]2 (33%)	0 (0%)
PF 30%-49%	20 (28%)	20 (32%)	10 (32%)	7 [redacted]	[redacted]	[redacted]	[redacted]4 (67%)	2 (67%)
PF 50%-99%	13 (18%)	4 (6.3%)	10 (32%)	2 [redacted]	[redacted]	[redacted]	[redacted]0 (0%)	1 (33%)
PF ≥100%	4 (5.6%)	2 (3.2%)	4 (13%)	3 [redacted]	[redacted]	[redacted]	[redacted]0 (0%)	0 (0%)

Abbreviations: CPB, cardiopulmonary bypass; IQR, interquartile range; PF, pulsatili [redacted]

45%

Predictors of Postoperative AKI

Table 3
Predictors of Postoperative AKI

	AKI stage ≥ 1		AKI stage ≥ 2	
	OR	p Value	OR	p Value
Baseline characteristics				
Age (y)	1.02 (0.99-1.06)	0.26	1.01 (0.96-1.07)	0.63
Female sex	0.63 (0.27-1.47)	0.29	1.26 (0.38-4.10)	0.71
Diabetes	2.05 (0.80-5.22)	0.13	1.48 (0.45-4.87)	0.52
Hypertension	2.62 (0.90-7.59)	0.08	∞ (all patients)	NS
Baseline creatinine (μmol/L)	1.04 (1.01-1.06)	0.003	0.97 (0.94-1.00)	0.08
eGFR (mL/min/1.73 m^2)	[redacted]			
Body mass index (kg/m^2)	[redacted]			
Left ventricular ejection fraction (%)	[redacted]			
Systolic PAP before surgery (mmHg)	[redacted]			
Use of iodinated contrast < 7 days	[redacted]			
EUROSCORE II[24] (for 1% increase)	[redacted]			
AKI prediction score by Thakar et al[25] (for 1-point i[redacted]	[redacted]			
During surgery				
Duration of CPB (h)	[redacted]			
Fluid balance (L)	[redacted]			
Blood transfusion	[redacted]			
Synthetic colloid (L)	[redacted]			
Albumin 5% (L)	[redacted]			
Use of epinephrine (yes/no)	[redacted]			
Use of vasopressin (yes/no)	[redacted]			
Use of inotropic support (yes/no)	1.082 (0.24-4.80)	0.918	0.890 (0.101-7.839)	0.916
Systolic PAP (mmHg) at the end of surgery	1.11 (1.04-1.20)	0.004	0.96 (0.88-1.04)	0.31
Diastolic PAP (mmHg) at the end of surgery	1.10 (1.00-1.20)	0.04	0.93 (0.83-1.05)	0.24
After surgery				
PF ≥ 30%	1.59 (0.6[illegible]-3.78)*	0.30	2.72 (0.56-13.20)†	0.22
PF ≥ 50%	4.31 (1.50-12.35)*	0.007	1.53 (0.45-5.25)†	0.23
Mean CV-SOFA score during POD 0 and 1[26]	1.76 (1.1[illegible]-2.69)	0.009	1.59 (0.79-3.21)	0.19
Maximal systolic PAP during POD 0	1.11 ([illegible].03-1.19)	0.003	1.06 (0.99-1.12)	0.08
Maximal diastolic PAP during POD 0	1.09 (1.00-1.19)	0.040	1.06 (0.96-1.17)	0.239
Maximal CVP during POD 0	1.081 (0.979-1.194)	0.122	1.12 (0.99-1.27)	0.079
Mean cardiac index during POD 0 (L/min/m^2)	0.39 (0.16-0.94)	0.04	0.53 (0.14-2.00)	0.35
Blood transfusion < 24 hours after surgery	2.63 (0.80-8.65)	0.11	4.75 (1.40-16.11)	0.01

OR 4.31

Abbreviations: AKI, acute kidney injury; CBP, cardiopulmonary bypass; CV-SOFA, cardiovascular component of the Sequential Organ Function Assessment; eGFR, estimated glomerular filtration rate; PAP, pulmonary artery pressure; PF, pulsatility fraction; POD, postoperative day.

*Patients without portal flow assessment before the day of AKI diagnosis were excluded from the analysis (18/102 patients).

†Patients without portal flow assessment before the day of stage 2 AKI diagnosis were excluded from the analysis (2/102 patients).

Canadian Journal of Cardiology 35 (2019) 1134–1141

Clinical Research

Portal Hypertension Is Associated With Congestive Encephalopathy and Delirium After Cardiac Surgery

Aymen Benkreira, MD,[a] William Beaubien-Souligny, MD,[a] Tanya Mailhot, RN, PhD,[b,c] Nadia Bouabdallaoui, MD,[d] Pierre Robillard, MD,[e] Georges Desjardins, MD,[a] Yoan Lamarche, MD, MSc,[f] Sylvie Cossette, PhD,[b,c] and André Denault, MD, PhD[a]

[a] *Department of Anesthesiology and Intensive Care, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada*

[b] *Nursing Research Laboratory, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada*

[c] *Faculty of Nursing, Université de Montréal, Montreal, Quebec, Canada*

[d] *Department of Cardiology, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada*

[e] *Department of Radiology, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada*

[f] *Department of Cardiac Surgery and Intensive Care, Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada*

See editorial by Randhawa et al., pages 1088–1090 of this issue.

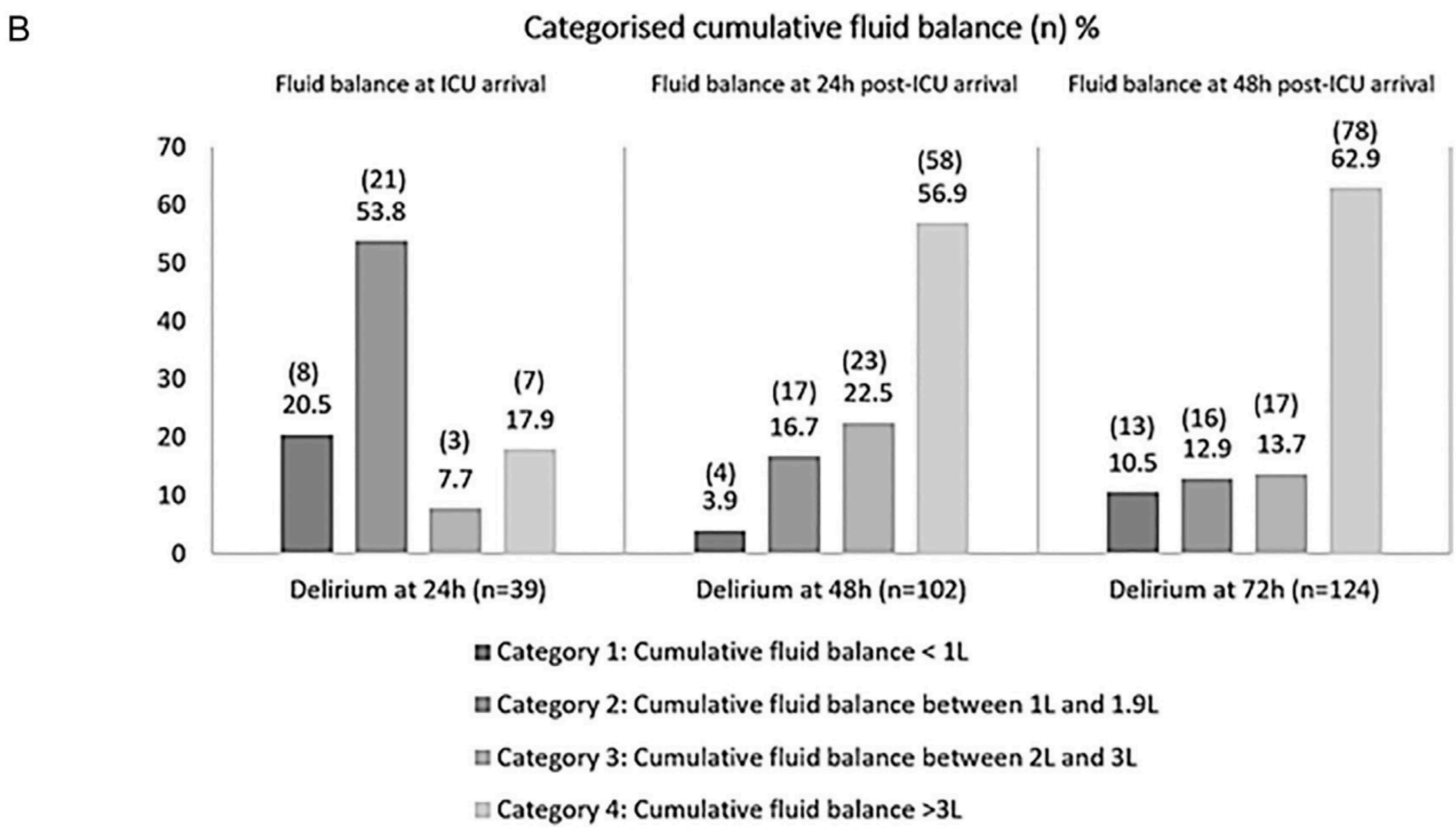


Fig. 2. Descriptive data on cumulative fluid balance. (A) Cumulative fluid balance 24 hours preceding each delirium time are presented as mean ± standard deviation. The *black line* represents cases who presented delirium, while the *gray line* reprensents controls who did not present delirium. (B) The categorized cumulative fluid balances are presented as frequency and percentage among patients with delirium for each category.

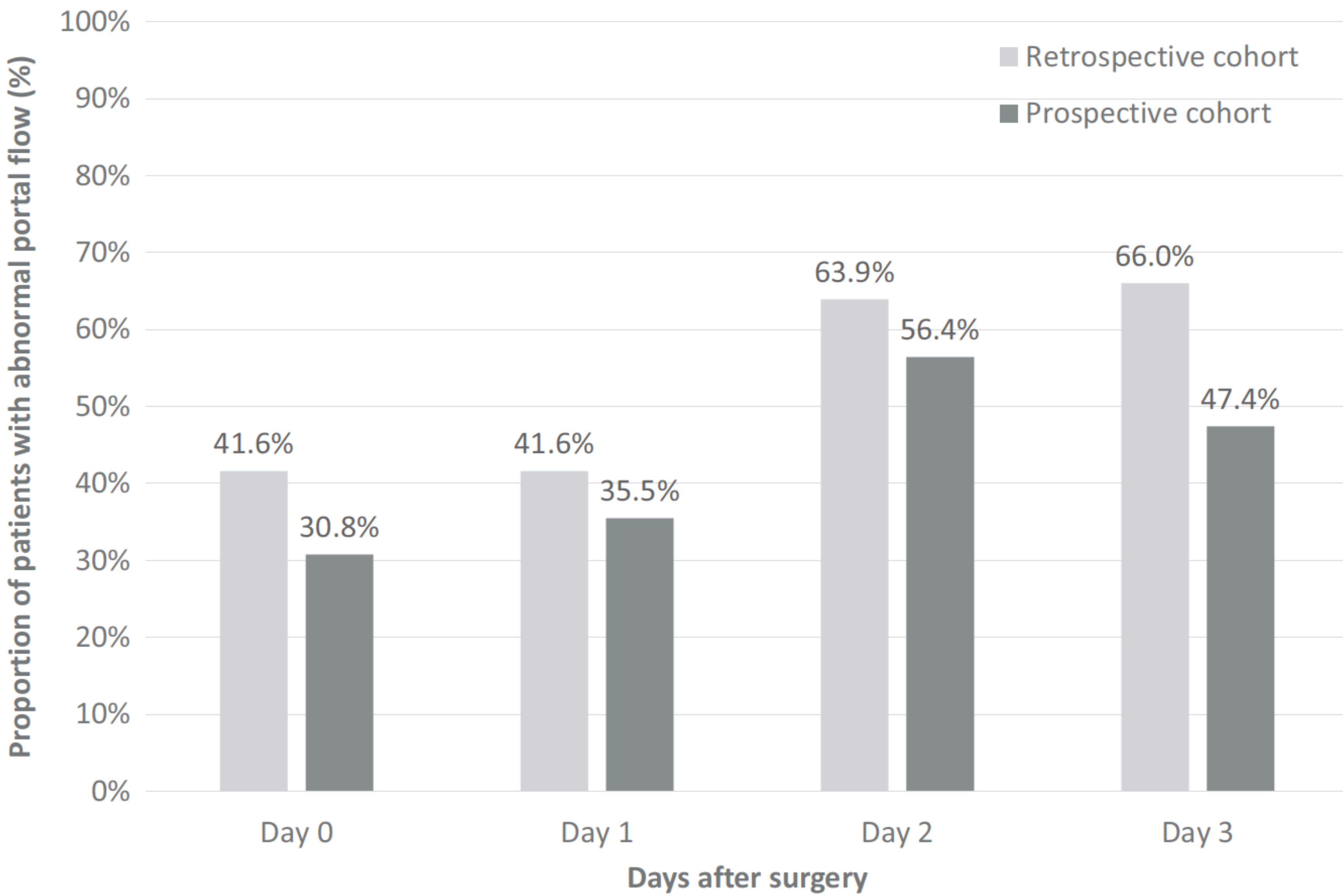


Figure 2. Relative prevalence of abnormal portal flow after cardiac surgery in the retrospective and prospective cohorts.

Association between portal flow pulsatility and neuro findings

Table 2. Association between portal flow pulsatility and neurologic parameters at the time of assessment

Neurologic parameters at the time of assessment	Retrospective cohort (236 patients, 366 assessments)			Prospective cohort (145 patients, 379 assessments)		
	OR	CI	*P* value	OR	CI	*P* value
Abnormal cognitive evaluation	2.69	1.47-4.90	0.001	2.10	1.25-3.53	0.005
Asterixis	5.19	2.27-11.88	< 0.001	2.23	1.13-4.41	0.02
Cerebral desaturation ($\geq$ 15% decrease from baseline values)				2.23	1.12-4.71	0.02

CI, confidence interval; OR, odds ratio.

Generalized estimating equation analysis was performed using a logistic link function. For each model, the studied neurologic variable and the time of assessment were included as factors. Interaction with time was tested for each model.

Prediction of Postop Delirium

Table 4. Multivariable proportional hazard regression models for the risk of delirium after cardiac surgery

	HR (CI)	*P* value
Portal flow pulsatility*	2.57 (1.01-6.57)	0.049
Previous stroke or transient ischemic attack	2.18 (0.44-6.47)	0.16
Chronic kidney disease (eGFR < 60)	1.40 (0.62-3.16)	0.43

CI, confidence interval; eGFR, estimated glomerular filtration rate; HR, hazard ratio.

* Programmed as a time-segmented variable.

Journal of Cardiothoracic and Vascular Anesthesia 33 (2019) 93–101

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Original Article

Delirium After Cardiac Surgery and Cumulative Fluid Balance: A Case-Control Cohort Study

Tanya Mailhot, RN, PhD[¶,1], Sylvie Cossette, RN, PhD[*], Jean Lambert, PhD[†], William Beaubien-Souligny, MD[‡], Alexis Cournoyer, MD[‡], Eileen O'Meara, MD, FRCPC[‡], Marc-André Maheu-Cadotte, RN, BSc[‡], Guillaume Fontaine, RN, MSc[*], Josée Bouchard, MD[‡], Yoan Lamarche, MD, MSc[‡], Aymen Benkreira, MD[§], Antoine Rochon, MD[||], André Denault, MD, PhD[||]

[*]*Faculty of Nursing, Université de Montréal, Montreal Heart Institute Research Center, Montreal, Canada*

[†]*School of Public Health, Department of Preventive Medicine, Montreal Heart Institute Research Center, Montreal, Canada*

[‡]*Faculty of Medicine, Université de Montréal, Montreal Heart Institute, Montreal, Canada*

[§]*Faculty of Medicine, Université de Sherbrooke, Montreal Heart Institute Research Center, Montreal, Canada*

[||]*Faculty of Medicine, Department of Anesthesiology, Université de Montréal, Montreal Heart Institute, Montreal, Canada*

[¶]*Faculty of Nursing, Faculty of Medicine, Université de Montréal, Montreal Heart Institute Research Center, 5000 Bélanger St, S-2490, Montreal, Quebec, H1T 1C8, Canada*

BJA

British Journal of Anaesthesia, 122 (2): 206–214 (2019)

doi: 10.1016/j.bja.2018.09.028
Advance Access Publication Date: 28 November 2018
Cardiovascular

High postoperative portal venous flow pulsatility indicates right ventricular dysfunction and predicts complications in cardiac surgery patients

R. Eljaiek[1], Y. A. Cavayas[2,3], E. Rodrigue[4], G. Desjardins[2], Y. Lamarche[2,3], F. Toupin[5], A. Y. Denault[2,6,*] and W. Beaubien-Souligny[2,6]

[1]Hôpital Pierre-Le Gardeur, Terrebonne, Quebec, Canada, [2]Montreal Heart Institute, Université de Montréal, Montreal, Quebec, Canada, [3]Hôpital Sacré-Cœur de Montréal, Montreal, Quebec, Canada, [4]Centre Hospitalier Sainte-Marie, Trois-Rivières, Quebec, Canada, [5]Hôpital Maisonneuve-Rosemont, Montreal, Quebec, Canada and [6]Centre Hospitalier de l'Université de Montréal, Montreal, Quebec, Canada

*Corresponding author. E-mail: andre.denault@gmail.com

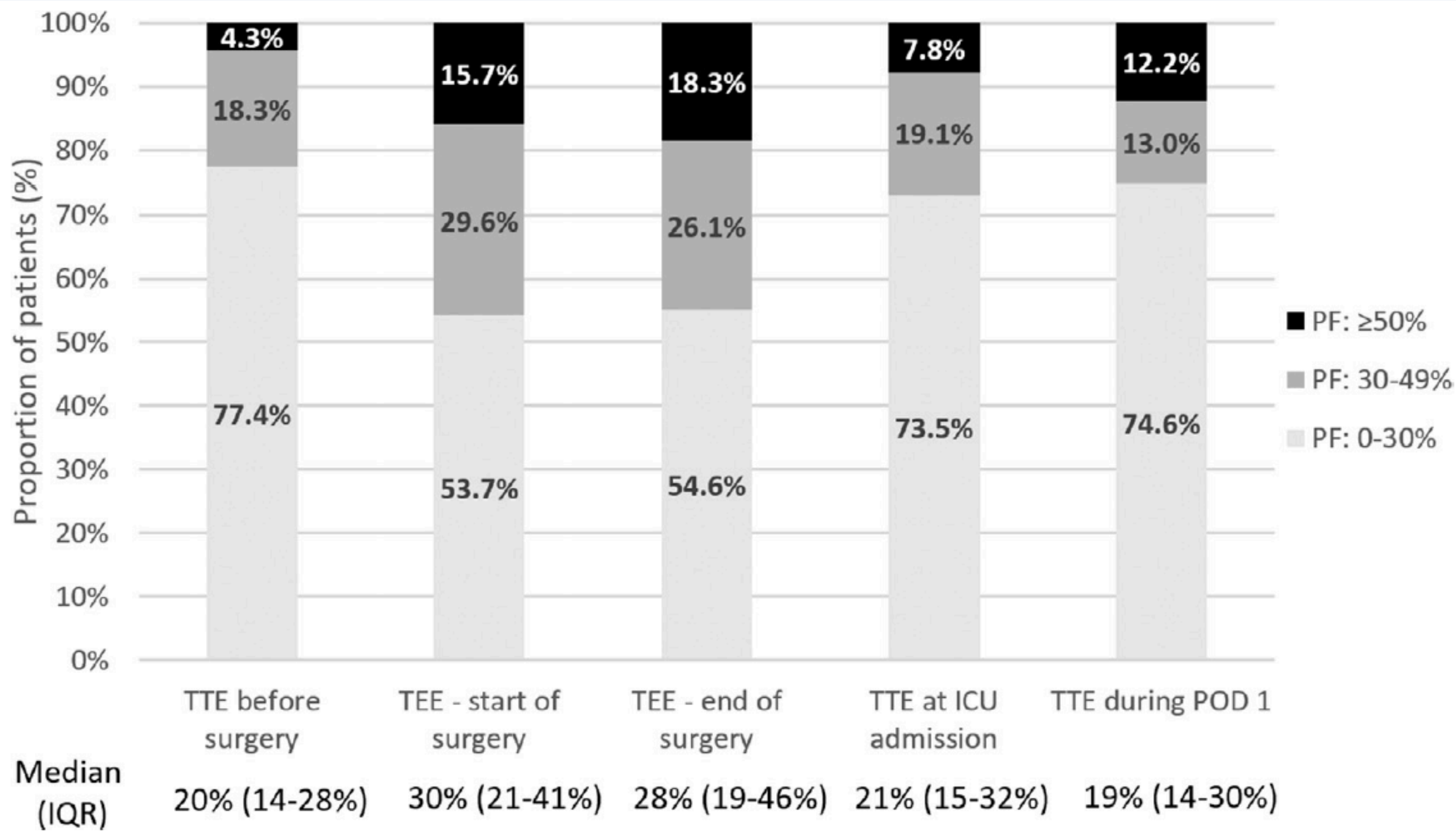


Fig 1. Portal flow pulsatility fraction (PF) in patients undergoing cardiac surgery (*n*=115). Portal flow assessment were performed using transoesophageal echography (TOE) during surgery before and after cardiopulmonary bypass and by transthoracic echography (TTE) before surgery, at ICU admission and during postoperative day (POD) 1 after surgery. IQR, inter-quartile range.

Portal Flow as a predictor of complications

Table 5 Duration of postoperative support and care after surgery in relationship to portal pulsatility fraction assessment in the operating room after cardiopulmonary bypass separation. PF, pulsatility fraction; IQR, inter-quartile range

	PF < 50% (*n*=89)	PF ≥ 50% (*n*=21)	P-value
Duration of mechanical ventilation (h)	4.7 (IQR, 3.5–6.5)	7.1 (IQR, 4.9–11.5)	0.007
Duration of intensive care stay (h)	31.1 (IQR, 22.5–69.3)	74.6 (IQR, 47.3–119.6)	0.007
Duration of hospital stay (days)	5 (IQR, 4–6)	8 (IQR, 6–9)	<0.001

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

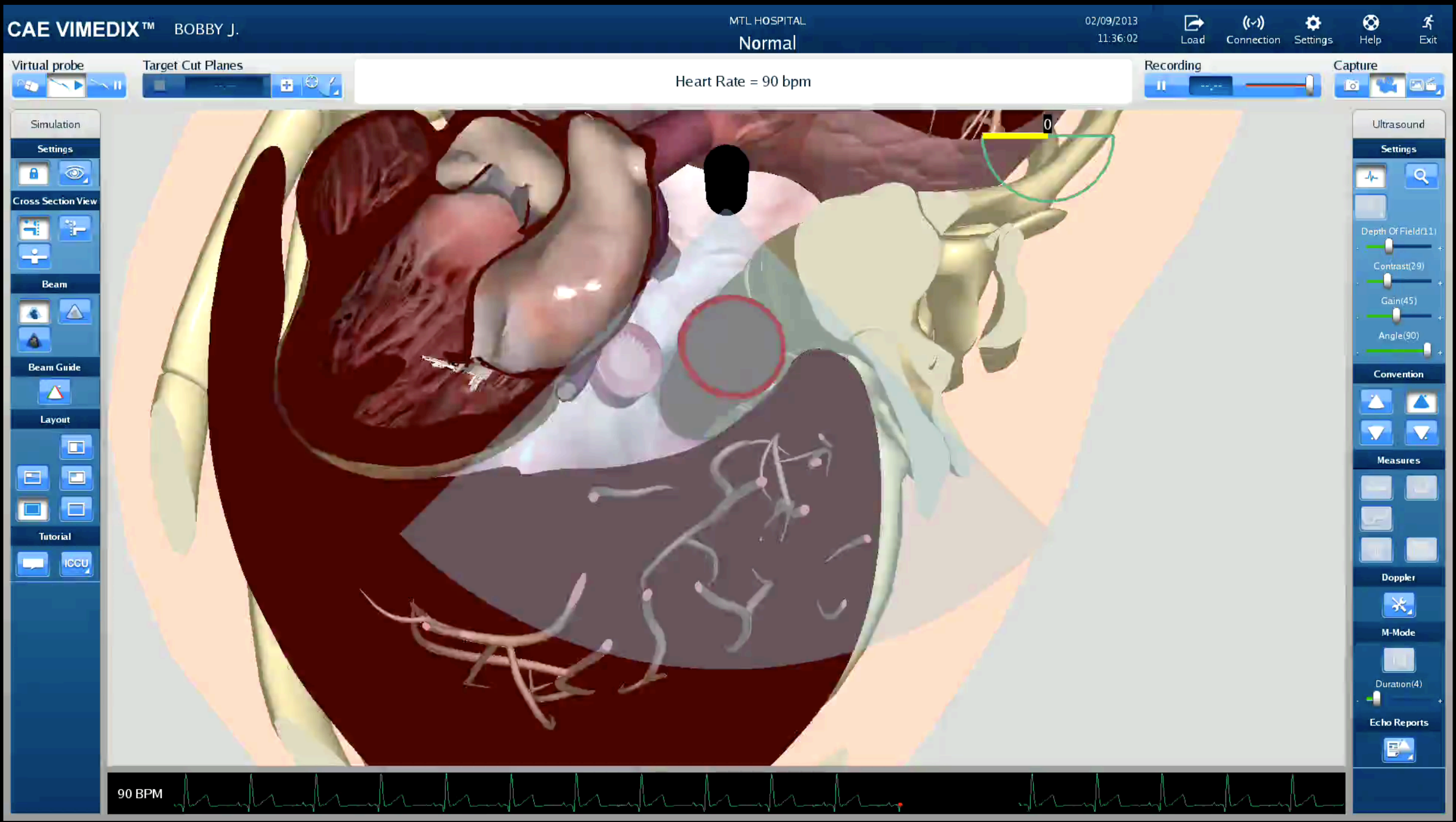
ANESTHÉSIOLOGIE • ICM

Portal Flow as a predictor of major complications

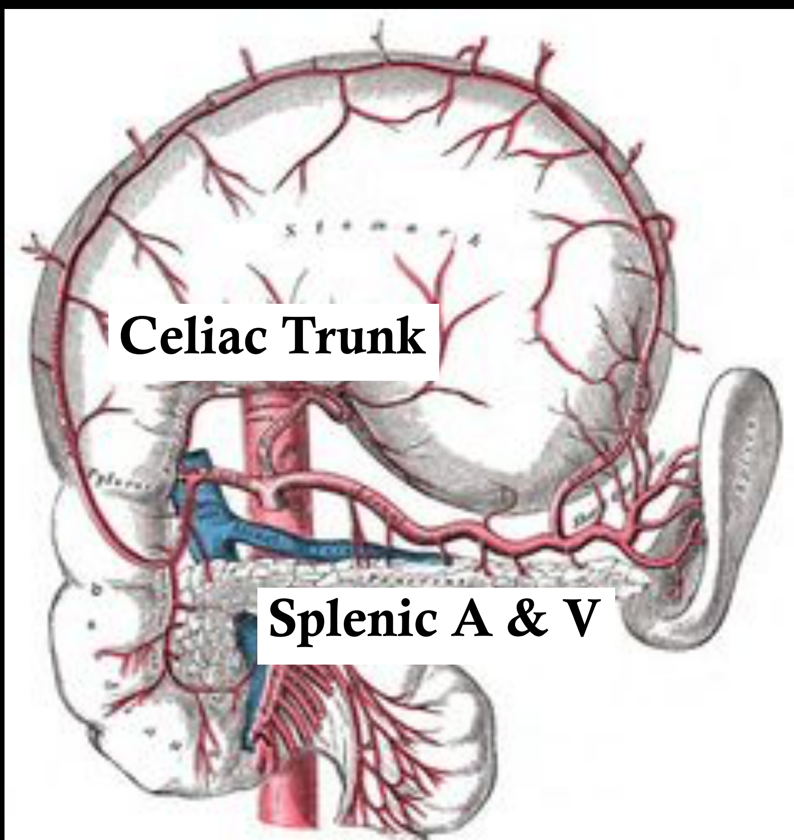
Table 4 Univariable and multivariable logistic regression models for the risk of major complications after cardiac surgery. CI, confidence interval; CPB, cardiopulmonary bypass; OR, odds ratio; RV, right ventricular

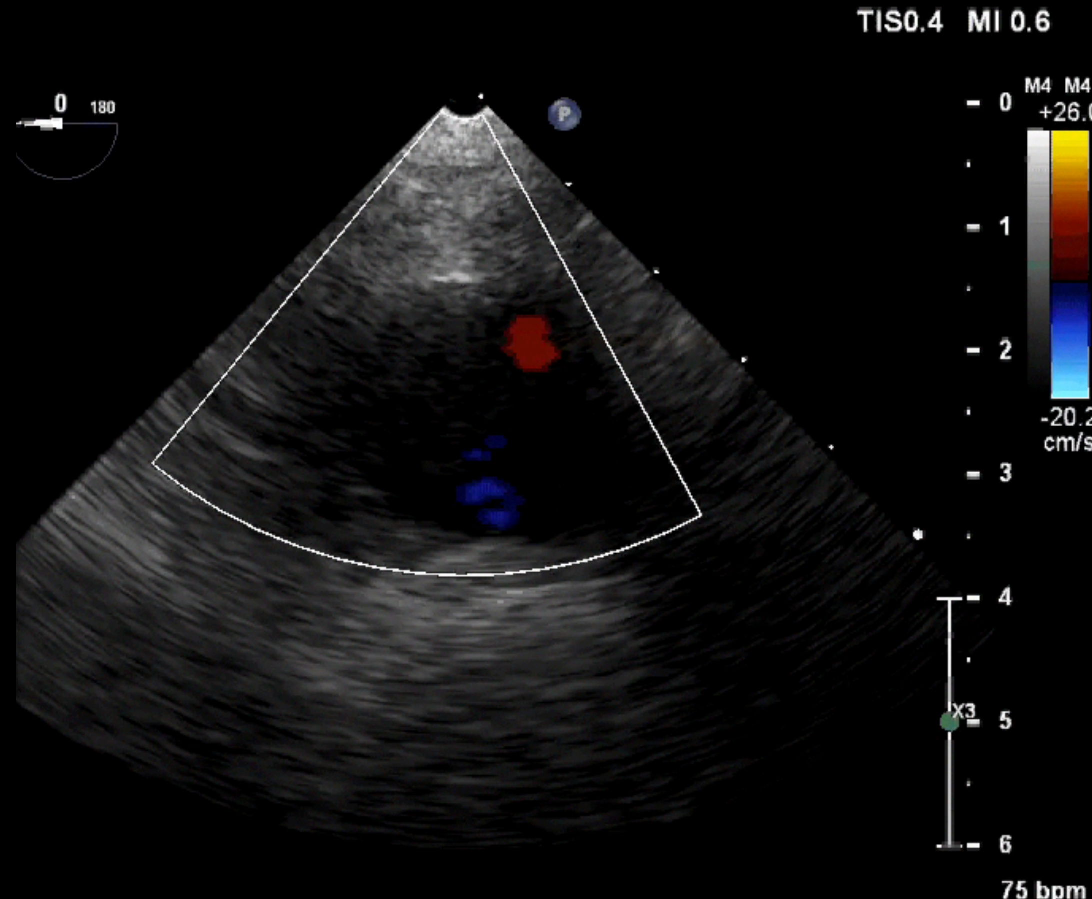
Variables	Univariable			Multivariable		
	OR	95% CI	P-value	OR	95% CI	P-value
Portal flow pulsatility after CPB	5.83	2.04–16.68	0.001	5.13	1.58–16.67	0.007
Systolic RV dysfunction	2.77	1.08–7.09	0.034	1.22	0.37–4.02	0.75
EuroSCORE II	1.41	1.17–1.70	<0.001	1.37	1.10–1.69	0.04

How to find the Splenic Vein - TEE

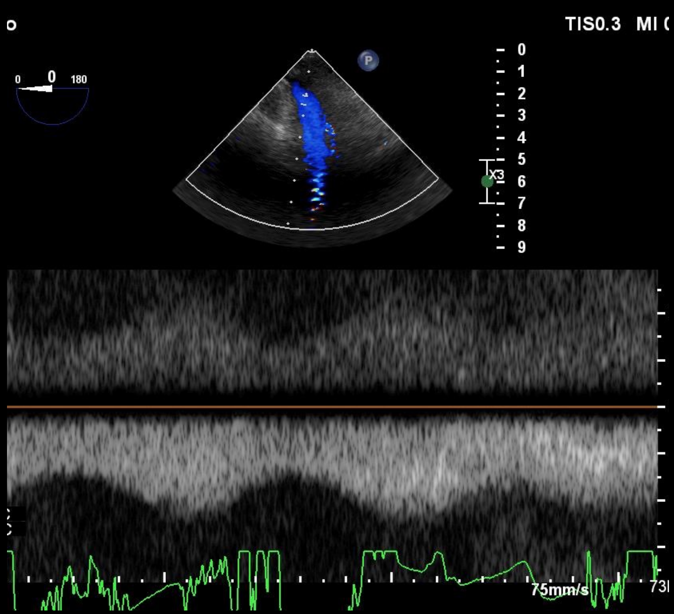


How to find the Splenic Vein - TEE

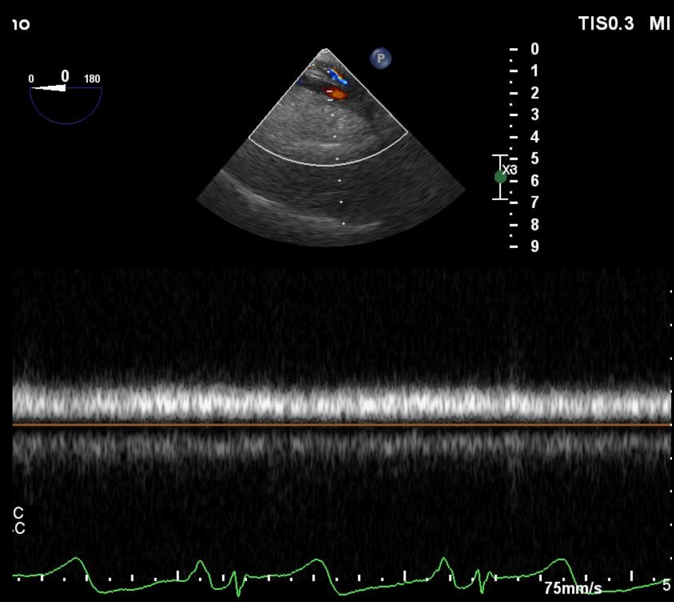




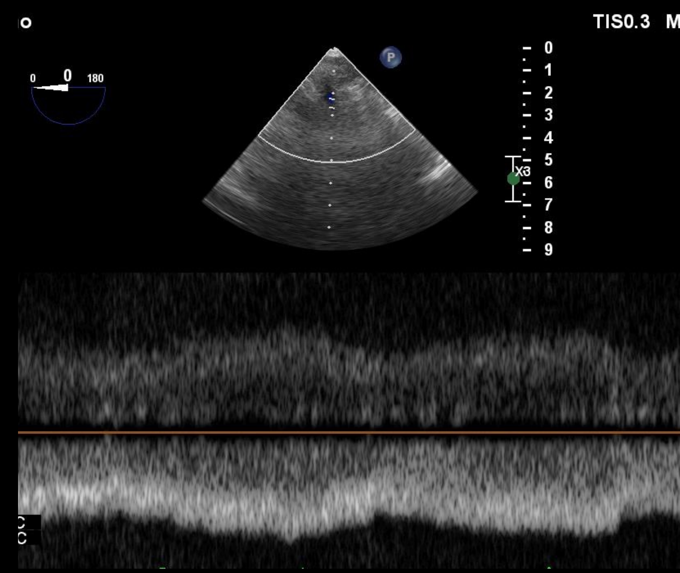
A Case of OPCAB



Pre Procedure

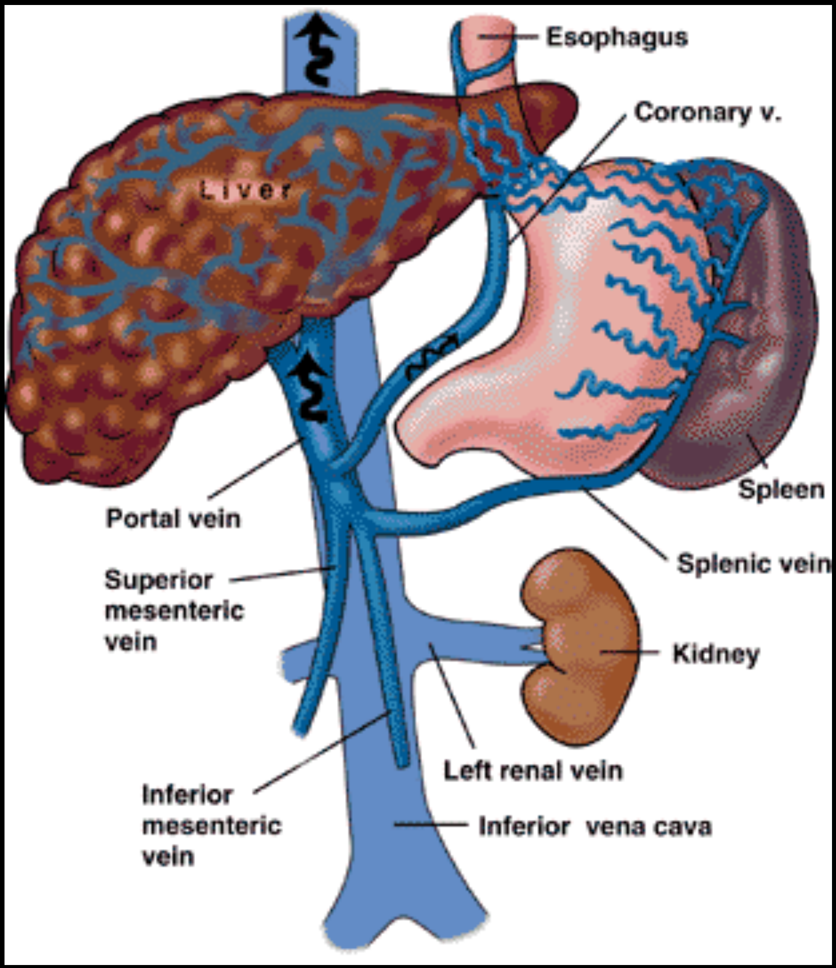


Post Procedure

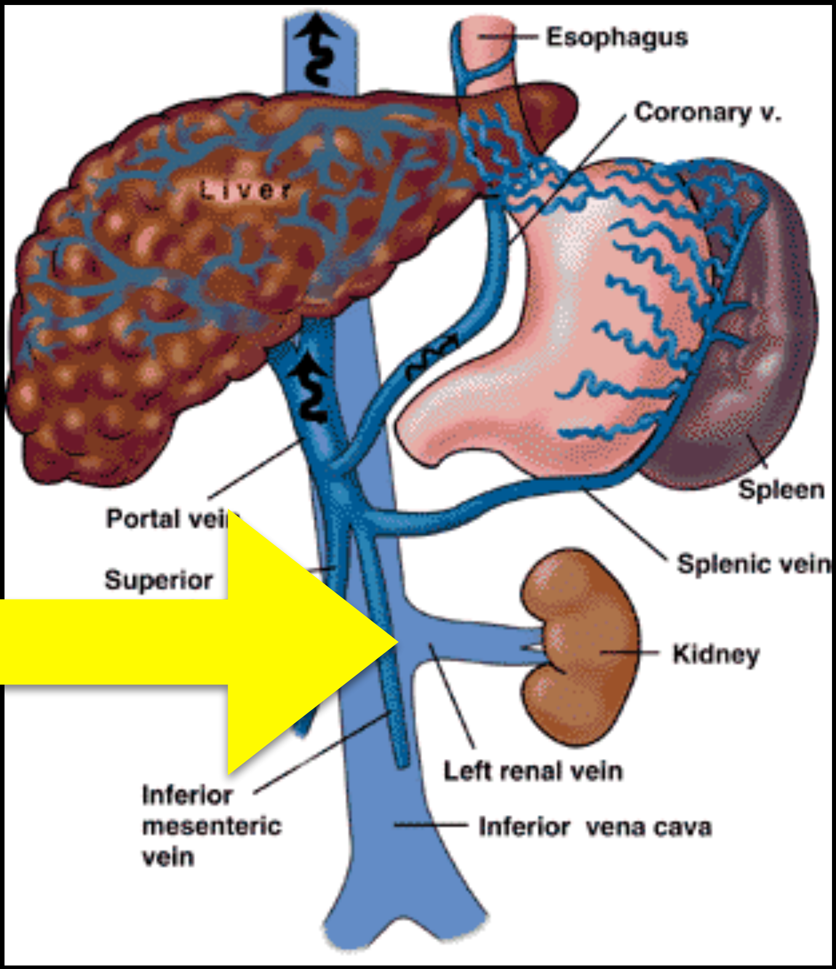


After Cellsaver

Renal Veins Flow Patterns



Renal Veins Flow Patterns



INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

Renal Veins Flow Patterns

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

Renal Veins Flow Patterns

Journal of Cardiothoracic and Vascular Anesthesia 33 (2019) 2781–2796

ELSEVIER

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia

journal homepage: www.jcvaonline.com

Review Article

The Role of Point-of-Care Ultrasound Monitoring in Cardiac Surgical Patients With Acute Kidney Injury

Check for updates

William Beaubien-Souligny, MD[*,†,1,2],
André Denault, MD, PhD[†,‡,3], Pierre Robillard, MD[§],
Georges Desjardins, MD[†]

[*]*Division of Nephrology, Centre Hospitalier de l'Université de Montréal, Montréal, Canada*
[†]*Department of Anesthesiology, Montreal Heart Institute, Montréal, Canada*
[‡]*Division of Intensive Care, Centre Hospitalier de l'Université de Montréal, Montréal, Canada*
[§]*Department of Radiology, Montreal Heart Institute, Montréal, Canada*

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

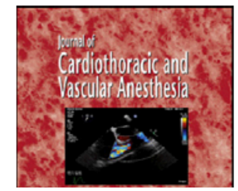
ANESTHÉSIOLOGIE • ICM

Renal Veins Flow Patterns

Journal of Cardiothoracic and Vascular Anesthesia 33 (2019) 2781–2796

Contents lists available at ScienceDirect

Journal of Cardiothoracic and Vascular Anesthesia



ECHO ROUNDS

Real-Time Assessment of Renal Venous Flow by Transesophageal Echography During Cardiac Surgery

William Beaubien-Souligny, MD, and André Y. Denault, MD, PhD

William Beaubien-Souligny, MD[*,†,1,2], André Denault, MD, PhD[†,‡,3], Pierre Robillard, MD[§], Georges Desjardins, MD[†]

[*]*Division of Nephrology, Centre Hospitalier de l'Université de Montréal, Montréal, Canada*
[†]*Department of Anesthesiology, Montreal Heart Institute, Montréal, Canada*
[‡]*Division of Intensive Care, Centre Hospitalier de l'Université de Montréal, Montréal, Canada*
[§]*Department of Radiology, Montreal Heart Institute, Montréal, Canada*

Renal Veins Flow Patterns

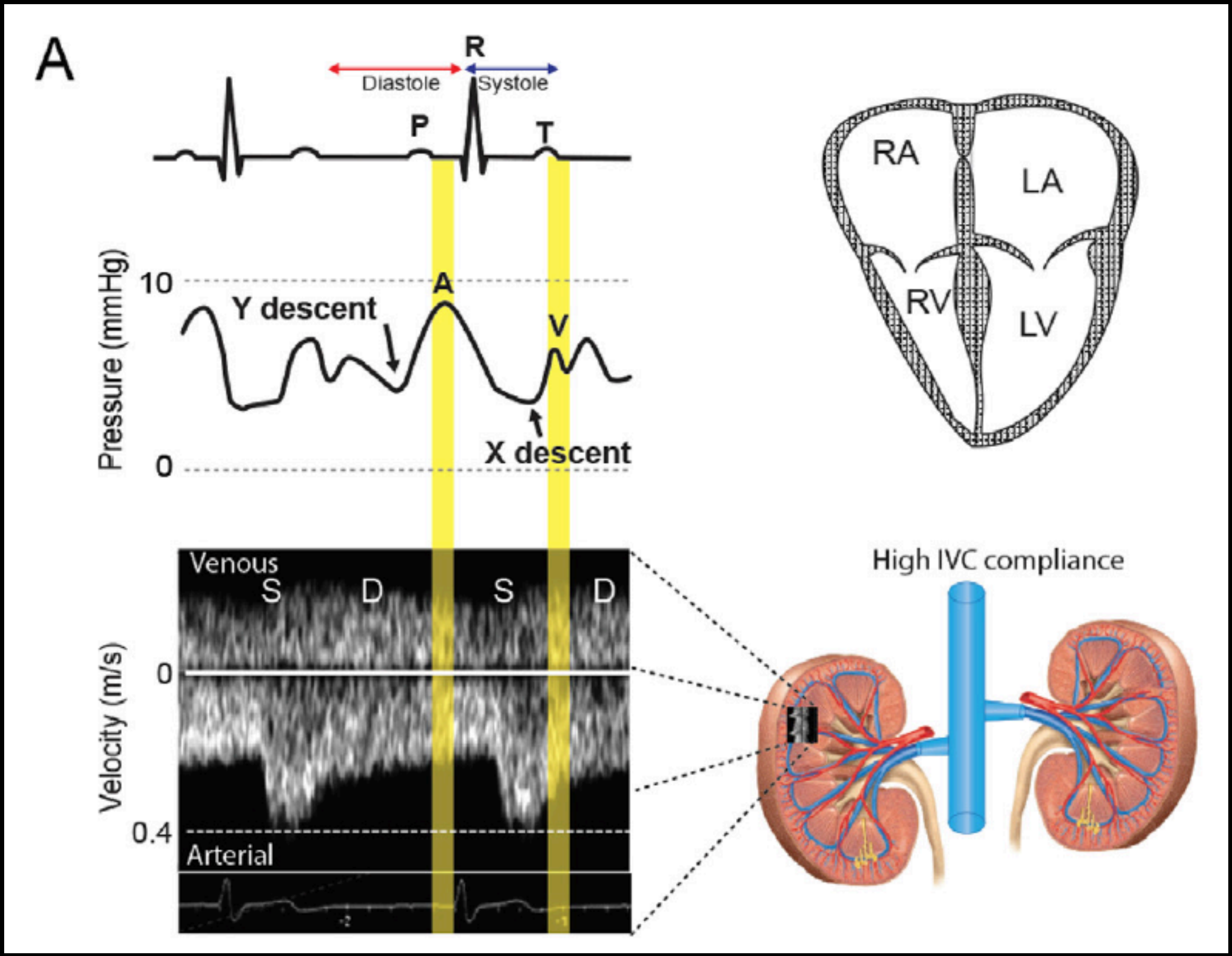
How to do it ?

Renal Veins Flow Patterns

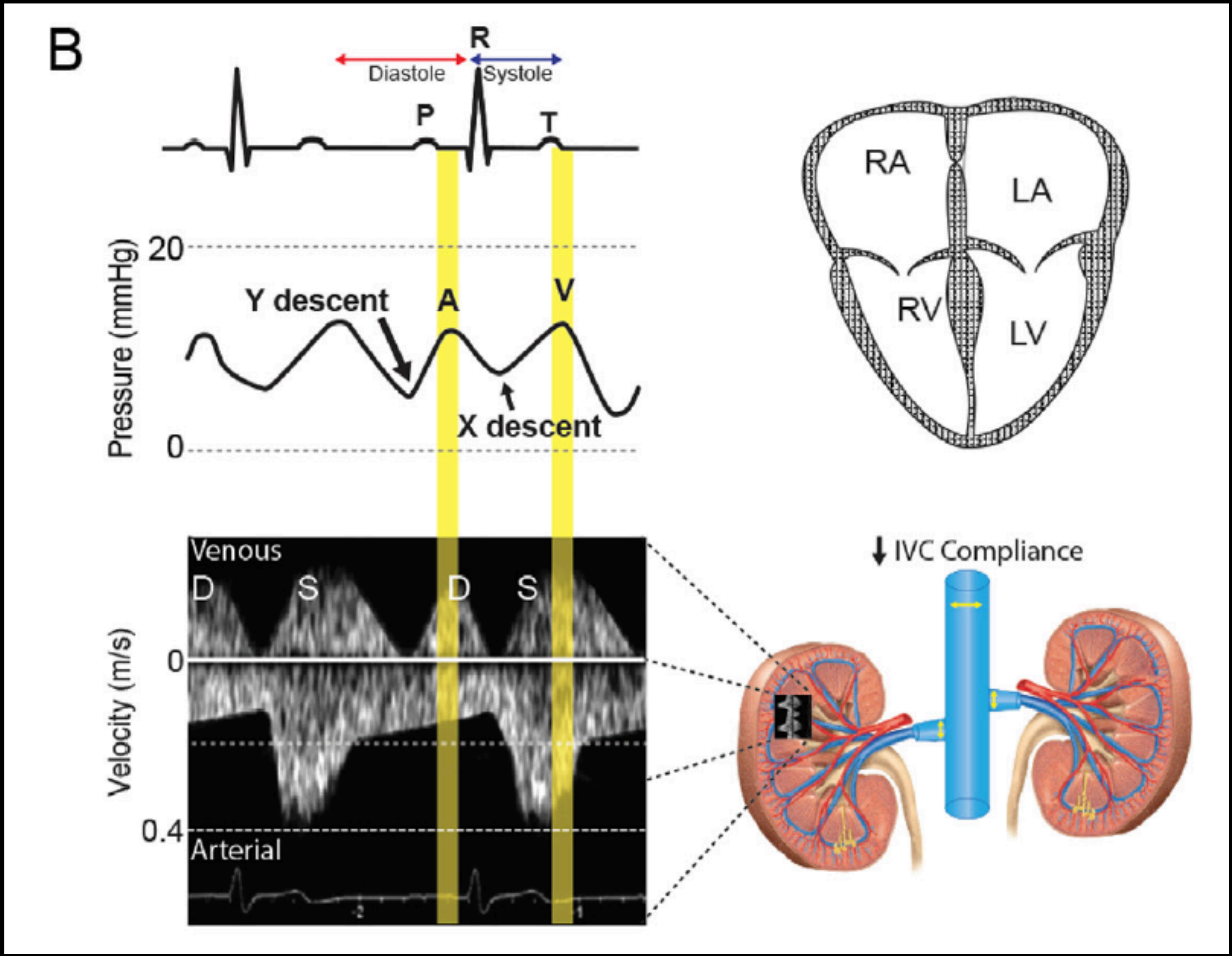
Off-pump CABG

Left kidney on TEE
(Transgastric view)

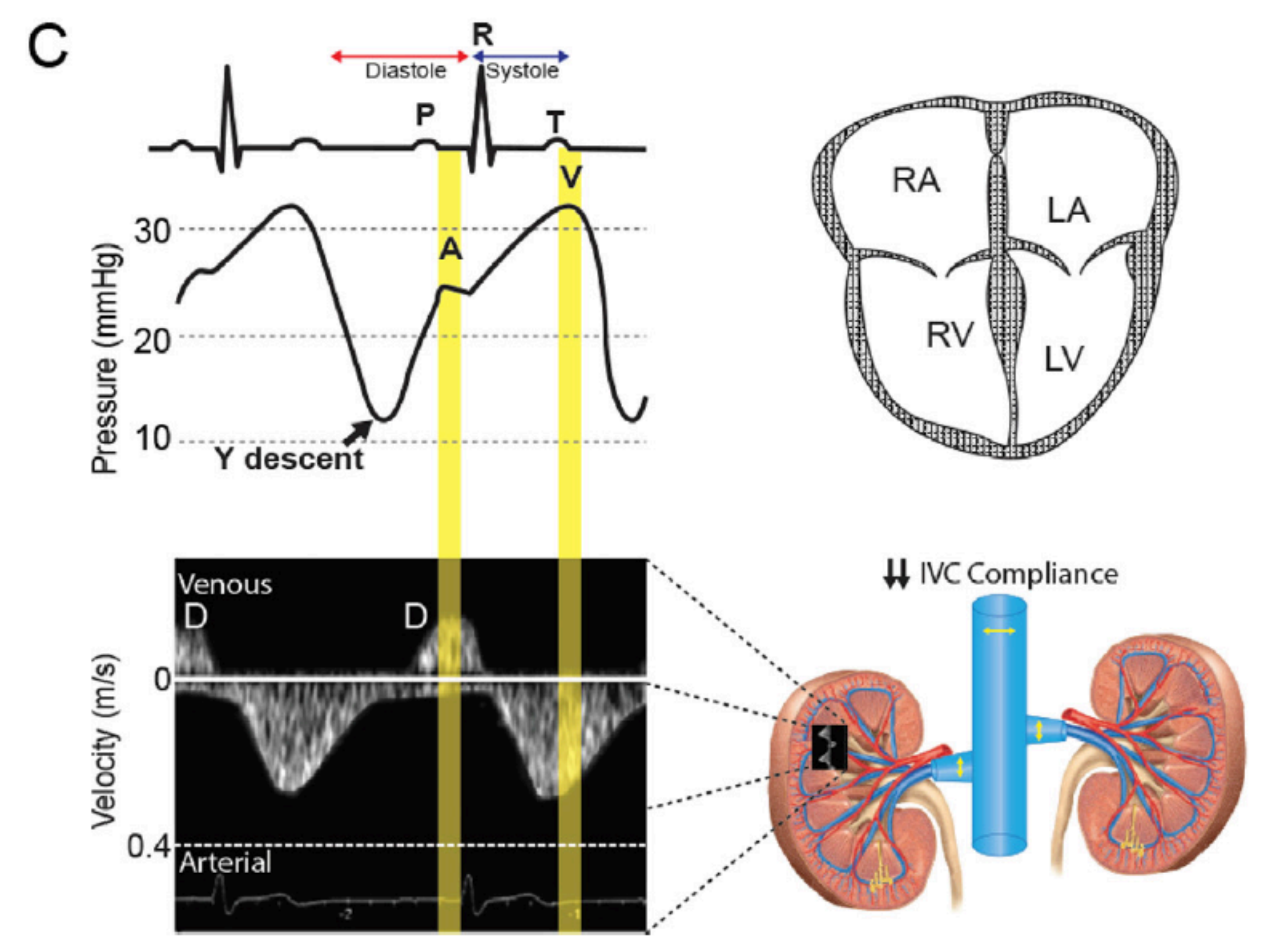
Renal Veins Flow Patterns



Renal Veins Flow Patterns



Renal Veins Flow Patterns



INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

JACC: HEART FAILURE
VOL. 4, NO. 8, 2016

ISSN 2213-1779/$36.00
PUBLISHED BY ELSEVIER
http://dx.doi.org/10.1016/j.jchf.2016.05.009

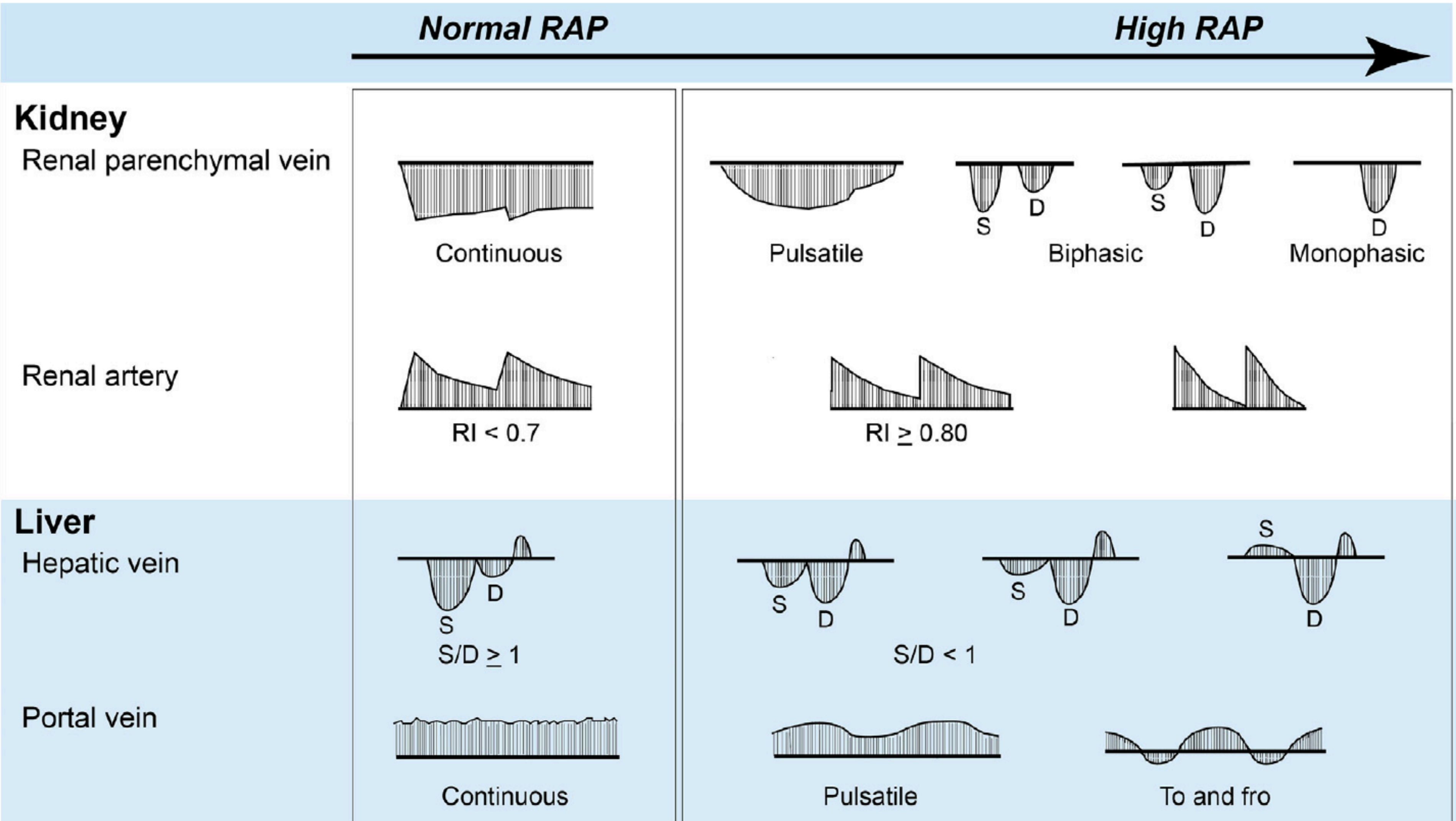
EDITORIAL COMMENT

Intrarenal Venous Flow

A Window Into the Congestive Kidney Failure Phenotype of Heart Failure?*

W.H. Wilson Tang, MD,[a,b] Takeshi Kitai, MD, PhD[b]

FIGURE 1 Ultrasound Patterns Across the Spectrum of RAP



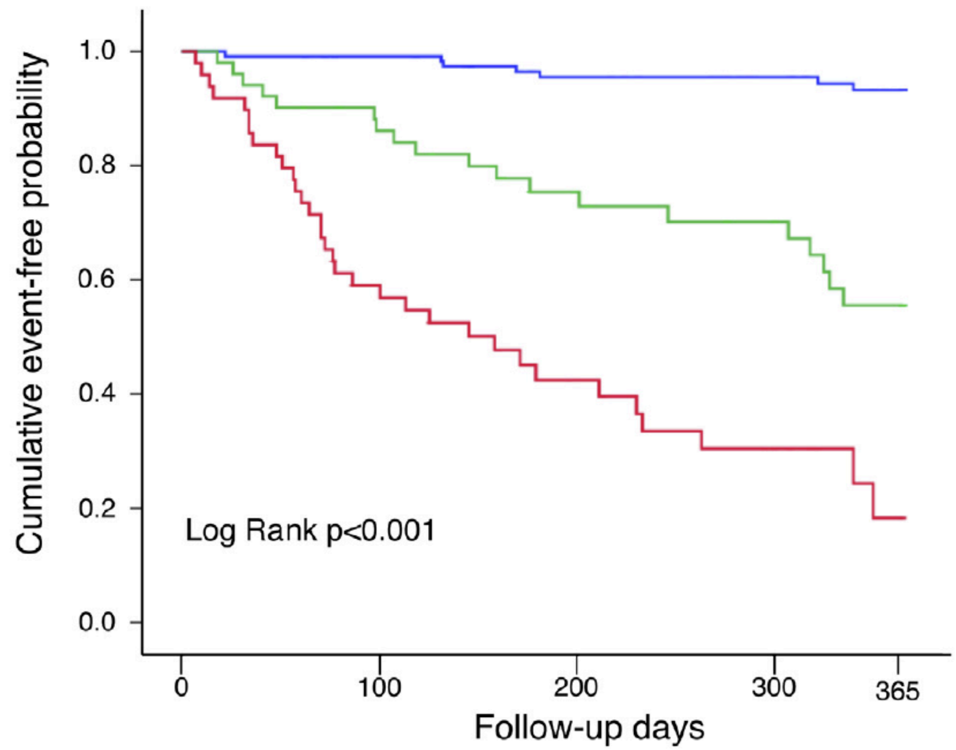
JACC: HEART FAILURE
VOL. 4, NO. 8, 2016

ISSN 2213-1779/$36.00
PUBLISHED BY ELSEVIER
http://dx.doi.org/10.1016/j.jchf.2016.03.016

Clinical Implications of Intrarenal Hemodynamic Evaluation by Doppler Ultrasonography in Heart Failure

Noriko Iida, BA,[a] Yoshihiro Seo, MD,[b] Seika Sai, MD,[b] Tomoko Machino-Ohtsuka, MD,[b] Masayoshi Yamamoto, MD,[b] Tomoko Ishizu, MD,[b,c] Yasushi Kawakami, MD,[c] Kazutaka Aonuma, MD[b]

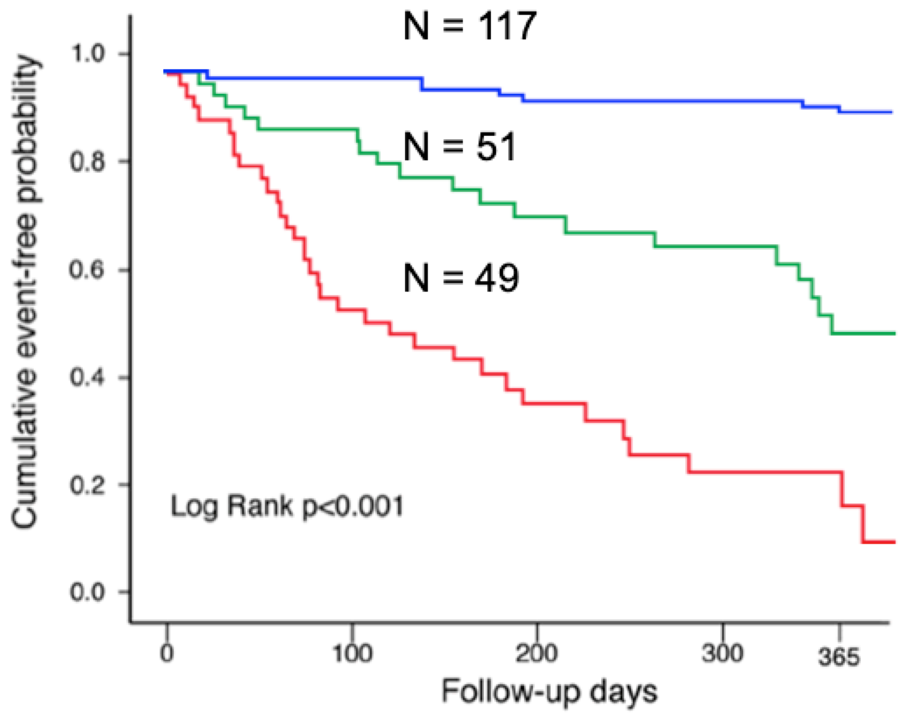
FIGURE 2 Kaplan-Meier Estimate Curves According to IRVF

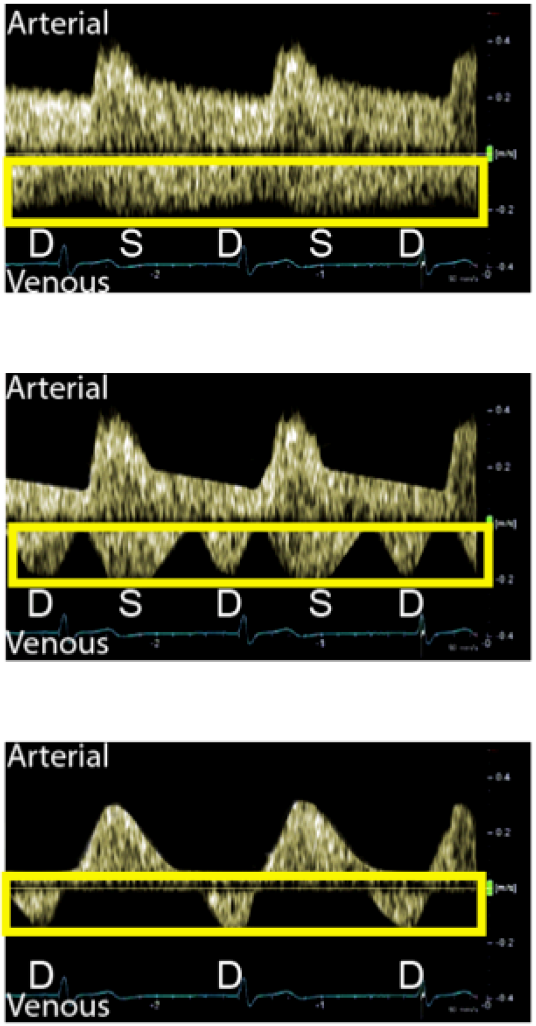


Number at risk

Continuous flow	117	115	109	104	93
Biphasic flow	51	42	28	23	16
Monophasic flow	49	28	18	11	5

Kaplan-Meier curves at 1-year follow-up for the probability of freedom from death from cardiac causes and unplanned hospitalizations for heart failure of 3 classifications of intrarenal venous flow. IRVF = intrarenal venous flow.





Renal venous Doppler superior to any cardiac 2D or Doppler echocardiographic measurement

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

TABLE 3 Predictors of Death From Cardiac Causes or Unplanned Hospitalization for Heart Failure by the Cox Proportional Hazard Model

	Univariate		Multivariate	
Predictor	HR (95% CI)	p Value	HR (95% CI)	p Value
NYHA functional class III or IV	4.13 (2.34–7.26)	<0.001		
Hemoglobin (per 1 g/dl increase)	0.79 (0.70–0.88)	<0.001		
BUN (per 10 mg/dl increase)	1.31 (1.14–1.50)	<0.001		
eGFR (per 10 ml/min/1.73 m^2 increase)	0.98 (0.97–0.95)	0.006		
Sodium (per 1 mEq/l increase)	0.84 (0.74–0.91)	<0.001	0.93 (0.86–0.99)	0.02
BNP (per 100 pg/ml increase)	1.06 (1.04–1.08)	<0.001	1.05 (1.02–1. 07)	<0.001
Use of loop diuretics	2.39 (1.38–4.16)	0.002		
LVEF (per 10% increase)	0.85 (0.76–0.94)	0.002		
E/E′ >15	2.77 (1.66–4.64)	<0.001		
LAVI (per 10-ml increase)	1.19 (1.09–1.30)	<0.001		
RV-FAC (per 10% increase)	0.67 (0.55–0.79)	<0.001		
Moderate or severe TR	2.81 (1.60–4.93)	<0.001		
RAP >10 mm Hg	5.26 (2.93–9.43)	<0.001		
RI ≥0.70	1.78 (1.06–3.00)	0.03		
HV-S/D <0.55 (lower quartile)	3.99 (2.38–6.69)	<0.001		
IRVF biphasic pattern	8.23 (3.45–19.7)	<0.001	6.85 (2.82–16.6)	<0.001
IRVF monophasic pattern	23.1 (10.0–53.5)	<0.001	17.8 (7.62–41.9)	<0.001

Abbreviations as in Tables 1 and 2.

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

TABLE 3 **Predictors of Death From Cardiac Causes or Unplanned Hospitalization for Heart Failure by the Cox Proportional Hazard Model**

Predictor	Univariate		Multivariate	
	HR (95% CI)	p Value	HR (95% CI)	p Value
NYHA functional class III or IV	4.13 (2.34–7.26)	<0.001		
Hemoglobin (per 1 g/dl increase)	0.79 (0.70–0.88)	<0.001		
BUN (per 10 mg/dl increase)	1.31 (1.14–1.50)	<0.001		
eGFR (per 10 ml/min/1.73 m^2 increase)	0.98 (0.97–0.95)	0.006		
Sodium (per 1 mEq/l increase)	0.84 (0.74–0.91)	<0.001	0.93 (0.86–0.99)	0.02
BNP (per 100 pg/ml increase)	1.06 (1.04–1.08)	<0.001	1.05 (1.02–1. 07)	<0.001
Use of loop diuretics	2.39 (1.38–4.16)	0.002		
LVEF (per 10% increase)	0.85 (0.76–0.94)	0.002		
E/E′ >15	2.77 (1.66–4.64)	<0.001		
LAVI (per 10-ml increase)	1.19 (1.09–1.30)	<0.001		
RV-FAC (per 10% increase)	0.67 (0.55–0.79)	<0.001		
Moderate or severe TR	2.81 (1.60–4.9[illegible])	<0.001		
RAP >10 mm Hg	5.26 (2.93–9.43)	<0.001		
RI ≥0.70	1.78 (1.06–3.00)	0.03		
HV-S/D <0.55 (lower quartile)	3.99 (2.38–6.69)	<0.001		
IRVF biphasic pattern	8.23 (3.45–19.7)	<0.001	6.85 (2.82–16.6)	<0.001
IRVF monophasic pattern	23.1 (10.0–53.5)	<0.001	17.8 (7.62–41.9)	<0.001

Abbreviations as in Tables 1 and 2.

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

TABLE 3 **Predictors of Death From Cardiac Causes or Unplanned Hospitalization for Heart Failure by the Cox Proportional Hazard Model**

Predictor	Univariate		Multivariate	
	HR (95% CI)	p Value	HR (95% CI)	p Value
NYHA functional class [illegible]	4.13 (2.34–7.26)	<0.001		
Hemoglobin (per 1 g/dl [illegible]se)	0.79 (0.70–0.88)	<0.001		
BUN (per 10 mg/dl incr[illegible]	1.31 (1.14–1.50)	<0.001		
eGFR (per 10 ml/min/1.[illegible] increase)	0.98 (0.97–0.95)	0.006		
Sodium (per 1 mEq/l in[illegible]	0.84 (0.74–0.91)	<0.001	0.93 (0.86–0.99)	0.02
BNP (per 100 pg/ml in[illegible]	1.06 (1.04–1.08)	<0.001	1.05 (1.02–1. 07)	<0.001
Use of loop diuretics	2.39 (1.38–4.16)	0.002		
LVEF (per 10% increase[illegible]	0.85 (0.76–0.94)	0.002		
E/E′ >15	2.77 (1.66–4.64)	<0.001		
LAVI (per 10-ml increa[illegible]	1.19 (1.09–1.30)	<0.001		
RV-FAC (per 10[illegible]	0.67 (0.55–0.79)	<0.001		
Moderate or severe [illegible]	2.81 (1.60–4.93)	<0.001		
RAP >10 mm Hg	5.26 (2.93–9.43)	<0.001		
RI ≥0.70	1.78 (1.06–3.00)	0.03		
HV-S/D <0.55 (lower quartile)	3.99 (2.38–6.69)	<0.001		
IRVF biphasic pattern	8.23 (3.45–19.7)	<0.001	6.85 (2.82–16.6)	<0.001
IRVF monophasic pattern	23.1 (10.0–53.5)	<0.001	17.8 (7.62–41.9)	<0.001

Abbreviations as in Tables 1 and 2.

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

ORIGINAL RESEARCH

American Heart Association.

Doppler-Derived Renal Venous Stasis Index in the Prognosis of Right Heart Failure

Faeq Husain-Syed, MD; Horst-Walter Birk, MD; Claudio Ronco, MD; Tanja Schörmann, MD; Khodr Tello, MD; Manuel J. Richter, MD; Jochen Wilhelm, PhD; Natascha Sommer, PhD; Ewout Steyerberg, PhD; Pascal Bauer, MD; Hans-Dieter Walmrath, MD; Werner Seeger, MD; Peter A. McCullough, MD, MPH; Henning Gall, PhD;* H. Ardeschir Ghofrani, MD*

Background—Persistent congestion with deteriorating renal function is an important cause of adverse outcomes in heart failure. We aimed to characterize new approaches to evaluate renal congestion using Doppler ultrasonography.

Methods and Results—We enrolled 205 patients with suspected or prediagnosed pulmonary hypertension (PH) undergoing right heart catheterization. Patients underwent renal Doppler ultrasonography and assessment of invasive cardiopulmonary hemodynamics, echocardiography, renal function, intra-abdominal pressure, and neurohormones and hydration status. Four spectral Doppler intrarenal venous flow patterns and a novel renal venous stasis index (RVSI) were defined. We evaluated PH-related morbidity using the Cox proportional hazards model for the composite end point of PH progression (hospitalization for worsening PH, lung transplantation, or PH-specific therapy escalation) and all-cause mortality for 1-year after discharge. The prognostic utility of RVSI and intrarenal venous flow patterns was compared using receiver operating characteristic curves. RVSI increased in a graded fashion across increasing severity of intrarenal venous flow patterns (P<0.0001) and was significantly associated with right heart and renal function, intra-abdominal pressure, and neurohormonal and hydration status. During follow-up, the morbidity/mortality end point occurred in 91 patients and was independently predicted by RVSI (RVSI in the third tertile versus referent: hazard ratio: 4.72 [95% CI, 2.10–10.59; P<0.0001]). Receiver operating characteristic curves suggested superiority of RVSI to individual intrarenal venous flow patterns in predicting outcome (areas under the curve: 0.789 and 0.761, respectively; P=0.038).

Conclusions—We propose RVSI as a conceptually new and integrative Doppler index of renal congestion. RVSI provides additional prognostic information to stratify PH for the propensity to develop right heart failure.

Clinical Trial Registration—URL: https://www.clinicaltrials.gov/. Unique identifier: NCT03039959. **(*J Am Heart Assoc*. 2019;8: e013584. DOI: 10.1161/JAHA.119.013584.)**

Key Words: cardiorenal syndromes • intrarenal venous flow patterns • pulmonary hypertension • renal Doppler ultrasonography • venous congestion

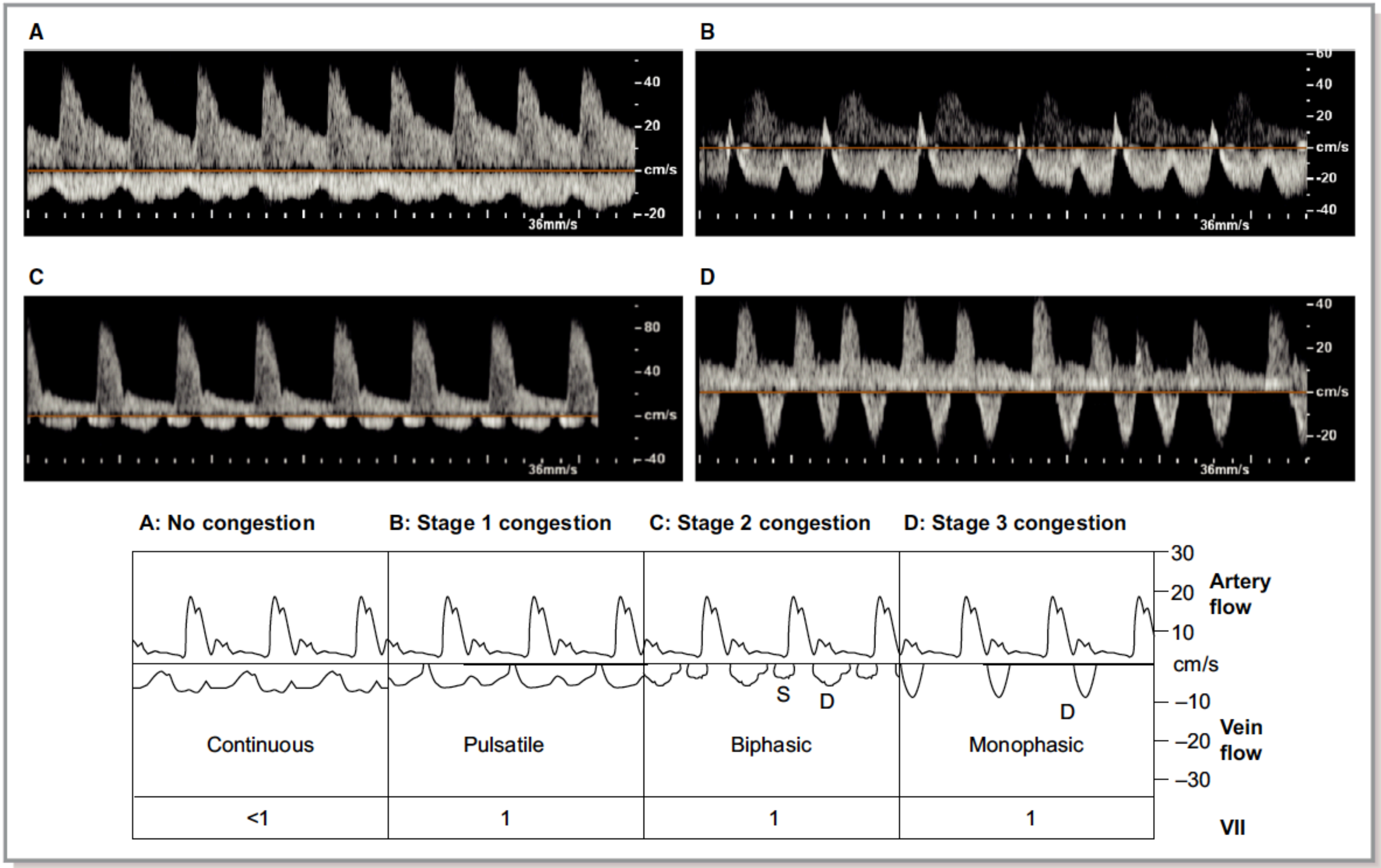
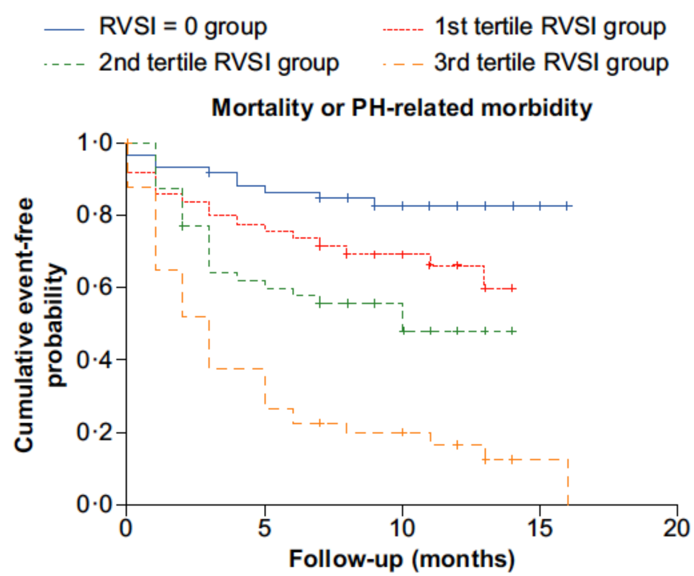


Figure 1. Congestion stages as defined by intrarenal venous flow patterns. Pulsed-wave Doppler samples of renal congestion patterns in the interlobar renal vessel. The upward Doppler signal shows the intrarenal arterial flow, which is used to measure renal resistive index; the downward Doppler signal shows the venous flow, used to measure venous impedance index or renal venous stasis index. **A**, No congestion: continuous venous flow. **B**, Stage 1 congestion: pulsatile venous flow. **C**, Stage 2 congestion: biphasic venous flow. **D**, Stage 3 congestion: monophasic venous flow. D indicates diastole; S, systole; VII, venous impedance index.

Death from any cause



	Follow-up (months)				
Number at risk (%)	0	3	6	9	12
RVSI = 0 group	59 (100%)	54 (92%)	50 (86%)	40 (83%)	23 (83%)
1st tertile RVSI group	49 (100%)	40 (84%)	36 (74%)	30 (69%)	16 (66%)
2nd tertile RVSI group	48 (100%)	35 (77%)	27 (58%)	20 (56%)	6 (48%)
3rd tertile RVSI group	49 (100%)	24 (52%)	12 (27%)	7 (20%)	4 (17%)

Figure 6. Kaplan-Meier estimate curve according to RVSI tertiles. Patients in the third tertile group had a significantly higher probability than other patients of the composite end point of PH-related morbidity or death from any cause (*P*<0.0001). PH indicates pulmonary hypertension; RVSI, renal venous stasis index.

Conclusions

Venous Congestion can cause injury and is a multisystem problem

Venous Congestion is a very dynamic process in the perioperative period

↑ CVP (RAP) is bad

Interventions to reverse venous congestion affect outcome

Conclusions

Portal Vein Flow Pattern Analysis
Splenic Vein Flow Pattern Analysis
Renal Vein Flow Pattern Analysis

Monitoring tools that are very effective to detect early RV Dysfunction and/or Venous Congestion

Predictors of major complications

Conclusions

Fluid administration should be considered a drug

The “correct dose” of intravenous should be individualized using:

Physical examination
TTE/TEE (IAS/RV)
CVP/RV monitoring/Wave Analysis
Portal Vein Flow Pattern Analysis
Splenic Vein Flow Pattern Analysis
Renal Vein Flow Pattern Analysis

Prevention of Venous Congestion

Extracardiac TEE to assess venous stasis and visceral perfusion

Should we include extracardiac echo to assess venous congestion in our perioperative examination ?

Extracardiac TEE to assess venous stasis and visceral perfusion

Should we in assess
venous cong
examination

YES !!

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

ANESTHÉSIOLOGIE • ICM

georgesdesjardins5@gmail.com

INSTITUT DE CARDIOLOGIE DE MONTRÉAL