JRUR 2023
19ème Journée de Réanimation & Urgences Respiratoires
JEUDI 6 AVRIL
Faculté de Médecine, Marseille

Prédiction de la réponse au remplissage vasculaire

20 ans de recherche clinique

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FHU SEPSIS Personalized Interventions

MIR Bicêtre

Disclosures

Pulsion Medical Systems (Getinge)

Honoraria for consulting
Institutional restricted research grants
Honoraria for giving lectures
Refunds of travel expenses

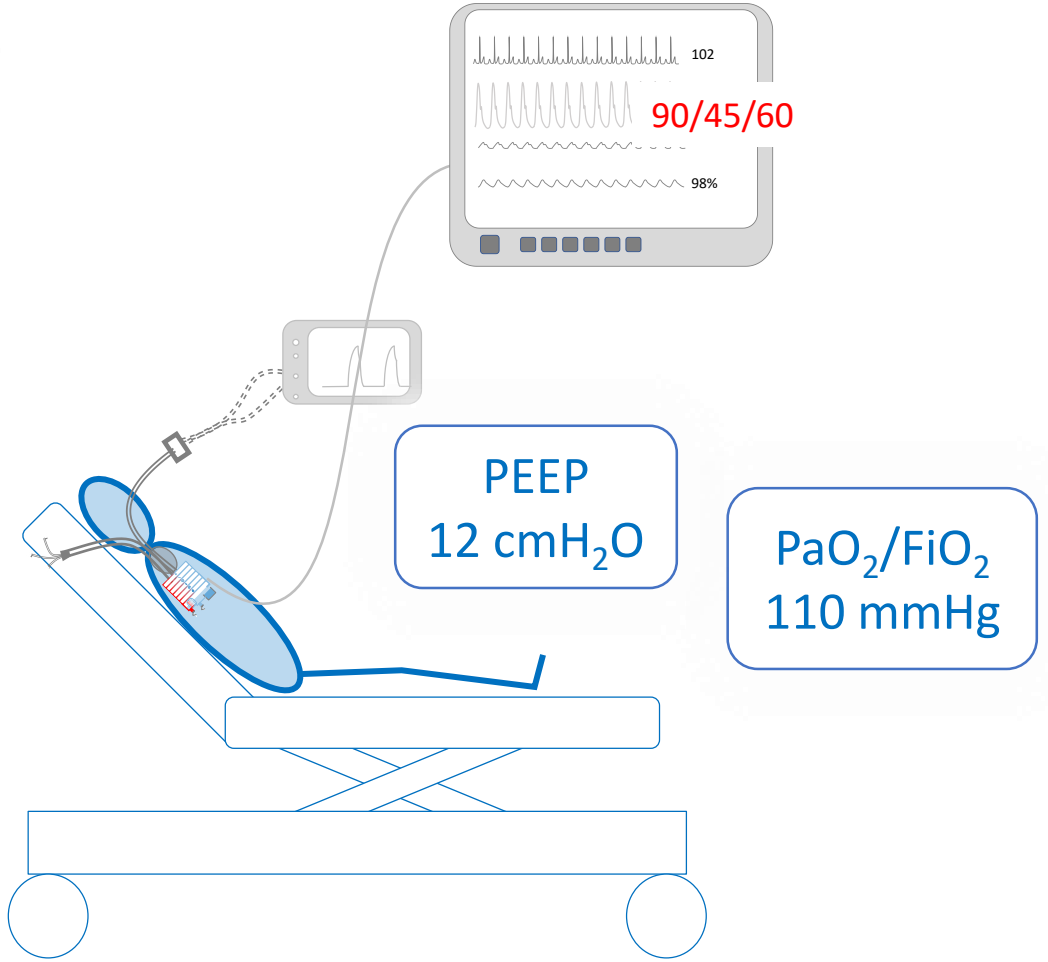
Baxter

Honoraria for consulting
Institutional restricted research grants
Honoraria for giving lectures
Refunds of travel expenses

What is the concept ?

Community-acquired pneumonia

Day-1



PEEP
12 cmH_2O

PaO_2/FiO_2
110 mmHg

What is the concept ?

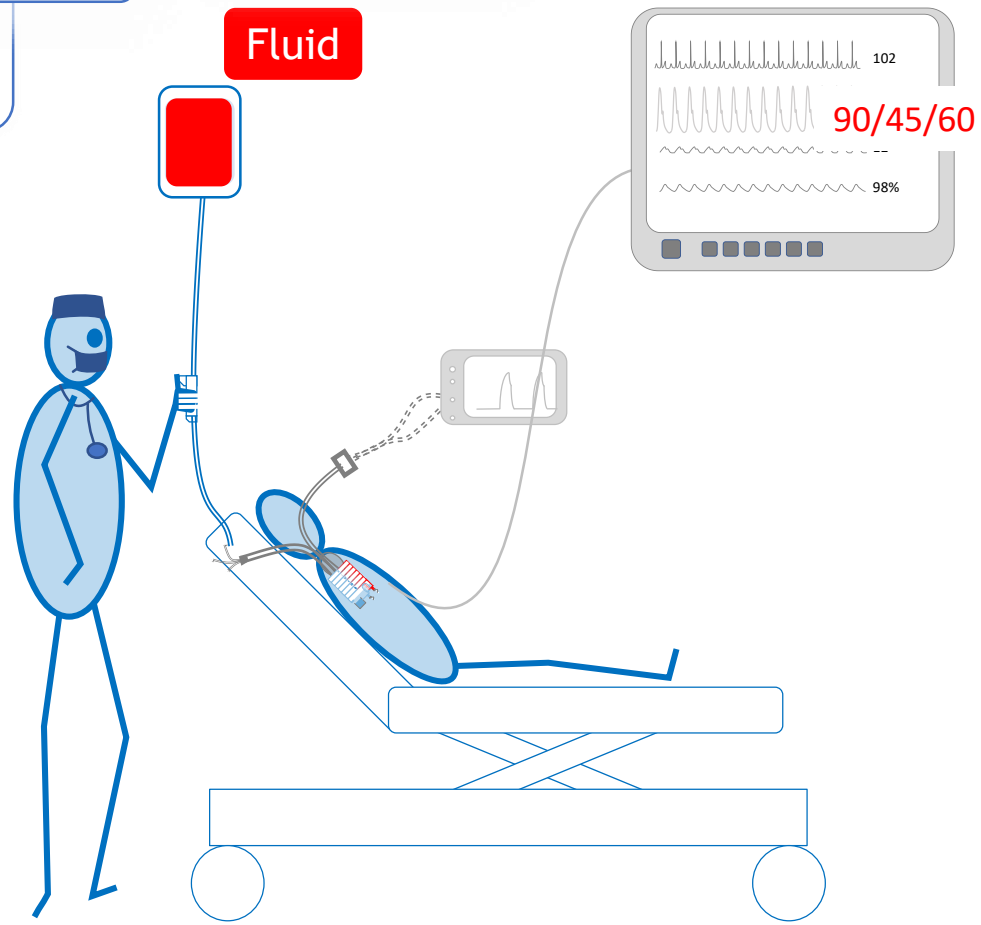
Community-acquired

Day-1

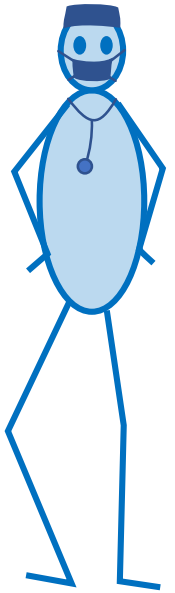
PEEP
12 cmH_2O

O_2/FiO_2
mmHg

Fluid



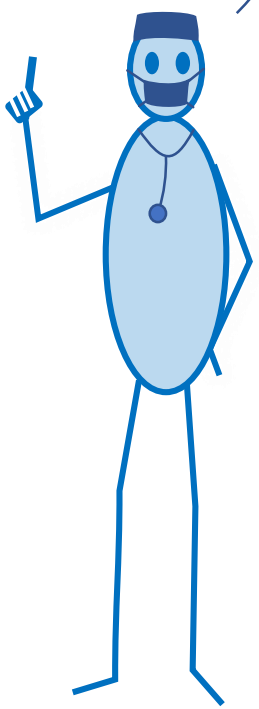
Why do we give fluid to shock patients ?

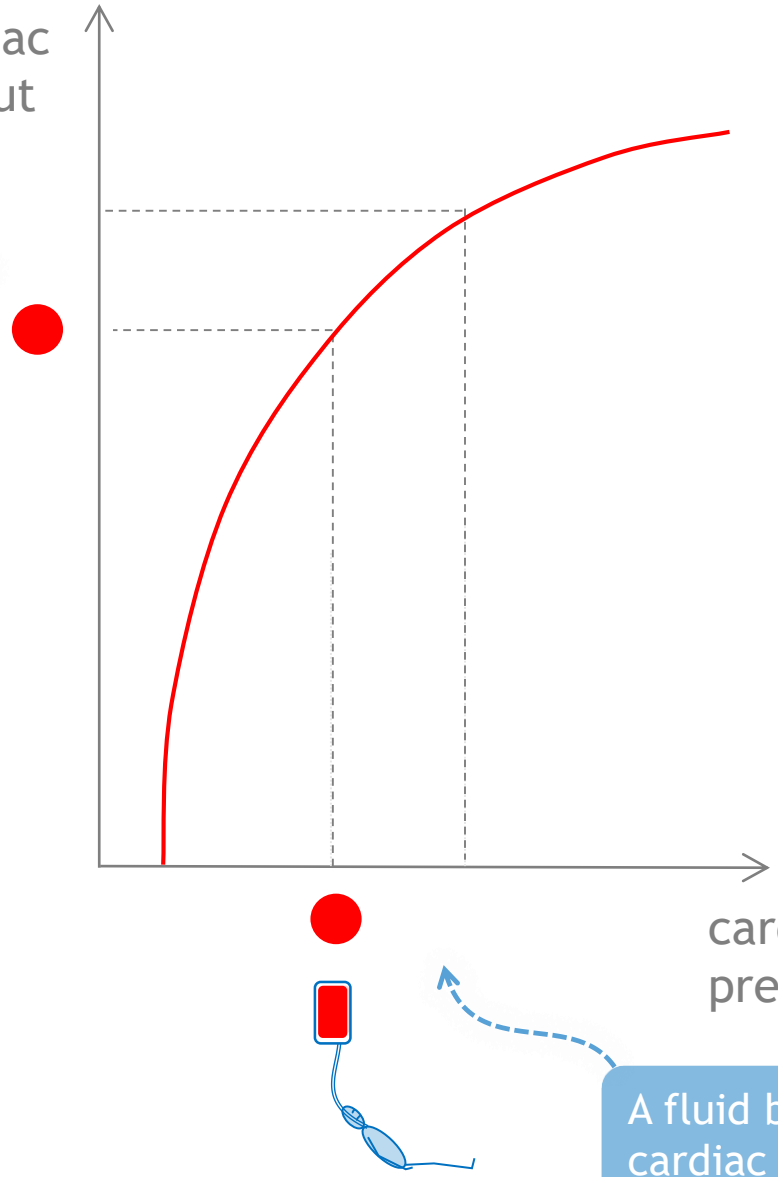


What is the concept ?

Why do we give fluid to shock patients ?

… in order to increase cardiac output





A fluid bolus increases cardiac preload…

What is the concept ?

Let's go back to physiology !

Messina et al. Critical Care (2022) 26:186
https://doi.org/10.1186/s13054-022-04056-3

Critical Care

REVIEW Open Access

Fluid challenge in critically ill patients receiving haemodynamic monitoring: a systematic review and comparison of two decades

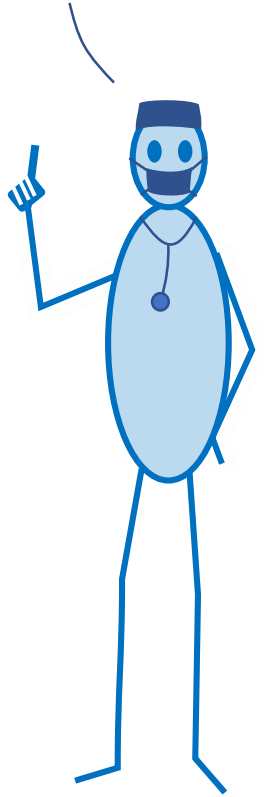
Antonio Messina[1,2*], Lorenzo Calabrò[1], Luca Pugliese[1], Aulona Lulja[1], Alexandra Sopuch[1], Daniela Rosalba[3], Emanuela Morenghi[1,2], Glenn Hernandez[4], Xavier Monnet[5,6,7] and Maurizio Cecconi[1,2]

124 studies published between 2010 and 2021

Cardiac output does not increase as expected in 50% of the patients !

References	Year	% R
Mahjoub et al. [35]	2010	76
Feissel et al. [37]	2004	41
Marik et al. [39]	2013	53
Wyffels et al. [41]	2007	62
Jozwiak et al. [43]	2017	50
Monnet et al. [45]	2009	70
Monnet et al. [47]	2012	55
Vaquer et al. [20]	2020	34
Chen et al. [49]	2021	60
Abdullah et al. [49]	2021	46
Messina et al. [52]	2021	48
Taccheri et al. [54]	2021	50
Kaur et al. [56]	2021	67
Biasucci et al. [58]	2019	60
Gavaud et al. [60]	2019	90
Dépret et al. [62]	2019	50
Messina et al. [64]	2019	66
Vistisen et al. [66]	2018	23
Xu et al. [68]	2017	45
Preau et al. [69]	2017	55
Machare-Delgado et al. [71]	2011	32
Monnet et al. [73]	2013	49
Monnet et al. [74]	2007	54
Ishihara et al. [76]	2013	54
Monge Garcia et al. [78]	2012	57
Luzi et al. [80]	2013	50
Dong et al. [82]	2012	69
Jabot et al. [84]	2008	100
Préau et al. [86]	2010	41
Monnet et al. [88]	2006	52
Monnet et al. [47]	2012	56
Monnet et al. [91]	2013	43
Loupec et al. [93]	2011	53
Monnet et al. [95]	2012	44
Huang et al. [97]	2008	46
Khwannimit et al. [98]	2012	57
Fischer et al. [100]	2013	71
Kramer et al. [102]	2004	29
Yazigi et al. [104]	2012	68
Wyler von Ballmoos et al. [106]	2010	28
Michard et al. [108]	2000	40
Lakhal et al. [110]	2011	40
Muller et al. [112]	2012	50
Giraud et al. [114]	2011	47
Suehiro et al. [116]	2012	48
Perner et al. [117]	2006	47
Smorenberg et al. [118]	2013	44
Monnet et al. [119]	2012	42
Yonis et al. [121]	2017	33
Xiao-ting et al. [122]	2015	70
Biais et al. [124]	2009	67
Mallat et al. [126]	2015	45
Maizel et al. [127]	2007	50
Lamia et al. [129]	2007	59
Silva et al. [131]	2004	63
Cecconi et al. [133]	2012	39
Georges et al. [135]	2018	56
Monnet et al. [137]	2013	52
Monnet et al. [139]	2005	53
Biais et al. [141]	2012	54
Lakhal et al. [115]	2013	37
Michard et al. [144]	2003	49
References	**Year**	**% R**
Préau et al. [36]	2012	44
Caille et al. [38]	2008	43
Mahjoub et al. [40]	2012	71
Wu et al. [42]	2014	54
Fellahi et al. [44]	2012	84
Smorenberg et al. [46]	2017	62
Muller et al. [48]	2011	54
Monnet et al. [28]	2011	62
Monge Garcia et al. [50]	2008	37
Natalini et al. [51]	2006	59
Mahjoub et al		
Fischer et al.		
Vistisen et al.		
Kupersztych-Hagege et al.		
Monge Garcia et al. [61]		
Lakhal et al. [63]	2012	39
Soubrier et al. [65]	2007	59
Fellahi et al. [67]	2012	56
Osman et al. [22]	2007	43
Lakhal et al. [70]	2010	42
De Oliveira-Costa et al. [72]	2012	46
Velissaris et al. [23]	2011	52
Monnet et al. [75]	2011	84
Muller et al. [77]	2010	72
Muller et al. [79]	2008	51
Heenen et al. [81]	2006	43
De Backer et al. [83]	2005	55
Le Dorze et al. [85]	2018	35
Wu et al. [87]	2018	45
Si et al. [89]	2018	63
Pouska et al. [90]	2018	49
		52
		50
		89
		54
Guérin et al. [103]	2015	50
Airapetian et al. [105]	2015	49
Messina et al. [107]	2015	–
Cecconi et al. [109]	2015	50
Soliman et al. [111]	2015	56
Nunes et al. [113]	2014	65
Lakhal et al. [115]	2013	37
Monge Garcia et al. [21]	2015	67
Cecconi et al. [26]	2013	43
Hu et al. [24]	2013	52
Schnell et al. [120]	2013	49
Pranskunas et al. [27]	2013	68
Elsayed et al. [123]	2021	35
Bataille et al. [125]	2021	50
De Santis et al. [25]	2021	58
Kumar et al. [128]	2021	64
raun et al. [130]	2020	43
ette et al. [132]	2020	77
elfattah et al. [13	2020	55
Jacq -Lagrèze et al. [6]	2019	38
Beurto t al. [138]	2019	60
Roger et [140]	2019	53
Mukhtar e [142]	2019	68
Trifi et al. [14	2019	70
Giraud et al. [1	2018	45

Positive response: 52 (42-58)%

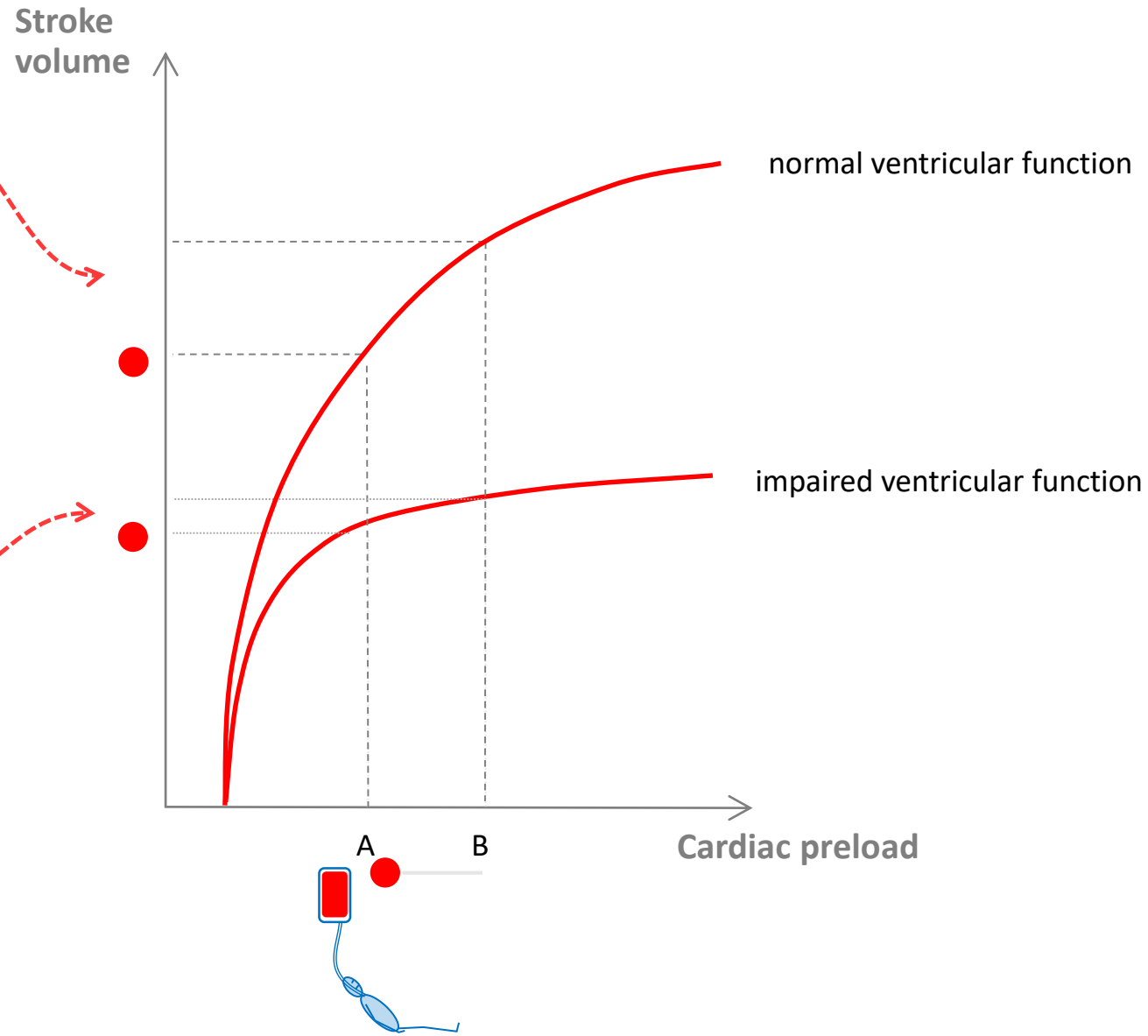


What is the concept ?

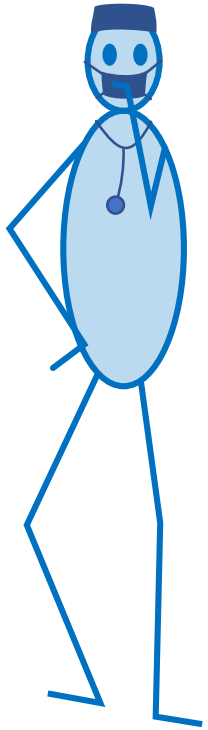
Let's go back to physiology !

No response…

No response…



Is that important ?



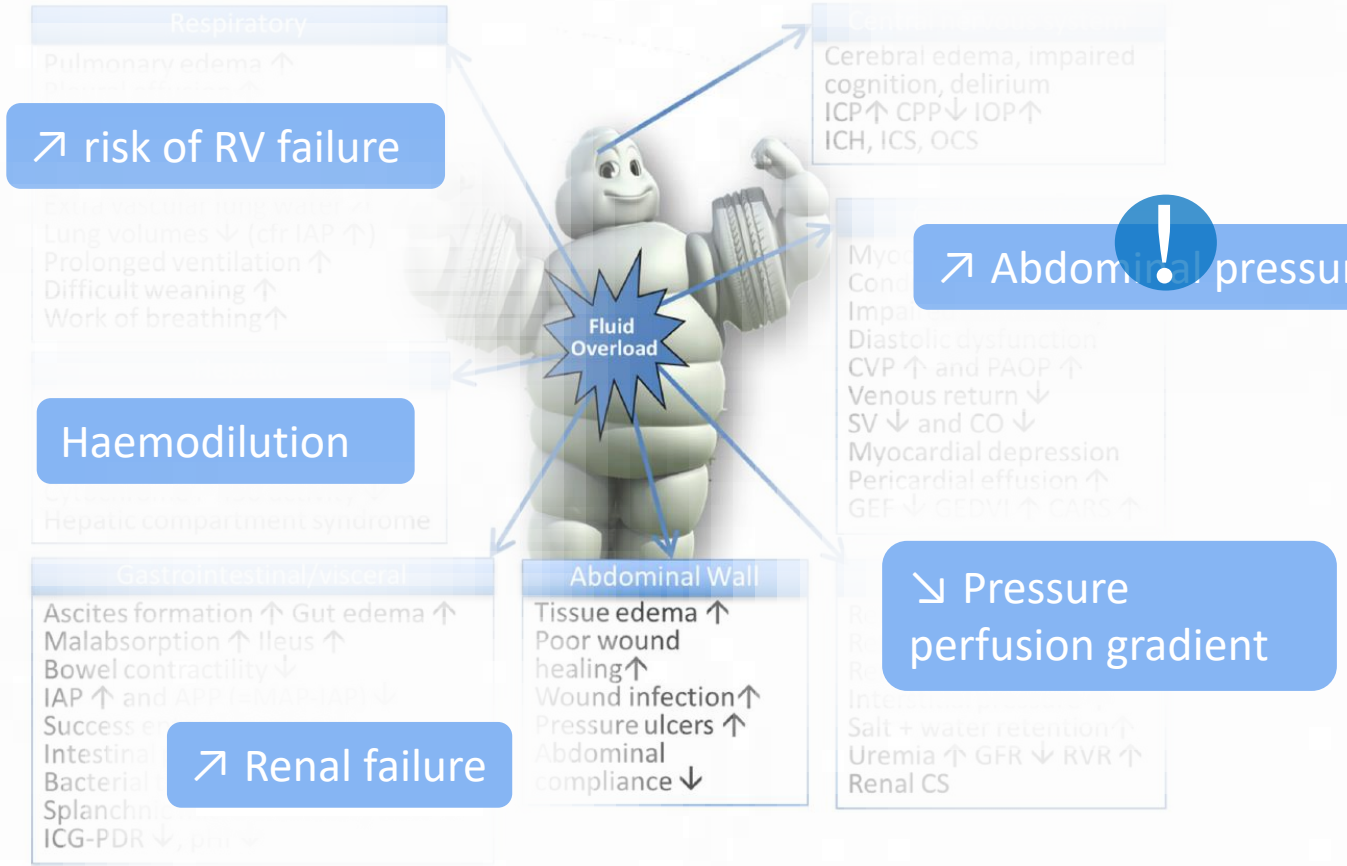
What is the concept ? The harmfulness of fluid overload

Ann. Intensive Care (2018) Annals of Intensive Care

REVIEW Open Access

Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy

Manu L. N. G. Malbrain[1,2*], Niels Van Regenmortel[3], Bernd Saugel[4], Brecht De Tavernier[3], Pieter-Jan Van Gaal[3], Olivier Joannes-Boyau[5], Jean-Louis Teboul[6], Todd W. Rice[7], Monty Mythen[8] and Xavier Monnet[6]



1 The effects of fluid infusion are not constant

2 Fluid overload is harmful !

What is the concept ? The harmfulness of fluid overload

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Sepsis in European intensive care units: Results of the SOAP study*

Jean-Louis Vincent, MD, PhD, FCCM; Yasser Sakr, MB, BCh, MSc; Charles L. Sprung, MD; V. Marco Ranieri, MD; Konrad Reinhart, MD, PhD; Herwig Gerlach, MD, PhD; Rui Moreno, MD, PhD; Jean Carlet, MD, PhD; Jean-Roger Le Gall, MD; Didier Payen, MD; on behalf of the Sepsis Occurrence in Acutely Ill Patients Investigators

Crit Care Med 2006

Cohort study

1,177 pts with sepsis

Table 7. Multivariate, forward stepwise logistic regression analysis in sepsis patients (n = 1177), with intensive care unit mortality as the dependent factor

	OR (95% CI)	*p* Value
SAPS II score[a] (per point increase)	1.0 (1.0–1.1)	<.001
Cumulative fluid balance[b] (per liter increase)	1.1 (1.0–1.1)	.001
Age (per year increase)	1.0 (1.0–1.0)	.001
Initial SOFA score (per point increase)	1.1 (1.0–1.1)	.002
Blood stream infection	1.7 (1.[illegible]–2.4)	.004
Cirrhosis	2.4 (1.3–4.5)	.008
Pseudomonas infection	1.6 (1.1–2.[illegible])	.017
Medical admission	1.4 (1.0–1.8)	
Female gender	1.4 (1.0–1.8)	

Fluid overload increases mortality during sepsis

What is the concept ? The harmfulness of fluid overload

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Faculté de Médecine, Marseille

Extravascular Lung Water is an Independent Prognostic Factor in Patients with Acute Respiratory Distress Syndrome

Mathieu Jozwiak, MD; Serena Silva, MD; Romain Persichini, MD; Nadia Anguel, MD; David Osman, MD; Christian Richard, MD; Jean-Louis Teboul, MD, PhD; Xavier Monnet, MD, PhD

Crit Care Med 2013

200 pts with ARDS

	Odds Ratio (CI 95%)	p value
$EVLWI_{max}$ (1 unit = 1 mL/kg)	1.07 (1.02 - 1.12)	0.007
Maximum blood lactate (1 unit = 1 mmol/L)	1.29 (1.14 - 1.46)	0.0001
Minimum Pa	0.98 (0.97 - 0.99)	0.006
Mean PEEP (1 unit = 1 cmH_2O)	0.[illegible] (0.67 - 0.91)	0.002
SAPS II (1 unit = 1 point)	1.03 (1.01 - 1.05)	0.02
Mean cumulative fluid balance (1 unit = 1 mL)	1.0004 (1.0001 - 1.0008)	0.02

Fluid overload increases mortality during ARDS

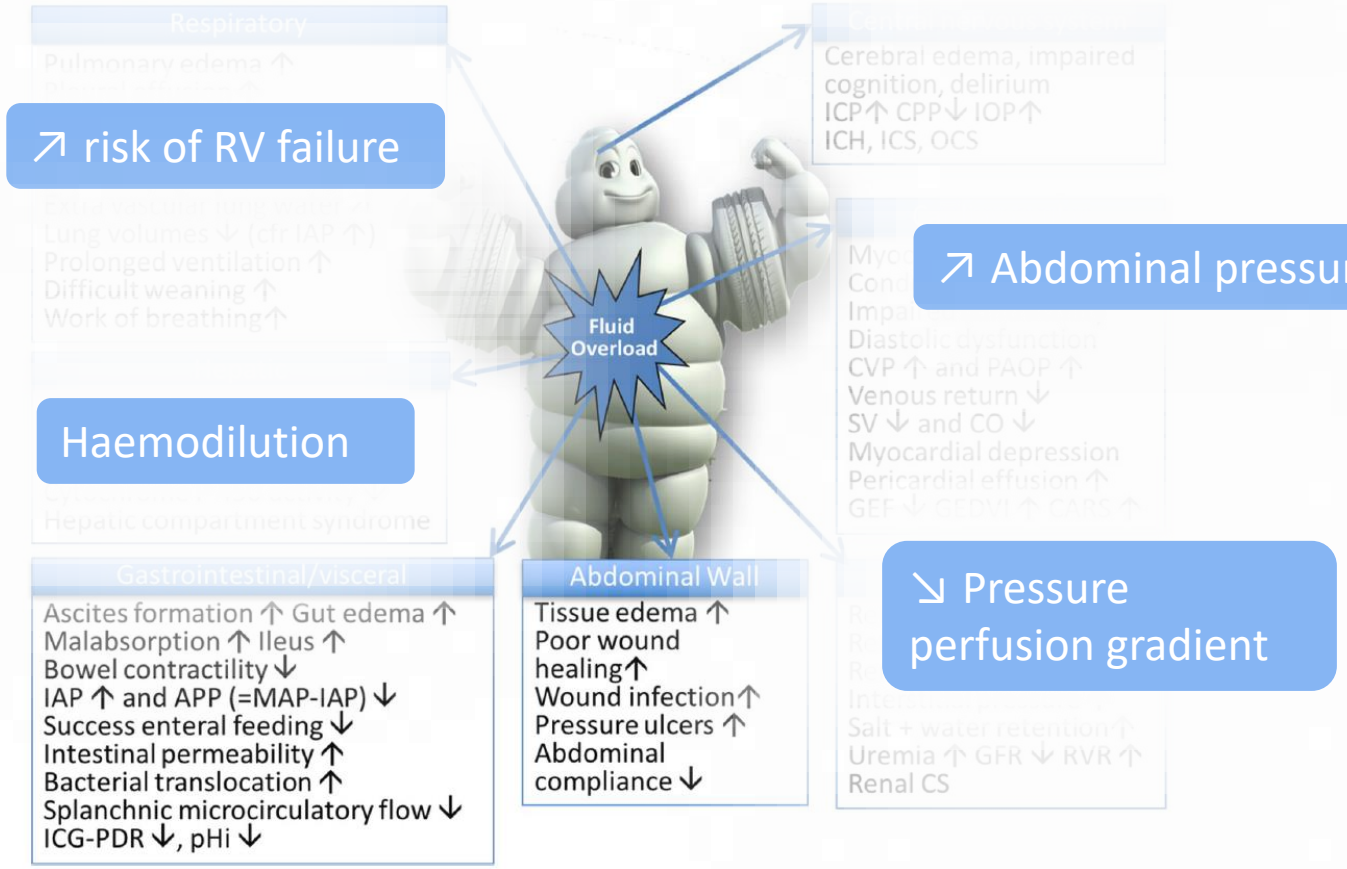
What is the concept ? The harmfulness of fluid overload

Ann. Intensive Care (2018) Annals of Intensive Care

REVIEW Open Access

Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy

Manu L. N. G. Malbrain[1,2*], Niels Van Regenmortel[3], Bernd Saugel[4], Brecht De Tavernier[3], Pieter-Jan Van Gaal[3], Olivier Joannes-Boyau[5], Jean-Louis Teboul[6], Todd W. Rice[7], Monty Mythen[8] and Xavier Monnet[6]



1 The effects of fluid infusion are not constant

2 Fluid infusion is potentially harmful !

The concept of fluid responsiveness

The harmfulness of fluid overload

Ann. Intensive Care (2018) Annals of Intensive Care

REVIEW Open Access

Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy

Manu L. N. G. Malbrain[1,2*], Niels Van Regenmortel[3], Bernd Saugel[4], Brecht De Tavernier[3], Pieter-Jan Van Gaal[3], Olivier Joannes-Boyau[5], Jean-Louis Teboul[6], Todd W. Rice[7], Monty Mythen[8] and Xavier Monnet[6]

1. The effects of fluid infusion are not constant

2. Fluid infusion is potentially harmful !

→ One should predict fluid responsiveness

What is the concept ?

x adverse effects

Inconstant efficacy

Prediction of fluid responsiveness

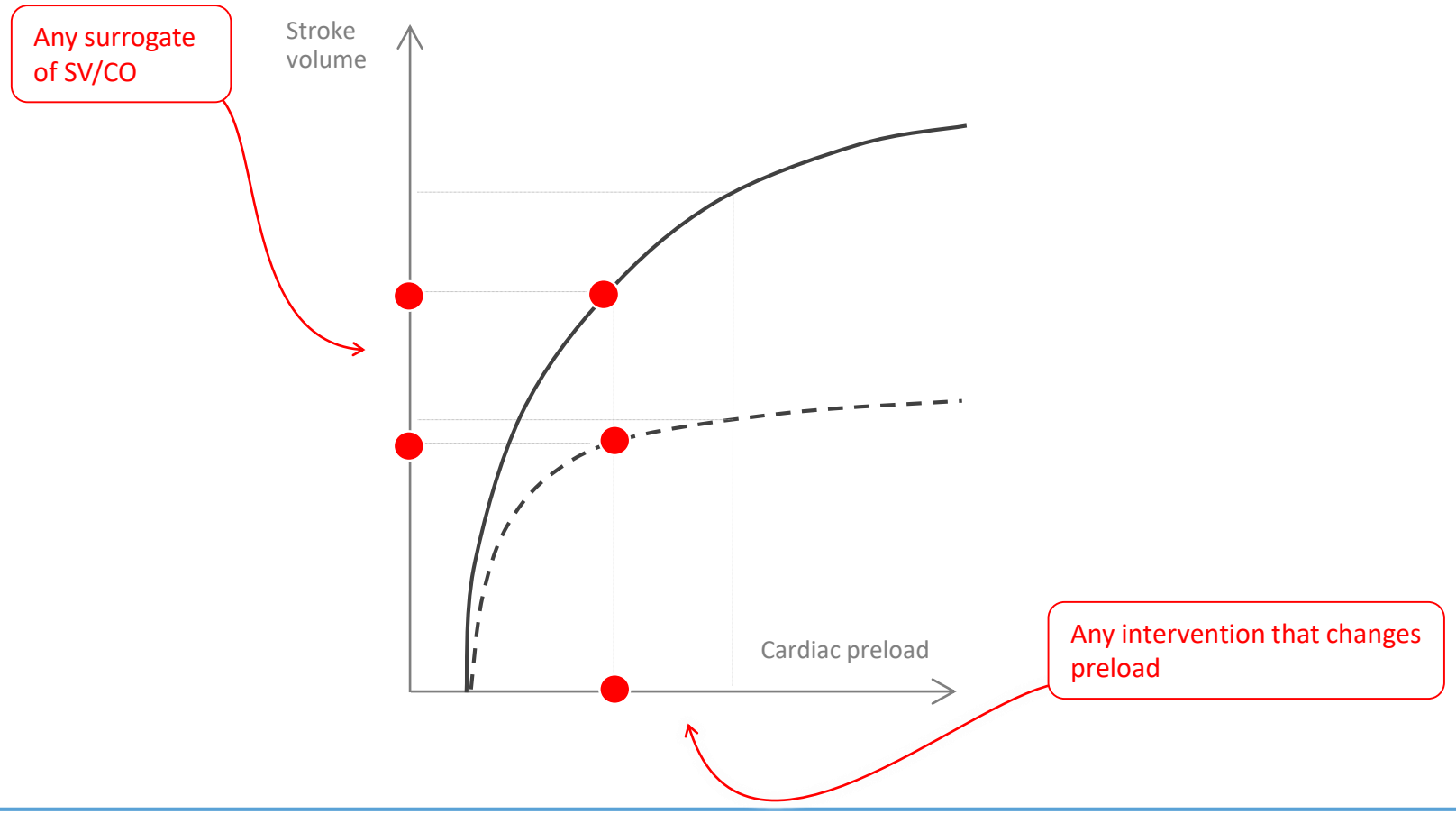
Which tests and indices could be used ?

Intensive Care Med
https://doi.org/10.1007/s00134-022-06900-0

LASTING LEGACY IN INTENSIVE CARE MEDICINE

The prediction of fluid responsiveness

Xavier Monnet[1*], Manu L. N. G. Malbrain[2,3,4] and Michael R. Pinsky[5]

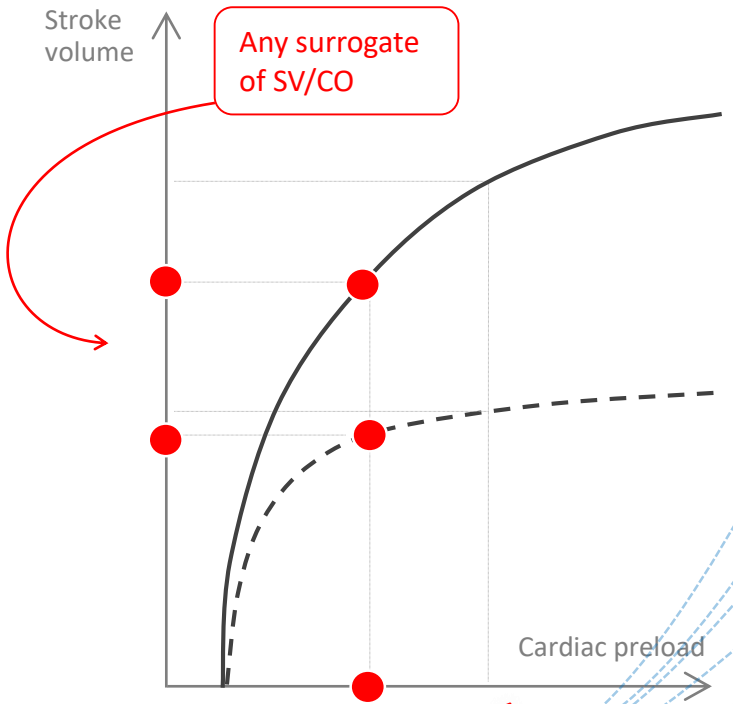


Which tests and indices could be used ?

Intensive Care Med
https://doi.org/10.1007/s00134-022-06900-0

LASTING LEGACY IN INTENSIVE CARE MEDICINE

The prediction of fluid responsi



Any surrogate of SV/CO

Any intervention that changes preload

Mimicking a fluid challenge

- Mini-fluid challenge
- Passive leg raising test

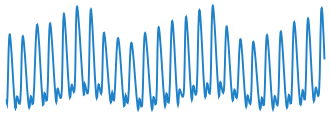
Using heart-lung interactions

- PPV, SVV
- Tidal volume challenge
- Vena cava collapsibility
- End-exp. occlusion test
- PEEP test

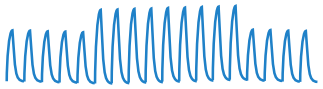
Which tests and indices could be used ?

Mini-fluid challenge

Passive leg raising test



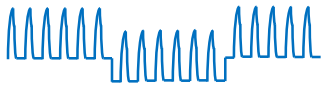
PPV, SVV



Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test



PEEP test

Well demonstrated	Reliable (Se, Sp)	Easy to perform	Applicable in many patients	Possible with no CO monitoring

Which tests and indices could be used ?

Mini-fluid challenge

Passive leg raising test

PPV, SVV

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test

PEEP test

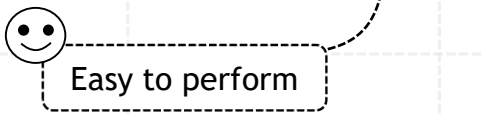
Well demonstrated

Reliable (Se, Sp)

Easy to perform

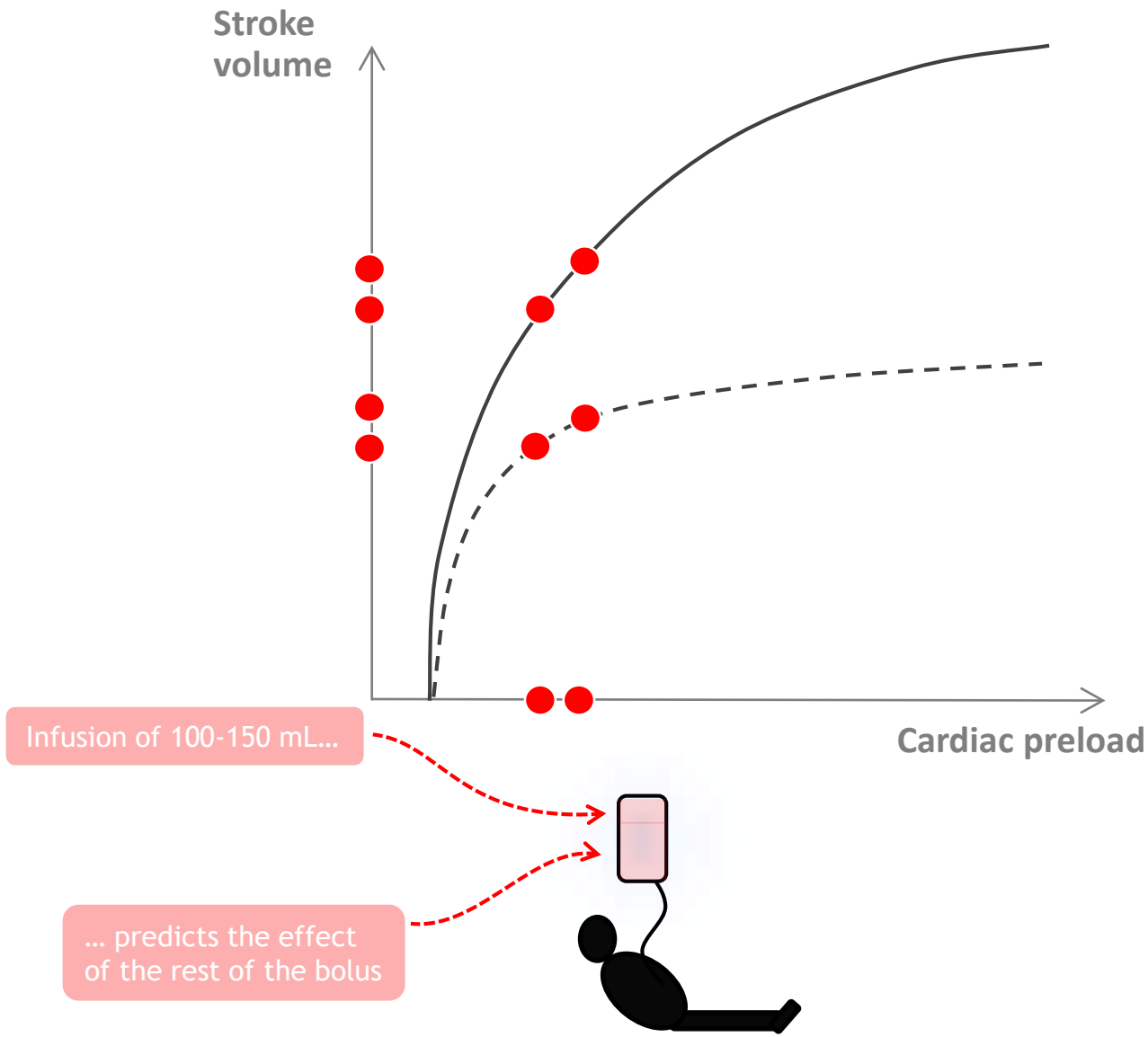
Applicable in many patients

Possible with no CO monitoring



Which tests and indices could be used ?

Mini-fluid challenge



Which tests and indices could be used ?

Mini-fluid challenge

Passive leg raising test

Different thresholds reported

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test

PEEP test

Well demonstrated

Reliable (Se, Sp)

Easy to perform

Applicable in many patients

Possible with no CO monitoring

Easy to perform

Which tests and indices could be used ?

Mini-fluid challenge

Messina et al. Critical Care (2019) 23:264
https://doi.org/10.1186/s13054-019-2545-z

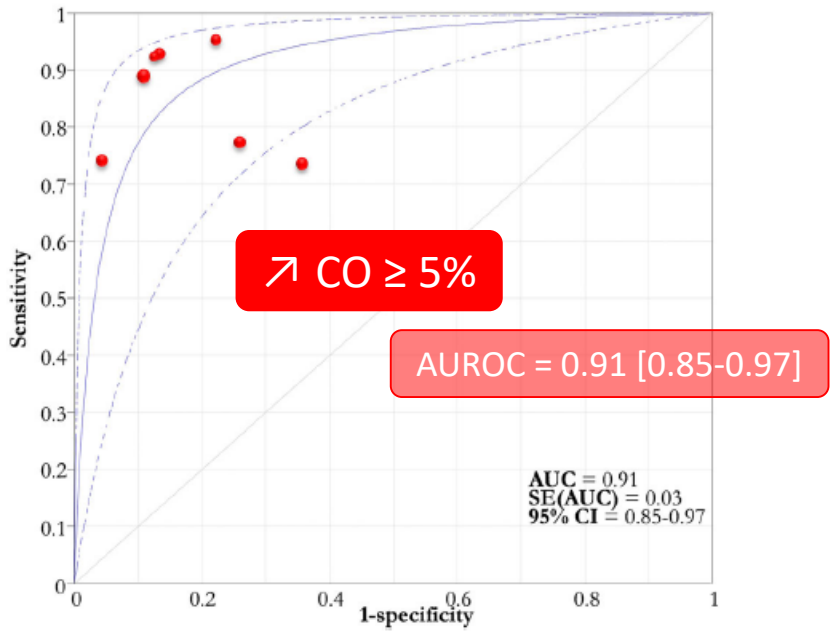
Critical Care

RESEARCH Open Access

Functional hemodynamic tests: a systematic review and a metanalysis on the reliability of the end-expiratory occlusion test and of the mini-fluid challenge in predicting fluid responsiveness

Antonio Messina[1*], Antonio Dell'Anna[2,3], Marta Baggiani[4], Flavia Torrini[2,3], Gian Marco Maresca[2,3], Victoria Bennett[5], Laura Saderi[6], Giovanni Sotgiu[6], Massimo Antonelli[2,3] and Maurizio Cecconi[1,7]

7 studies
368 patients



↗ CO ≥ 5%

AUROC = 0.91 [0.85-0.97]

Alvarado Sánchez et al. Ann. Intensive Care (2021) 11:28
https://doi.org/10.1186/s13613-021-00817-5

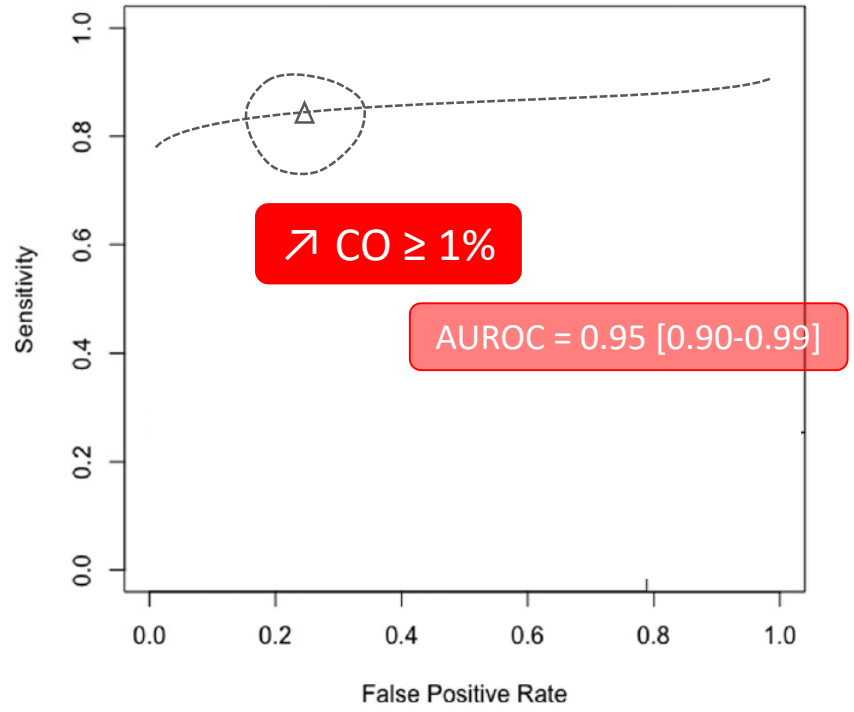
Annals of Intensive Care

REVIEW Open Access

Predictors of fluid responsiveness in critically ill patients mechanically ventilated at low tidal volumes: systematic review and meta-analysis

Jorge Iván Alvarado Sánchez[1,2*], Juan Daniel Caicedo Ruiz[2], Juan José Diaztagle Fernández[2,3,4], William Fernando Amaya Zuñiga[5], Gustavo Adolfo Ospina-Tascón[6] and Luis Eduardo Cruz Martínez[2]

2 studies (low Vt only)
88 patients

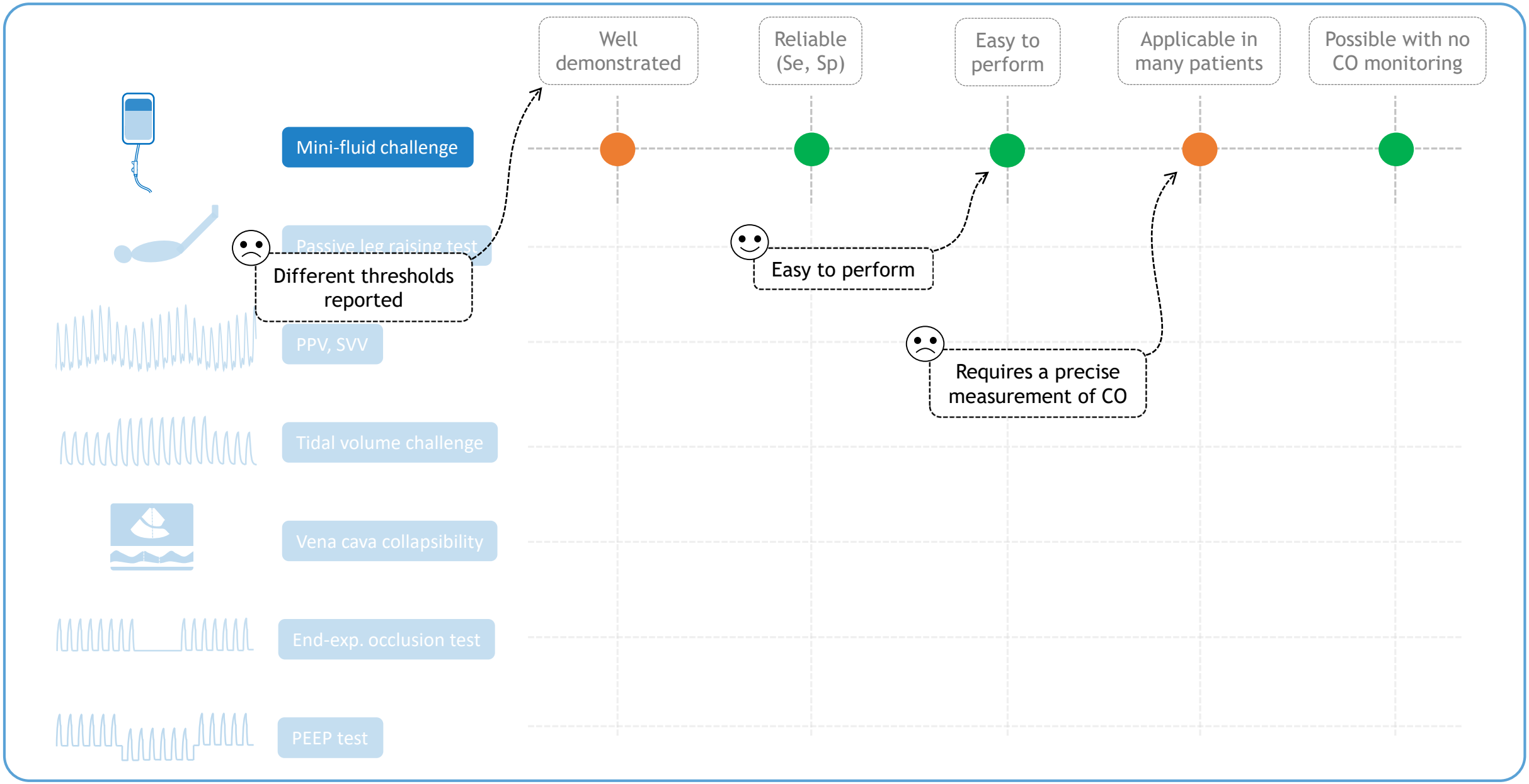


↗ CO ≥ 1%

AUROC = 0.95 [0.90-0.99]

Which tests and indices could be used ?

Mini-fluid challenge



Which tests and indices could be used ?

Mini-fluid challenge

An Increase in Aortic Blood Flow after an Infusion of 100 ml Colloid over 1 Minute Can Predict Fluid Responsiveness

The Mini-fluid Challenge Study

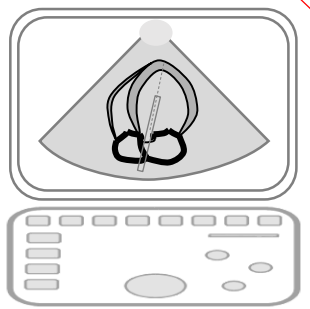
Laurent Muller, M.D., M.Sc.,* Medhi Toumi, M.D.,* Philippe-J... Bousquet, M.D.,† Béatrice Riu-Poulenc, M.D.,‡ Guillaume Louart, M.D.,* Damien Ca... M.D.,* Lana Zoric, M.D.,* Carey Suehs, Ph.D.,† Jean-Emmanuel de La Coussaye, M.D., Ph.D.,§ Nicol... Molinari, Ph.D.,† Jean-Yves Lefrant, M.D., Ph.D.,§ in the AzuRéa Group

Anesthesiology 201...

Small amount of fluid

Small change in CO/SV

Cardiac US



Changes in VTI

Detectable by echo?..

Which tests and indices could be used ?

Mini-fluid challenge

Jozwiak et al. Critical Care (2019) 23:116
https://doi.org/10.1186/s13054-019-2413-x

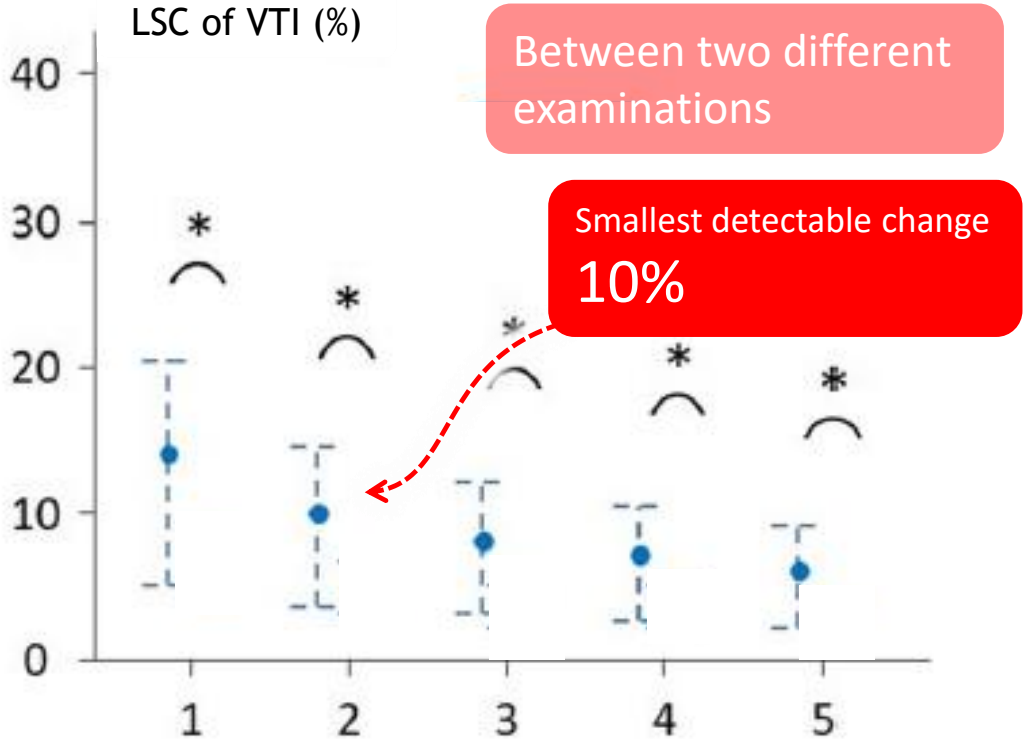
Critical Care

RESEARCH Open Access

What is the lowest change in cardiac output that transthoracic echocardiography can detect?

Mathieu Jozwiak[1,2*], Pablo Mercado[1,2], Jean-Louis Teboul[1,2], Anouar Benmalek[3], Julia Gimenez[1,2], François Dépret[1,2], Christian Richard[1,2] and Xavier Monnet[1,2]

100 stable patients
16% in 1F, 54% under MV



Between two different examinations

Smallest detectable change
10%

Which tests and indices could be used ?

Mini-fluid challenge

An Increase in Aortic Blood Flow after an Infusion of 100 ml Colloid over 1 Minute Can Predict Fluid Responsiveness

The Mini-fluid Challenge Study

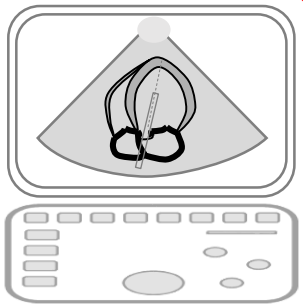
Laurent Muller, M.D., M.Sc.,* Medhi Toumi, M.D.,* Philippe-Jean Bousquet, M.D.,† Béatrice Riu-Poulenc, M.D.,‡ Guillaume Louart, M.D.,* Damien Candela, M.D.,* Lana Zoric, M.D.,* Carey Suehs, Ph.D.,† Jean-Emmanuel de La Coussaye, M.D., Ph.D.,§ Nicolas Molinari, Ph.D.,† Jean-Yves Lefrant, M.D., Ph.D.,§ in the AzuRéa Group

Anesthesiology 2011

Small amount of fluid

Small change in CO/SV

Cardiac US



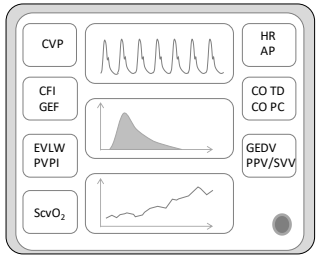
Changes in VTI

Detectable by echo?..

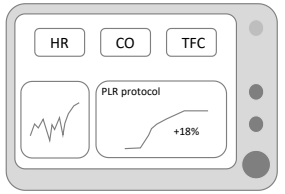
… or by more precise techniques ?

Changes in pulse contour-derived CO

Transpulmonary thermodilution

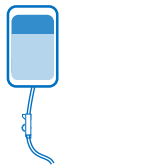


Uncalibrated pulse contour anlaysis



Which tests and indices could be used ?

Mini-fluid challenge



Mini-fluid challenge

Passive leg raising test

PPV, SVV

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test

PEEP test

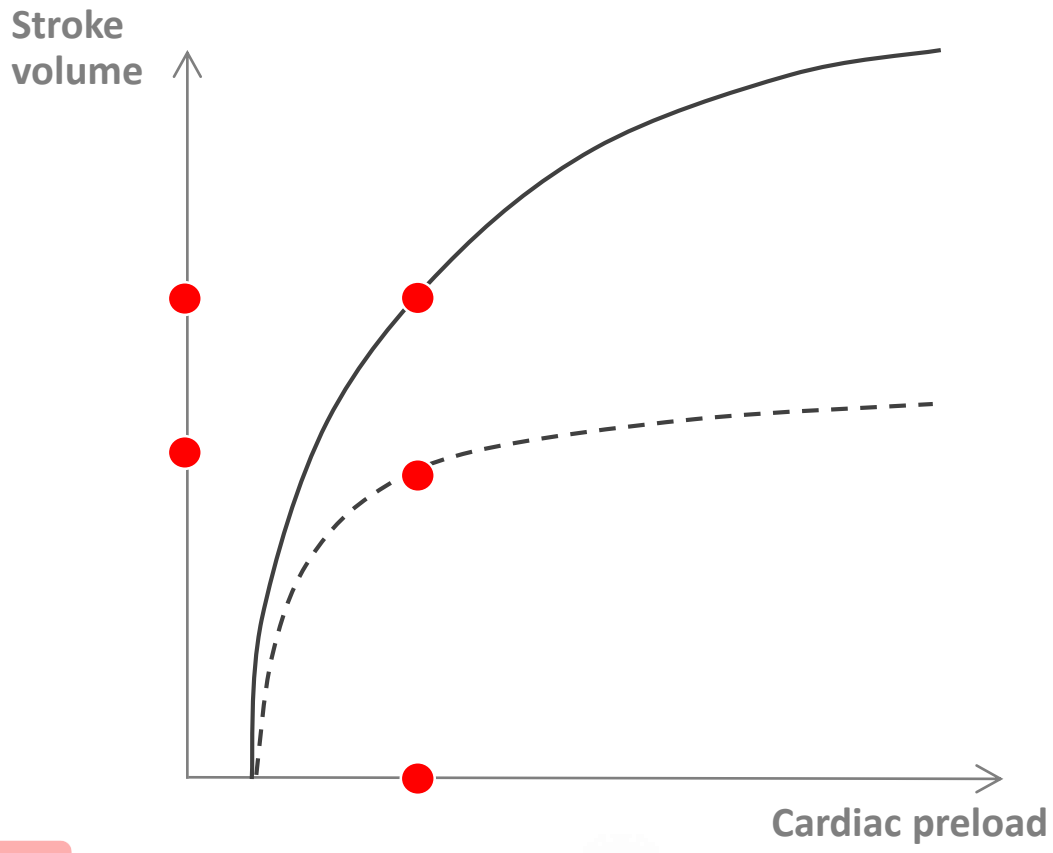
Which tests and indices could be used ?

Passive leg raising test

	Well demonstrated	Reliable (Se, Sp)	Easy to perform	Applicable in many patients	Possible with no CO monitoring
Mini-fluid challenge	●	●	●	●	●
Passive leg raising test					
PPV, SVV					
Tidal volume challenge					
Vena cava collapsibility					
End-exp. occlusion test					
PEEP test					

Which tests and indices could be used ?

Passive leg raising test



Which tests and indices could be used ?

Passive leg raising test

Which tests and indices could be used ?

Passive leg raising test

Intensive Care Med
https://doi.org/10.1007/s00134-021-06506-y

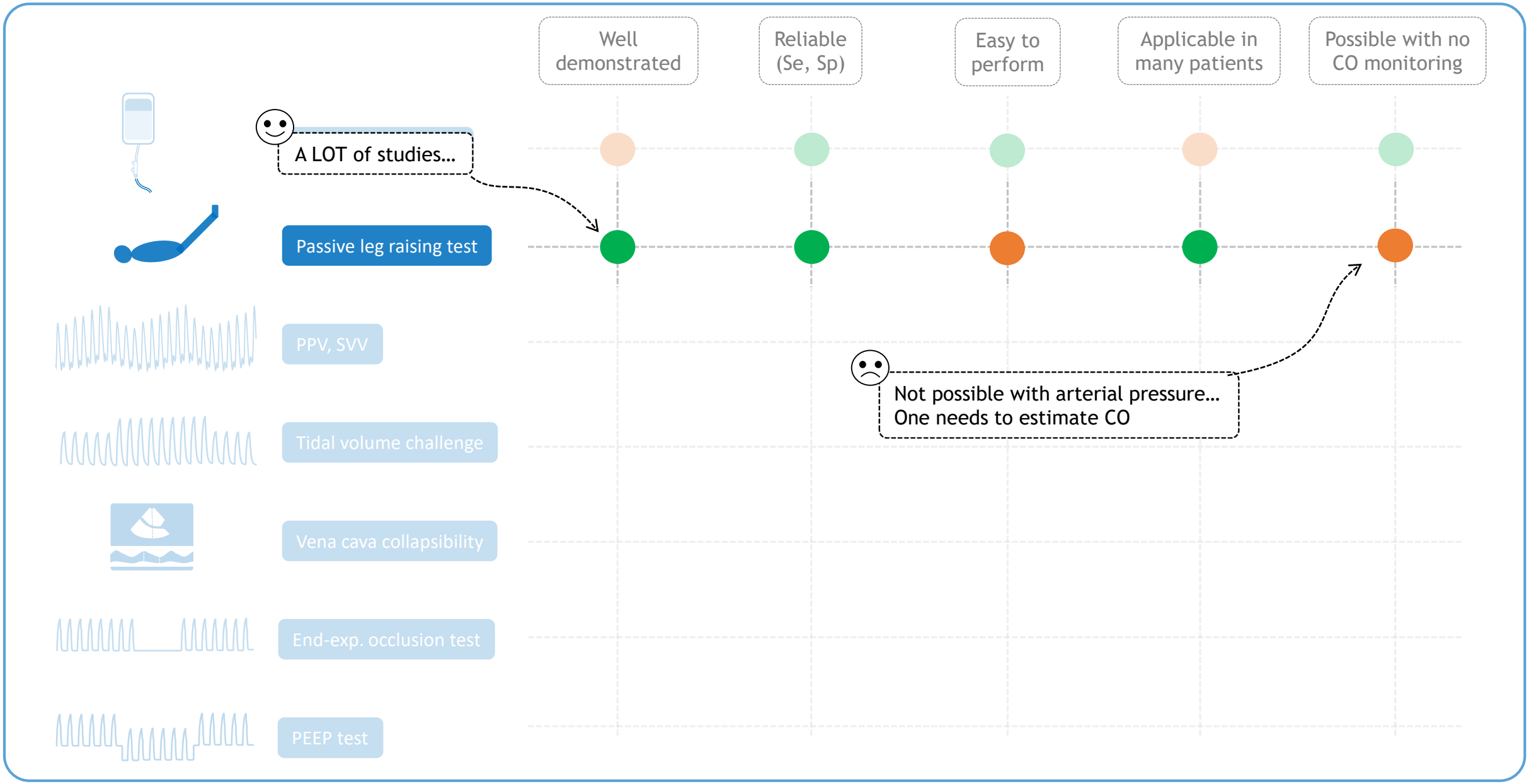
GUIDELINES

Surviving sepsis campaign: international guidelines for management of sepsis and septic shock 2021

Most patients require continued fluid administration following initial resuscitation. Such administration needs to be balanced with the risk of fluid accumulation and potential harm associated with fluid overload, in particular, prolong
kidney injury (AKI
most important p
patients is the nec
ongoing re-evaluat
avoid over- and un
beyond the initial
ful assessment of
perfusion. Heart
and systolic bloo
of fluid status. D
better diagnostic
siveness compare
measures include
diac output (CO)
stroke volume (S
and increases of S
racic pressure. In
dynamic assessme
with reduced mort
length of stay (MD
and duration of m
CI −5.08 to −0.89) [3]. Th
analysis, there was no significant difference in mortality between septic patients resuscitated with a volume

of fluid status. Dynamic measures have demonstrated better diagnostic accuracy at predicting fluid responsiveness compared with static techniques. Dynamic measures include passive leg raising combined with cardiac output (CO) measurement, fluid challenges against stroke volume (SV), systolic pressure or pulse pressure, and increases of SV in response to changes in intratho-

Which tests and indices could be used ? Passive leg raising test



Which tests and indices could be used ?

Passive leg raising test

Monnet and Teboul *Critical Care*
DOI 10.1186/s13054-014-0708-5

CRITICAL CARE

EDITORIAL

Passive leg raising: five rules, not a drop of fluid!

Xavier Monnet[1,2*] and Jean-Louis Teboul[1,2]

Changes in pulse pressure

Arterial pressure

Not that reliable

Which variables may be used ?

Which tests and indices could be used ?

Passive leg raising test

Monnet and Teboul *Critical Care*
DOI 10.1186/s13054-014-0708-5

CRITICAL CARE

EDITORIAL

Passive leg raising: five rules, not a drop of fluid!

Xavier Monnet[1,2*] and Jean-Louis Teboul[1,2]

Arterial pressure

Changes in pulse pressure

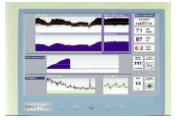
Changes in pulse contour-derived CO

PiCCO

EV 1000

Vigileo

LidCO rapid



Pulsioflex

Oeso Doppler

Changes in aortic blood flow

Arterial pressure

PPV

Plethysmography

Changes in perfusion index

Echo

Changes in VTI

Capnography

Changes in $EtCO_2$

Starling SV

Changes in CO

Which tests and indices could be used ?

Passive leg raising test

Taccheri et al. Crit Care (2021) 25:110
https://doi.org/10.1186/s13054-021-03515-7

Critical Care

RESEARCH Open Access

Do changes in pulse pressure variation and inferior vena cava distensibility during passive leg raising and tidal volume challenge detect preload responsiveness in case of low tidal volume ventilation?

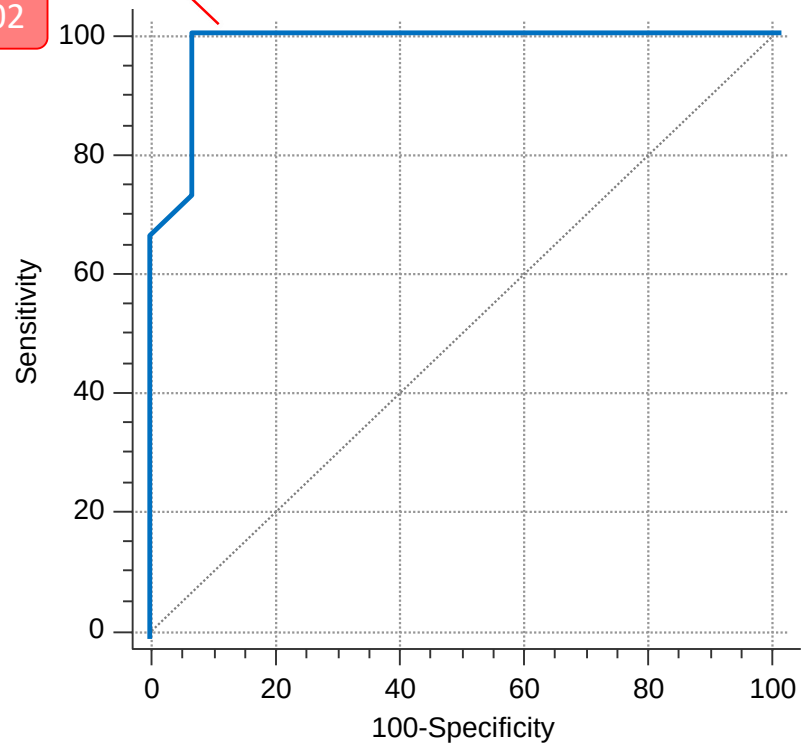
Temistocle Taccheri*, Francesco Gavelli, Jean-Louis Teboul, Rui Shi and Xavier Monnet

30 patients without SB nor arrhythmias

Assessing PLR and Vt challenge through PPV and IVC changes

↘PPV during PLR ≥ -2 pts

AUROC = 0.98 ± 0.02

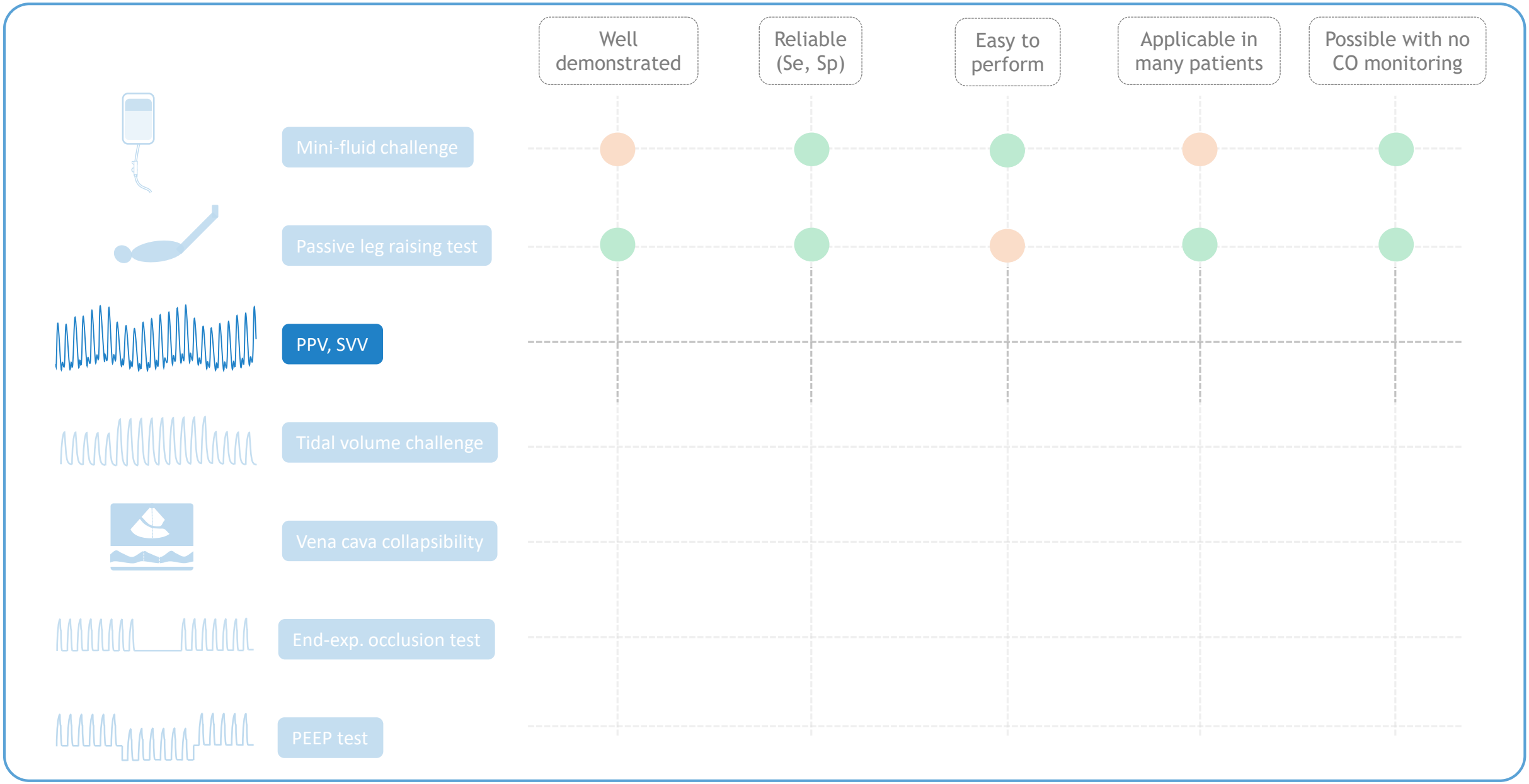


Which tests and indices could be used ?

Passive leg raising test

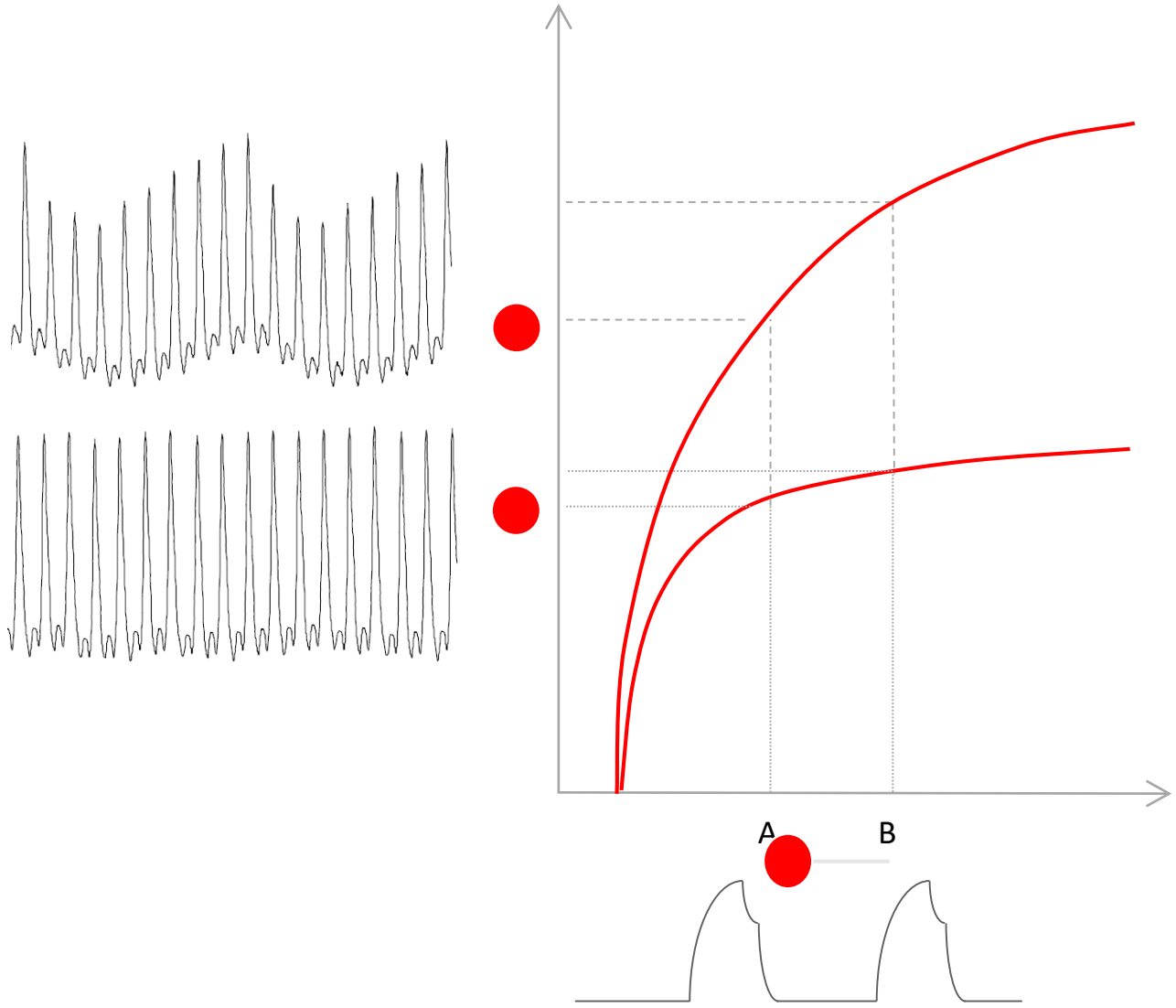
	Well demonstrated	Reliable (Se, Sp)	Easy to perform	Applicable in many patients	Possible with no CO monitoring
Mini-fluid challenge					
Passive leg raising test	●	●	●	●	●
PPV, SVV					
Tidal volume challenge					
Vena cava collapsibility					
End-exp. occlusion test					
PEEP test					

Which tests and indices could be used ? PPV, SVV



Which tests and indices could be used ?

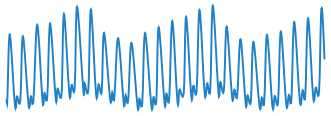
PPV, SVV



Which tests and indices could be used ? PPV, SVV

Mini-fluid challenge

Passive leg raising test

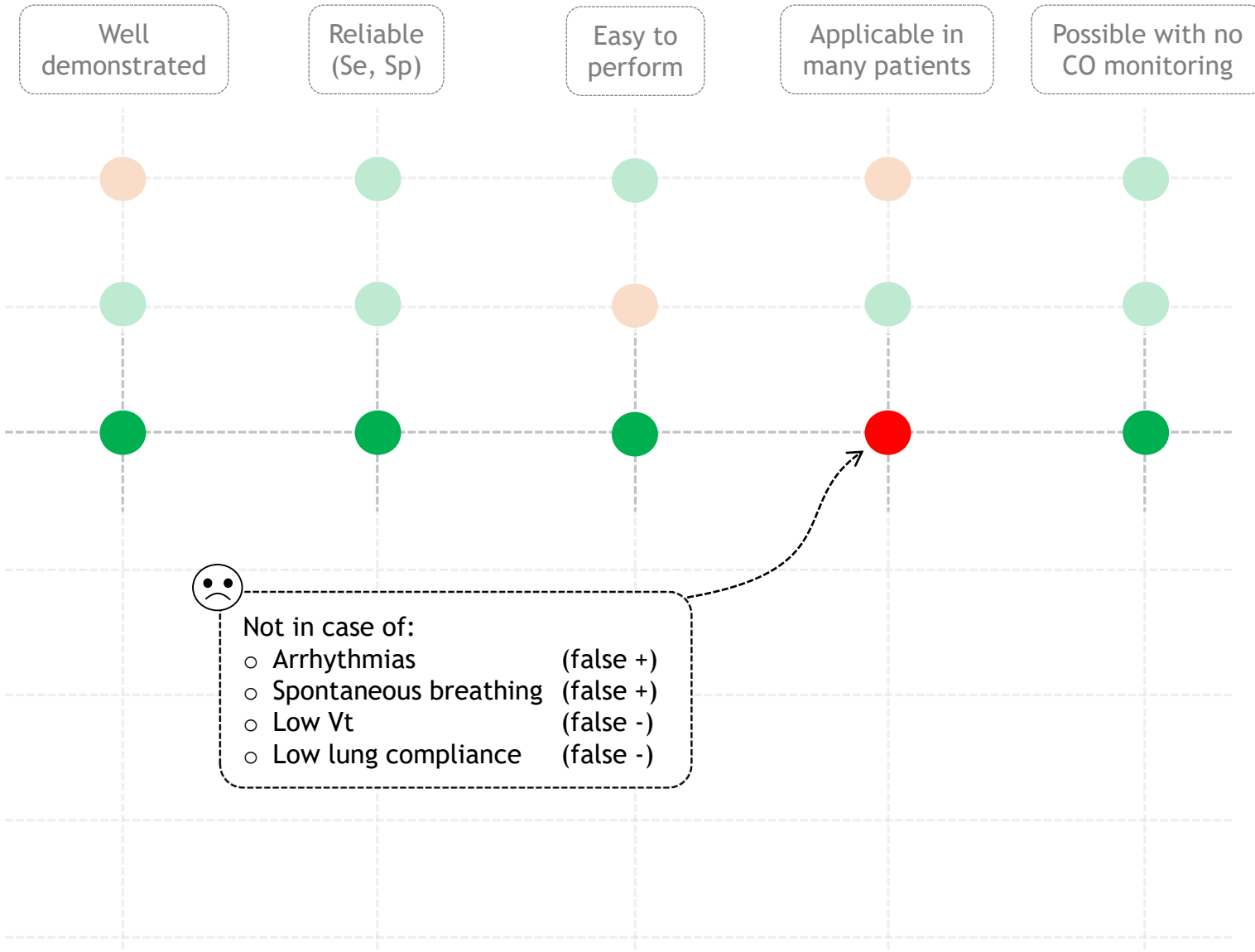

PPV, SVV

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test

PEEP test



Which tests and indices could be used ?

Tidal volume challenge

Which tests and indices could be used ?

Tidal volume challenge

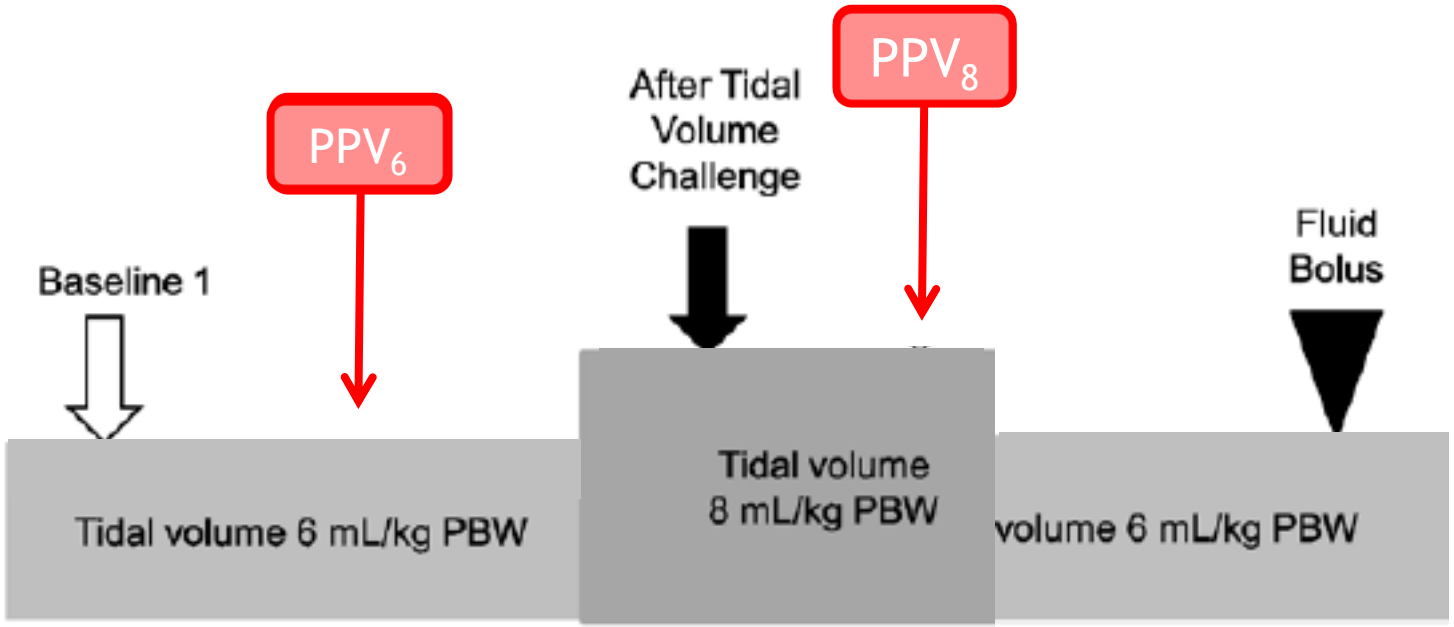
The Changes in Pulse Pressure Variation or Stroke Volume Variation After a "Tidal Volume Challenge" Reliably Predict Fluid Responsiveness During Low Tidal Volume Ventilation* *Crit Care Med* 2017

Sheila Nainan Myatra, MD, FCCM[1]; Natesh R Prabu, MD, DM[1]; Jigeeshu Vasishtha Divatia, MD, FCCM[1]; Xavier Monnet, MD, PhD[2]; Atul Prabhakar Kulkarni, MD, FICCM[1]; Jean-Louis Teboul, MD, PhD[2]

30 measurements in 20 pts

Increase in Vt from 6 to 8 mL/kg

$\Delta PPV = (PPV_8 - PPV_6)$



Which tests and indices could be used ?

Tidal volume challenge

	Well demonstrated	Reliable (Se, Sp)	Easy to perform	Applicable in many patients	Possible with no CO monitoring
Mini-fluid challenge	●	●	●	●	●
Passive leg raising test	●	●	●	●	●
PPV, SVV	●	●	●	●	●
Tidal volume challenge	●	●	●	●	●
Vena cava collapsibility	●	●	●	●	●
End-exp. occlusion test	●	●	●	●	●
PEEP test	●	●	●	●	●

No so many studies

Which tests and indices could be used ?

Tidal volume challenge

The Changes in Pulse Pressure Variation or Stroke Volume Variation After a "Tidal Volume Challenge" Reliably Predict Fluid Responsiveness During Low Tidal Volume Ventilation* *Crit Care Med* 2017

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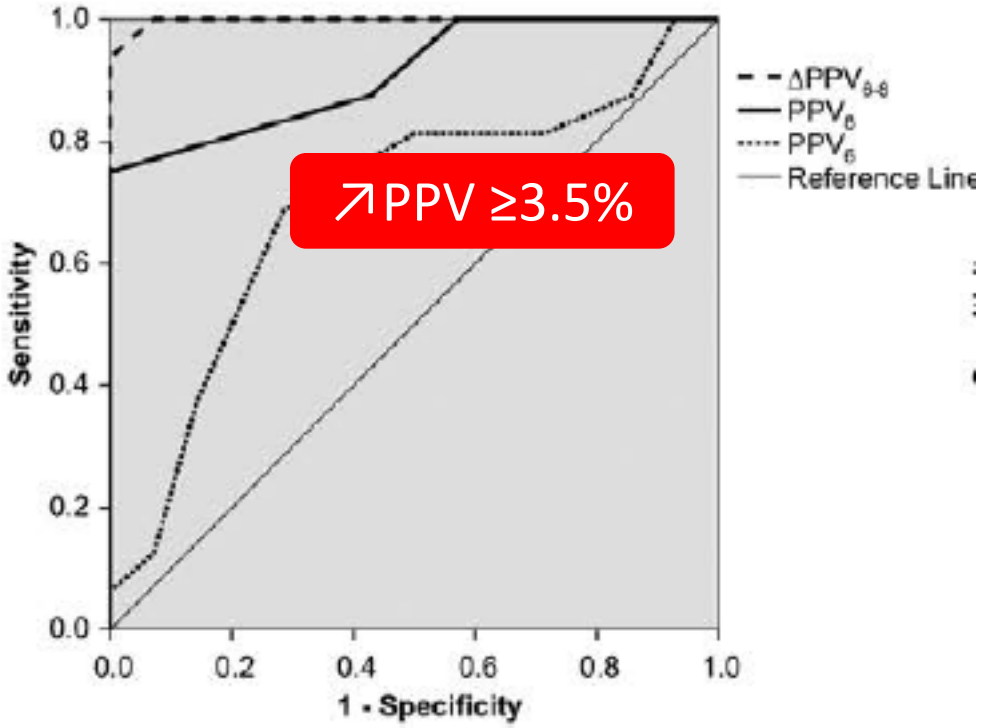


↗PPV ≥3.5%

Which tests and indices could be used ?

Tidal volume challenge

Wang et al. Critical Care (2023) 27:45
https://doi.org/10.1186/s13054-023-04336-6

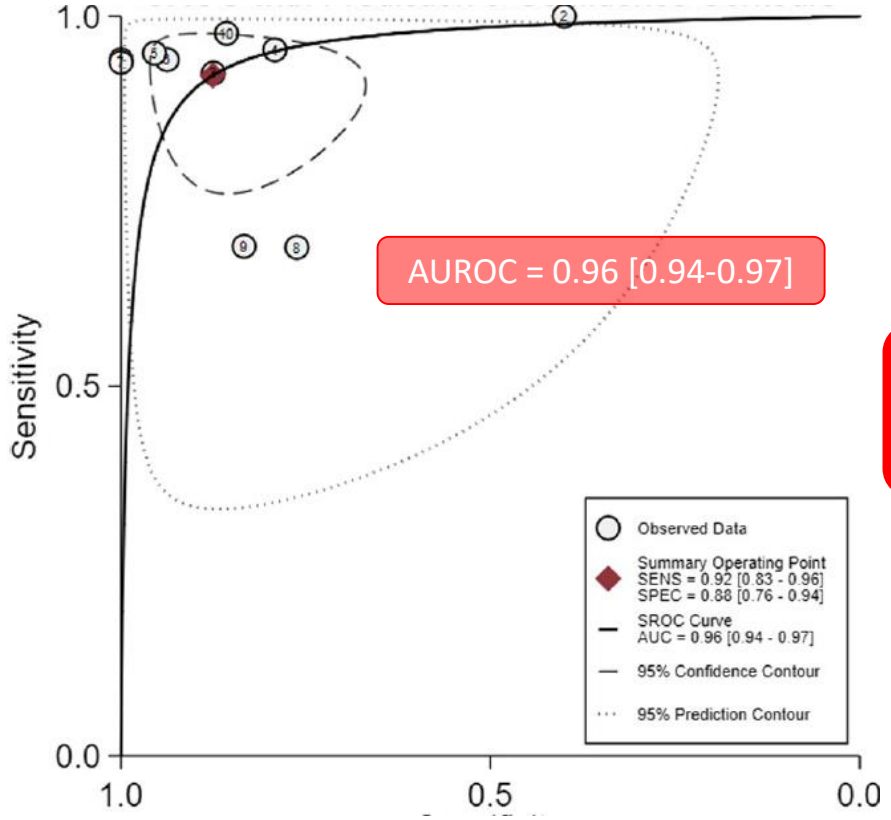
Critical Care

RESEARCH Open Access

Does tidal volume challenge improve the feasibility of pulse pressure variation in patients mechanically ventilated at low tidal volumes? A systematic review and meta-analysis

Xiaoying Wang[1*], Shuai Liu[2], Ju Gao[1], Yang Zhang[1] and Tianfeng Huang[1]

10 studies
457 measurements

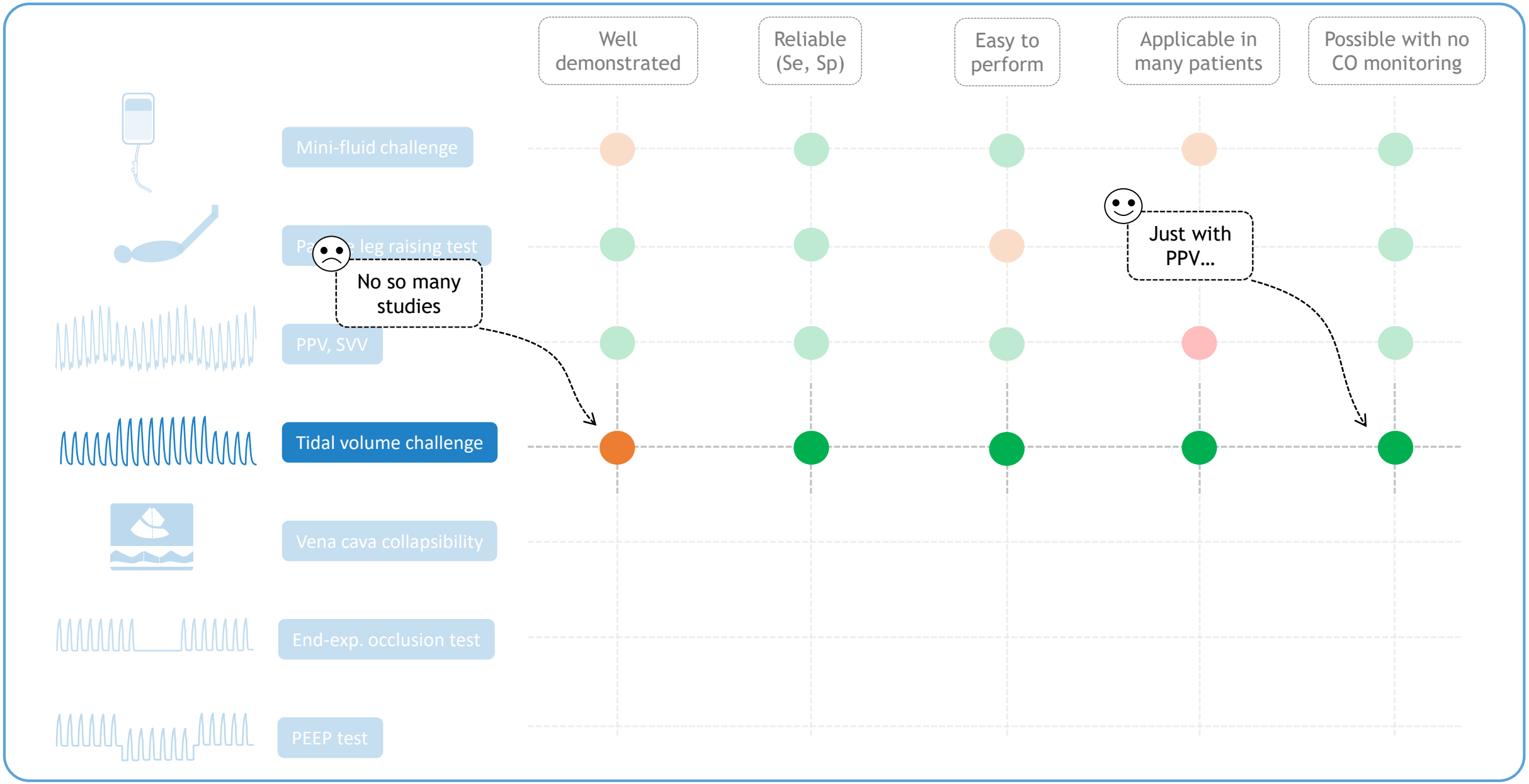


AUROC = 0.96 [0.94-0.97]

↗ $PPV_{(abs)}$ ≥ 2% (ranging from 1 to 3.5%)
↗ $PPV_{(\%)}$ ≥ 25% (ranging from 25 to 48%)

Which tests and indices could be used ?

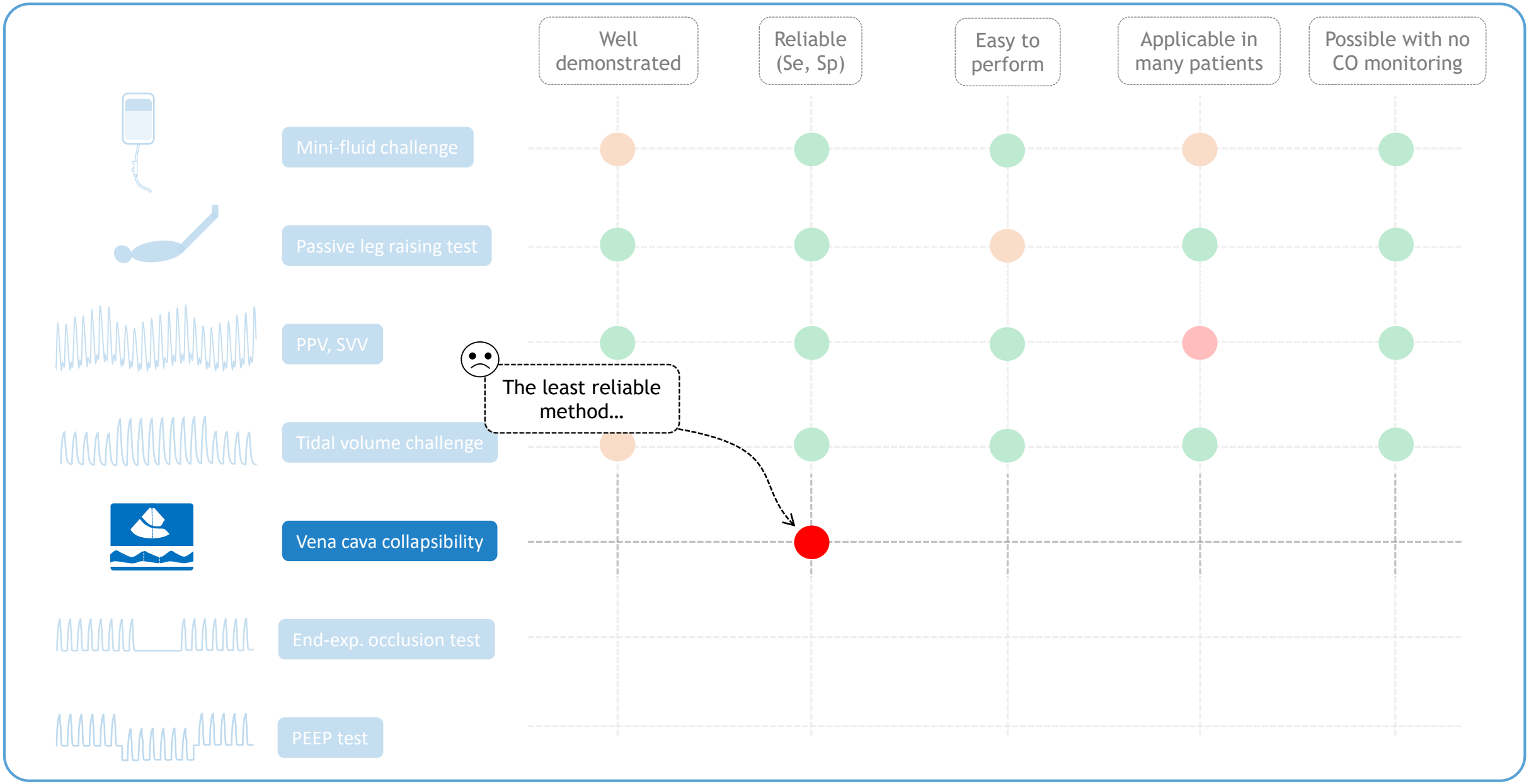
Tidal volume challenge



Which tests and indices could be used ?

Vena cava collapsibility

JRUR 2023
19ème Journée de Réanimation & Urgences Respiratoires
JEUDI 6 AVRIL
Faculté de Médecine, Marseille



Which tests and indices coud be used ?

Vena cava collapsibility

SHOCK, Vol. 47, No. 5, pp. 550–559, 2017

Review Article

DOES RESPIRATORY VARIATION IN INFERIOR VENA CAVA DIAMETER PREDICT FLUID RESPONSIVENESS: A SYSTEMATIC REVIEW AND META-ANALYSIS

Elliot Long,*†‡ Ed Oakley,*†‡ Trevor Duke,†‡§ and Franz E. Babl*†‡, on behalf of the Paediatric Research in Emergency Departments International Collaborative (PREDICT)

EJA

Eur J Anaesthesiol 2018; **35**:1–11

ORIGINAL ARTICLE

Diagnostic accuracy of inferior vena caval respiratory variation in detecting fluid unresponsiveness

A systematic review and meta-analysis

Saurabh K. Das, Nang S. Choupoo, Debasis Pradhan, Priyam Saikia and Xavier Monnet

ELSEVIER

http://dx.doi.org/10.1016/j.ultrasmedbio.2013.12.010

Review

ULTRASONOGRAPHIC MEASUREMENT OF THE RESPIRATORY VARIATION IN THE INFERIOR VENA CAVA DIAMETER IS PREDICTIVE OF FLUID RESPONSIVENESS IN CRITICALLY ILL PATIENTS: SYSTEMATIC REVIEW AND META-ANALYSIS

RESEARCH Open Access

Value of variation index of inferior vena cava diameter in predicting fluid responsiveness in patients with circulatory shock receiving mechanical ventilation: a ...iew and meta-analysis

...Liu, Hua Xu and Yixin Fang

Accuracy of Ultrasonographic Measurements of Inferior Vena Cava to Determine Fluid Responsiveness: A Systematic Review and Meta-Analysis

Daniele Orso, MD, Irene Paoli, MD, Tommaso Piani, RN, Francesco L. Cilenti, RN, Lorenzo Cristiani, RN, Nicola Guglielmo, MD

Show less

First Published January 17, 2018 | Research Article | Check for updates

https://doi.org/10.1177/0885066617752308

Anesthesia & Analgesia. 127(5):1157–1164, NOV 2018

DOI: 10.1213/ANE.0000000000003459, PMID: 29787412

Issn Print: 0003-2999

Publication Date: 2018/11/01

Print

Does Respiratory Variation in Inferior Vena Cava Diameter Predict Fluid Responsiveness in Mechanically Ventilated Patients? A Systematic Review and Meta-analysis

Xiang Si;Hailin Xu;Zimeng Liu;Jianfeng Wu;Daiyin Cao;Juan Chen;Minying Chen;Yongjun Liu;Xiangdong Guan;

‘Disappointing’ meta-analyses

Large negative study

Comparison of Echocardiographic Indices Used to Predict Fluid Responsiveness in Ventilated Patients

Philippe Vignon[1,2,3], Xavier Repessé[4*], Emmanuelle Bégot[1,2*], Julie Léger[5], Christophe Jacob[6], Koceila Bouferrache[7], Michel Slama[8], Gwenaël Prat[6], and Antoine Vieillard-Baron[4,9,10]

Am J Respir Crit Care Med Vol 2017

[1]Medical-Surgical Intensive Care Unit and [2]INSERM CIC 1435, Limoges University Hospital, Limoges, France; [3]Faculty of Medicine, University of Limoges, Limoges, France; [4]Intensive Care Unit, Assistance Publique-Hôpitaux de Paris, University Hospital Ambroise Paré, Boulogne-Billancourt, France; [5]INSERM CIC 1415, Tours University Hospital, Tours, France; [6]Medical Intensive Care Unit, Brest University Hospital, Brest, France; [7]Medical-Surgical Intensive Care Unit, Foch Hospital, Paris, France; [8]Medical Intensive Care Unit, Amiens University Hospital, Amiens, France; [9]Faculty of Medicine Paris Ile-de-France Ouest, University of Versailles Saint-Quentin en Yvelines, Saint-Quentin en Yvelines, France; and [10]INSERM U-1018, CESP, Team 5, University of Versailles Saint-Quentin en Yvelines, Villejuif, France

Which tests and indices could be used ?

Vena cava collapsibility

JRUR 2023
19ème Journée de Réanimation & Urgences Respiratoires
JEUDI 6 AVRIL
Faculté de Médecine, Marseille

Comparison of Echocardiographic Indices Used to Predict Fluid Responsiveness in Ventilated Patients

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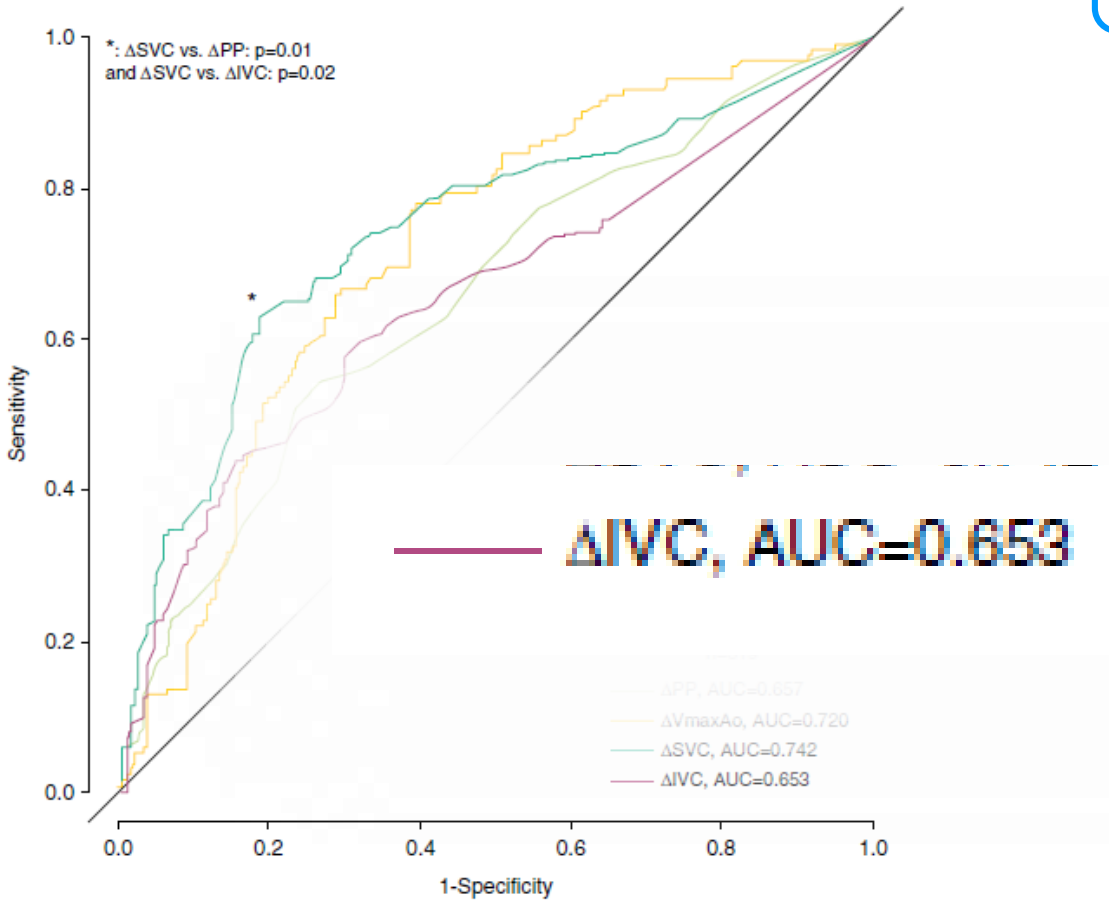
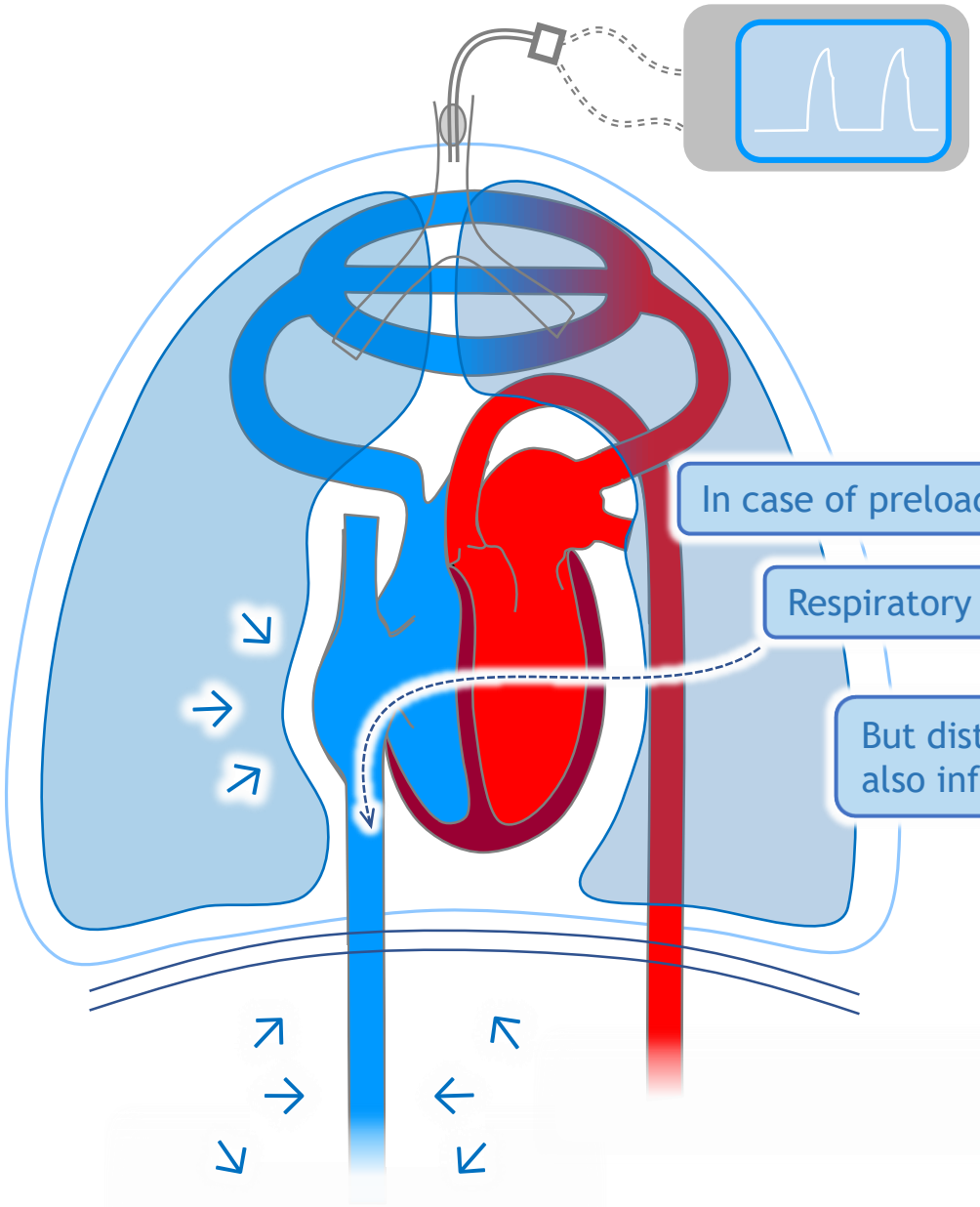
540 pts

Ability to detect preload responsiveness (positibve PLR test)



Which tests and indices could be used ?

Vena cava collapsibility



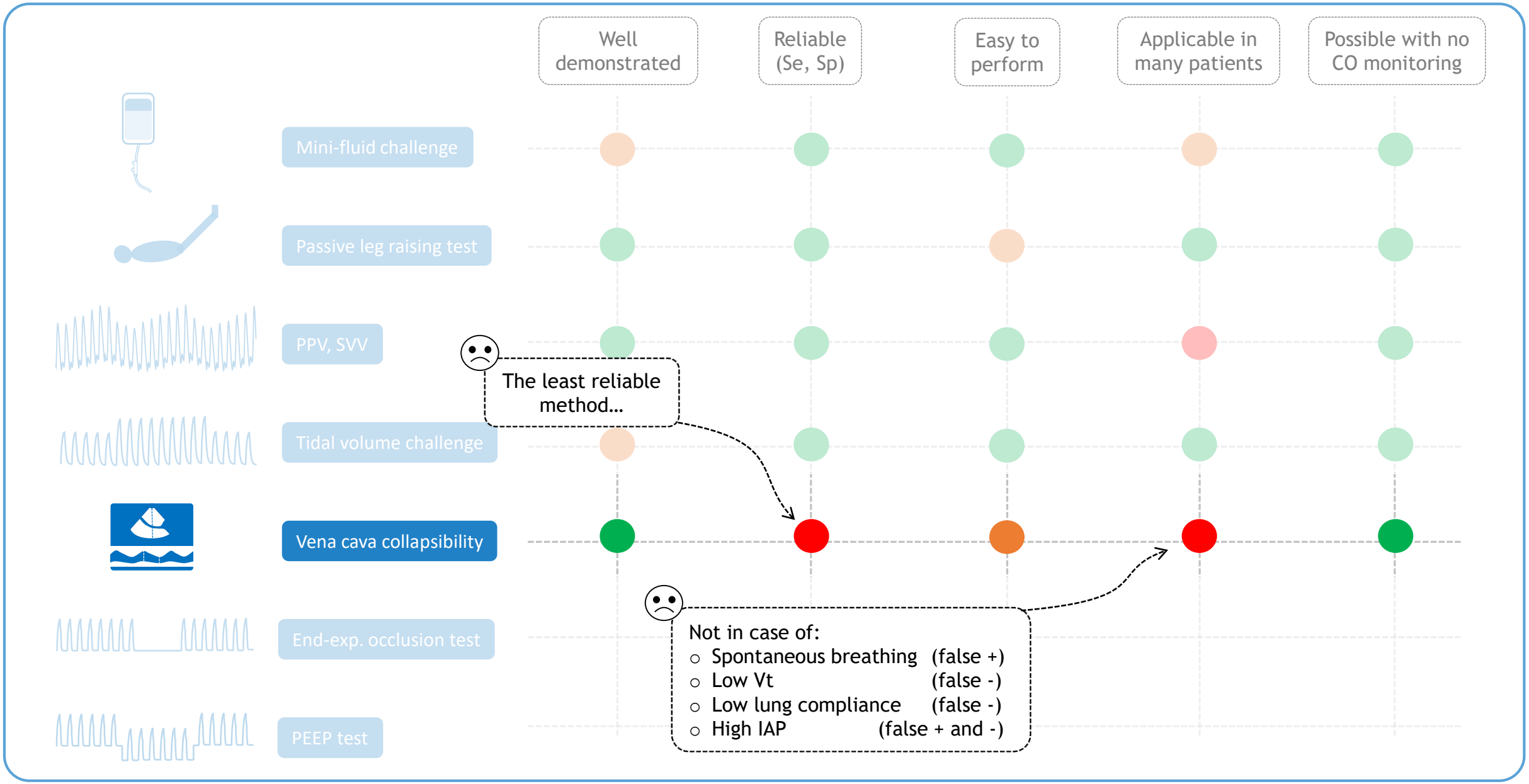
In case of preload responsiveness

Respiratory variations of CVP

But distensibility of the IVC is also influenced by :

- IAP
- Vein compliance
- Blood volume
- ...

Which tests and indices could be used ?



Which tests and indices could be used ?

Mini-fluid challenge

Passive leg raising test

PPV, SVV

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test

PEEP test

Well demonstrated	Reliable (Se, Sp)	Easy to perform	Applicable in many patients	Possible with no CO monitoring
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
		●		

Which tests and indices could be used ?

End-exp. occlusion test

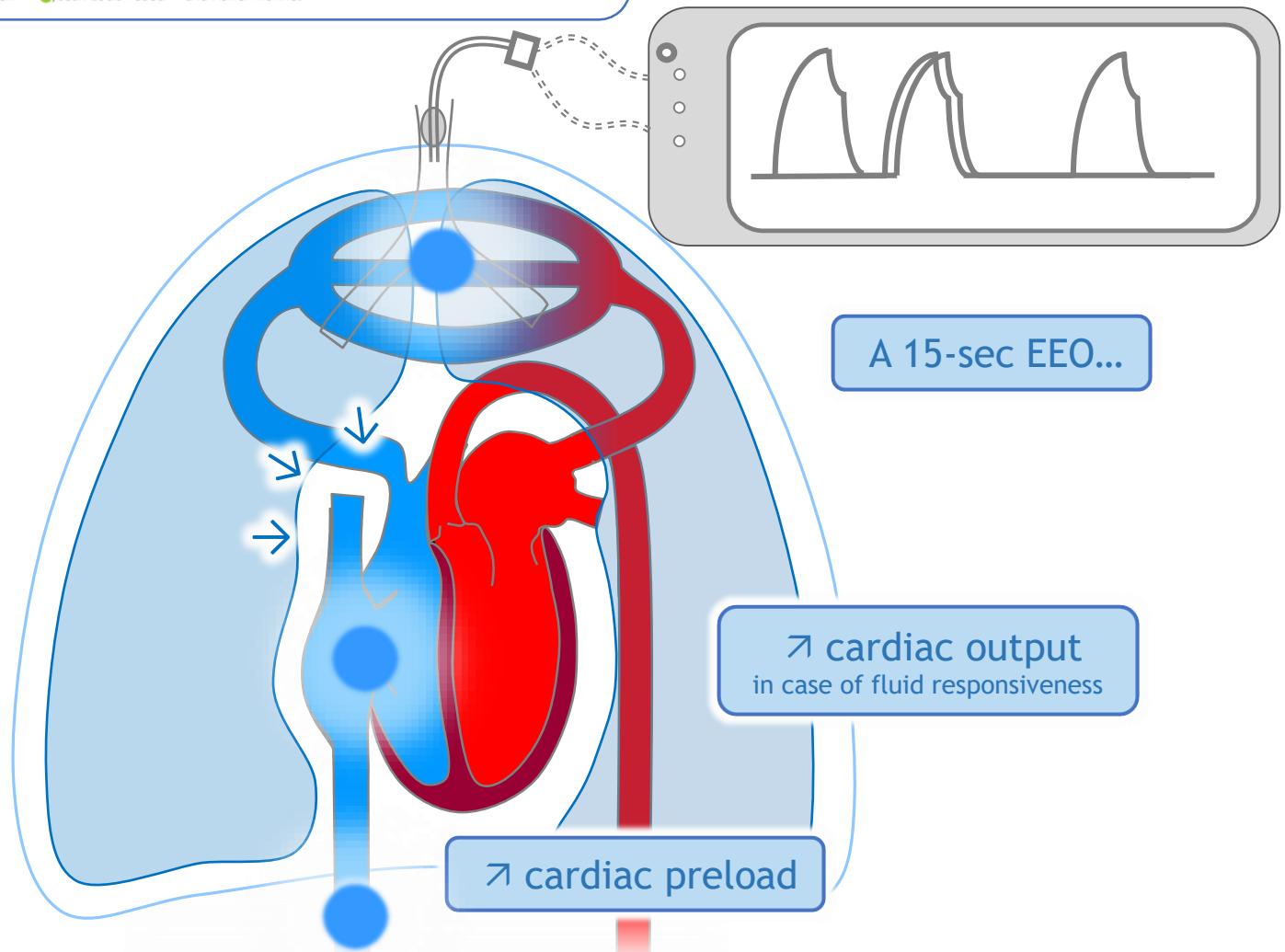
Gavelli *et al. Critical Care* (2019) 23:274
https://doi.org/10.1186/s13054-019-2554-y

Critical Care

EDITORIAL Open Access

The end-expiratory occlusion test: please, let me hold your breath!

Francesco Gavelli[1,2,3*], Jean-Louis Teboul[1,2] and Xavier Monnet[1,2]



A 15-sec EEO…

↗ cardiac output
in case of fluid responsiveness

↗ cardiac preload

Which tests and indices could be used ?

Mini-fluid challenge

Passive leg raising test

PPV, SVV

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test

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●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●
●	●	●	●	●

Many studies

Which tests and indices could be used ?

End-exp. occlusion test

Gavelli et al. Ann. Intensive Care (2020) 10:65
https://doi.org/10.1186/s13613-020-00682-8

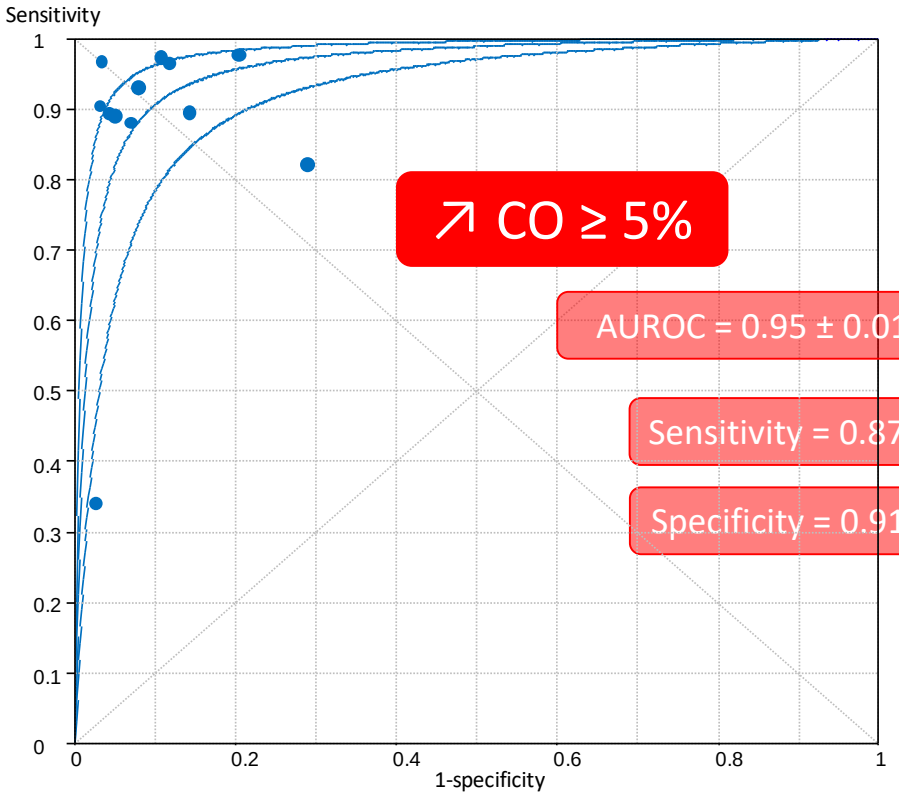
Annals of Intensive Care

RESEARCH Open Access

The end-expiratory occlusion test for detecting preload responsiveness: a systematic review and meta-analysis

Francesco Gavelli[1,2,3*], Rui Shi[1,2], Jean-Louis Teboul[1,2], Danila Azzolina[4] and Xavier Monnet[1,2]

13 studies
530 patients



↗ CO ≥ 5%

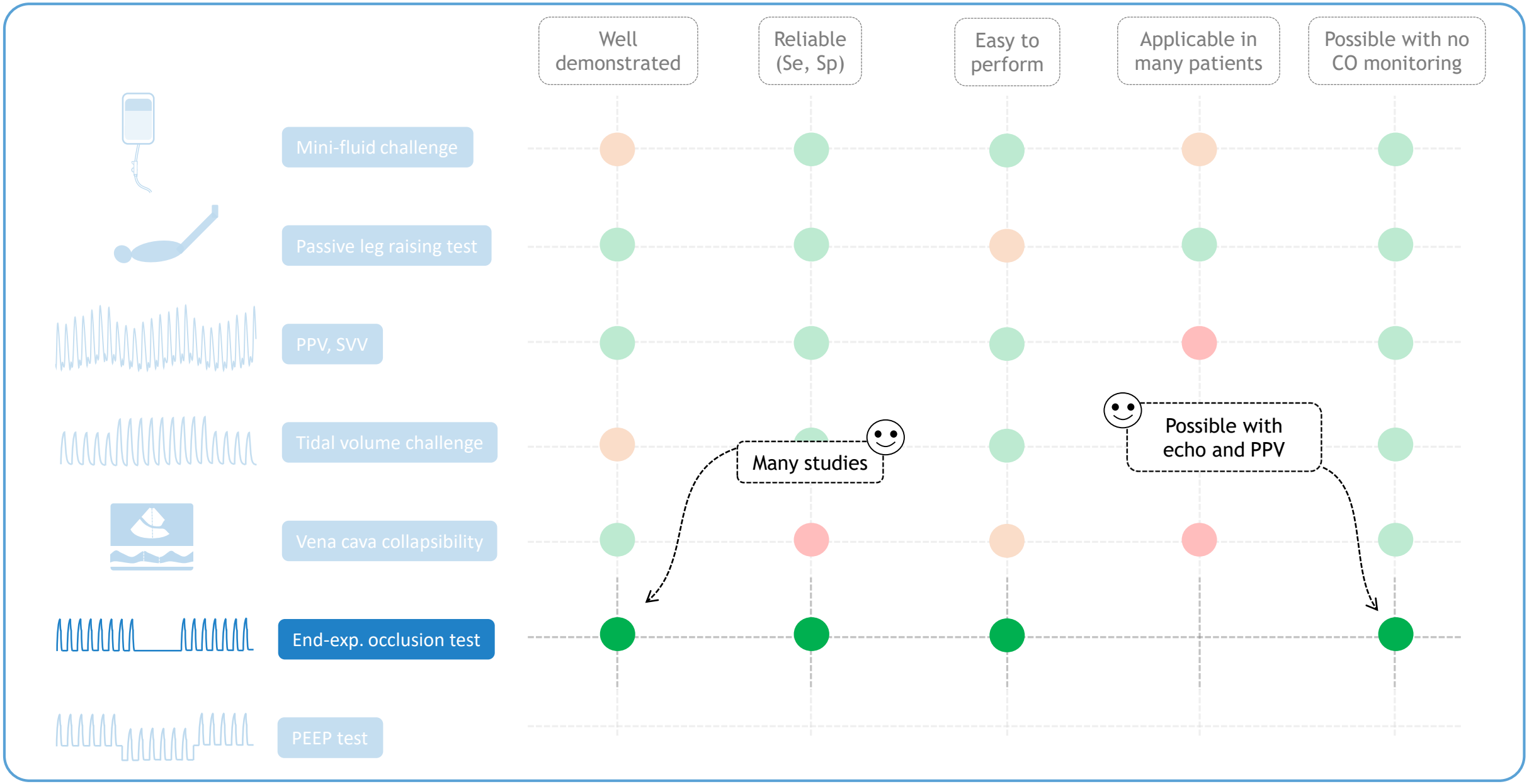
AUROC = 0.95 ± 0.01

Sensitivity = 0.87 (0.82-0.91)

Specificity = 0.91 (0.87-0.94)

Which tests and indices could be used ?

End-exp. occlusion test



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End-exp. occlusion test

Gavelli *et al. Critical Care* (2019) 23:274
https://doi.org/10.1186/s13054-019-2554-y

Critical Care

EDITORIAL Open Access

The end-expiratory occlusion test: please, let me hold your breath!

Francesco Gavelli[1,2,3*], Jean-Louis Teboul[1,2] and Xavier Monnet[1,2]

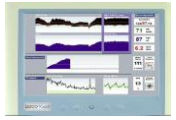
Changes in pulse contour-derived CO

PiCCO

EV 1000

Vigileo

LidCO rapid



Pulsioflex

Which tests and indices coud be used ? | End-exp. occlusion test | How to assess its effects ?

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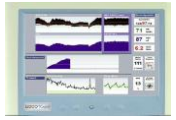


Pulsioflex

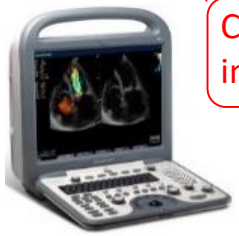
Changes in aortic blood flow

Oeso Doppler

Plethysmography

Changes in perfusion index

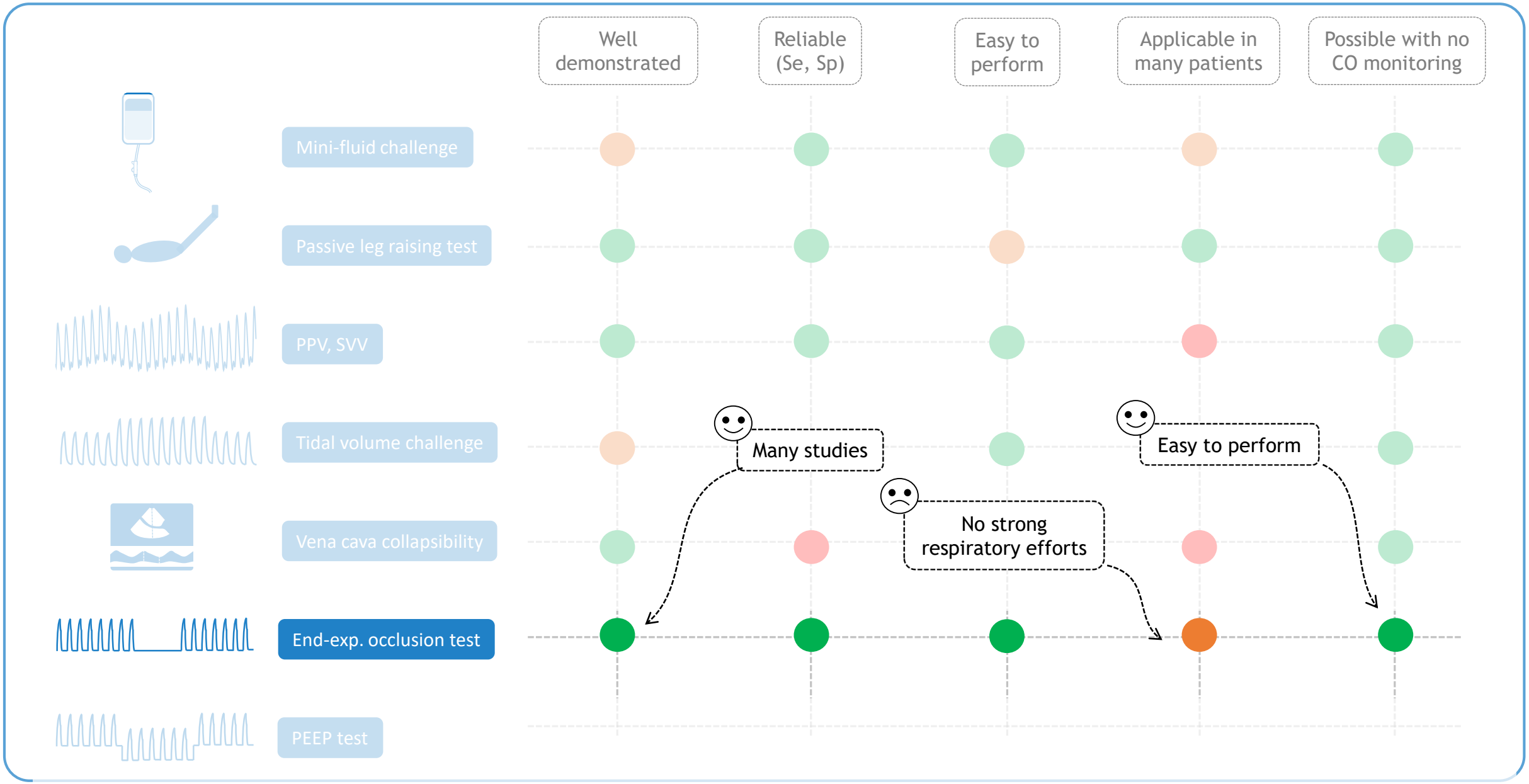
Echo



Changes in VTI

JRUR 2023
10ème Journée de Réanimation & Urgences Respiratoires
JEUDI 6 AVRIL
Faculté de Médecine, Marseille

Which tests and indices could be used ?



Which tests and indices could be used ?

Mini-fluid challenge

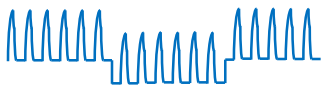
Passive leg raising test

PPV, SVV

Tidal volume challenge

Vena cava collapsibility

End-exp. occlusion test



PEEP test

Well demonstrated	Reliable (Se, Sp)	Easy to perform	Applicable in many patients	Possible with no CO monitoring

Which tests and indices could be used ?

PEEP test

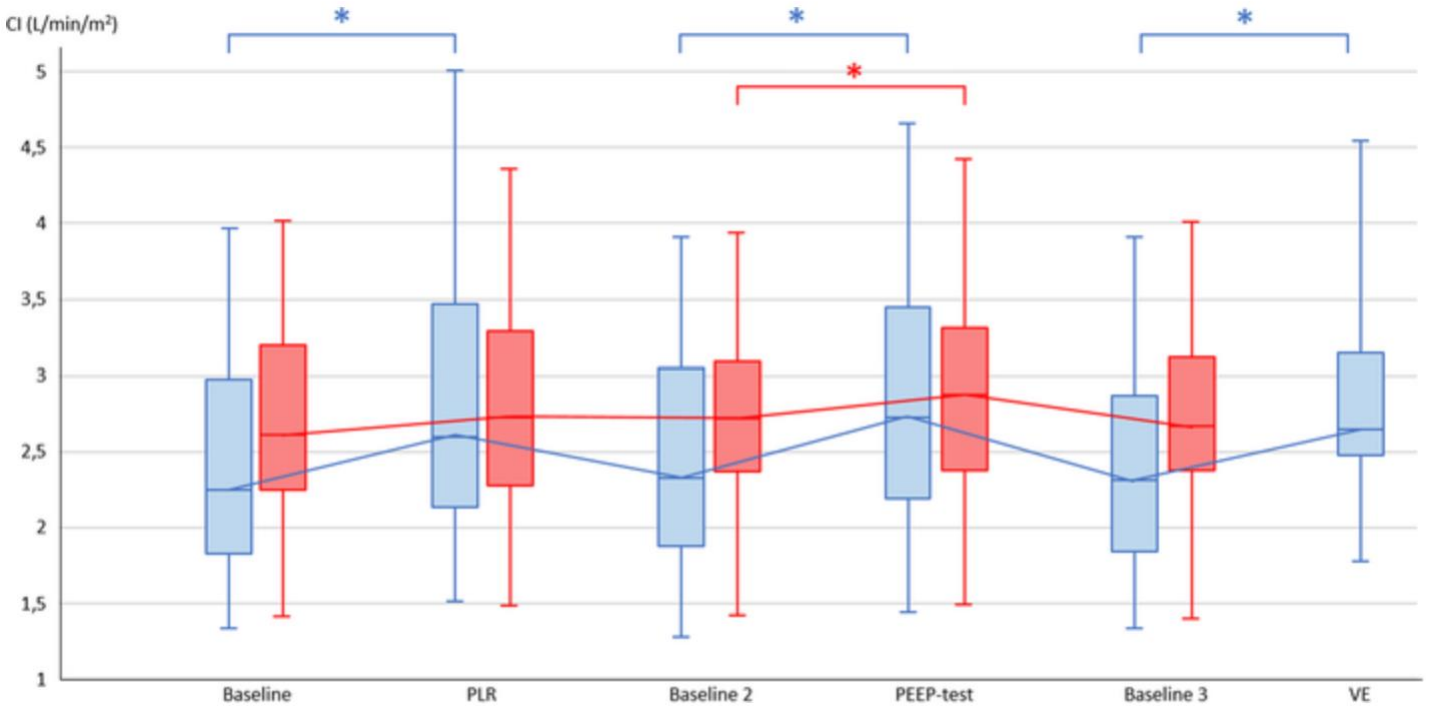
In press Critical Care

The increase in cardiac output induced by a decrease in positive end-expiratory pressure reliably detects volume responsiveness: the PEEP-test study

Christopher Lai, Rui Shi, Alexandra Beurton, Francesca Moretto, Soufia Ayed, Nicolas Fage, Francesco Gavelli, Arthur Pavot, Martin Dres, Jean-Louis Teboul, Xavier Monnet,

64 patients

Decrease in PEEP from 12 to 5 cmH_2O



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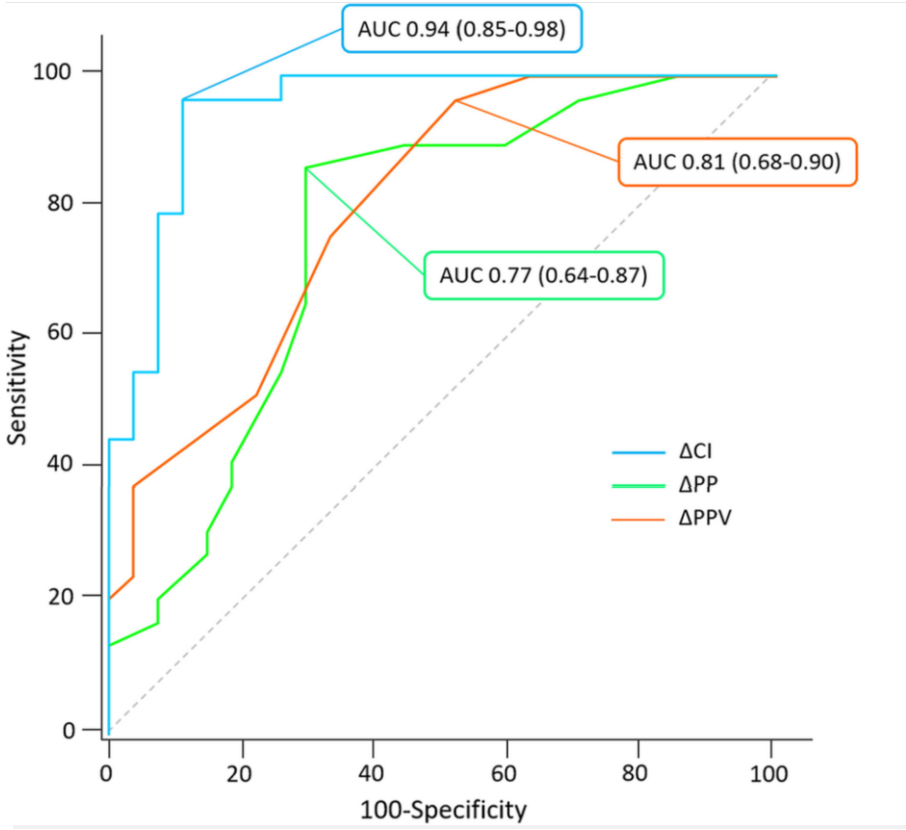

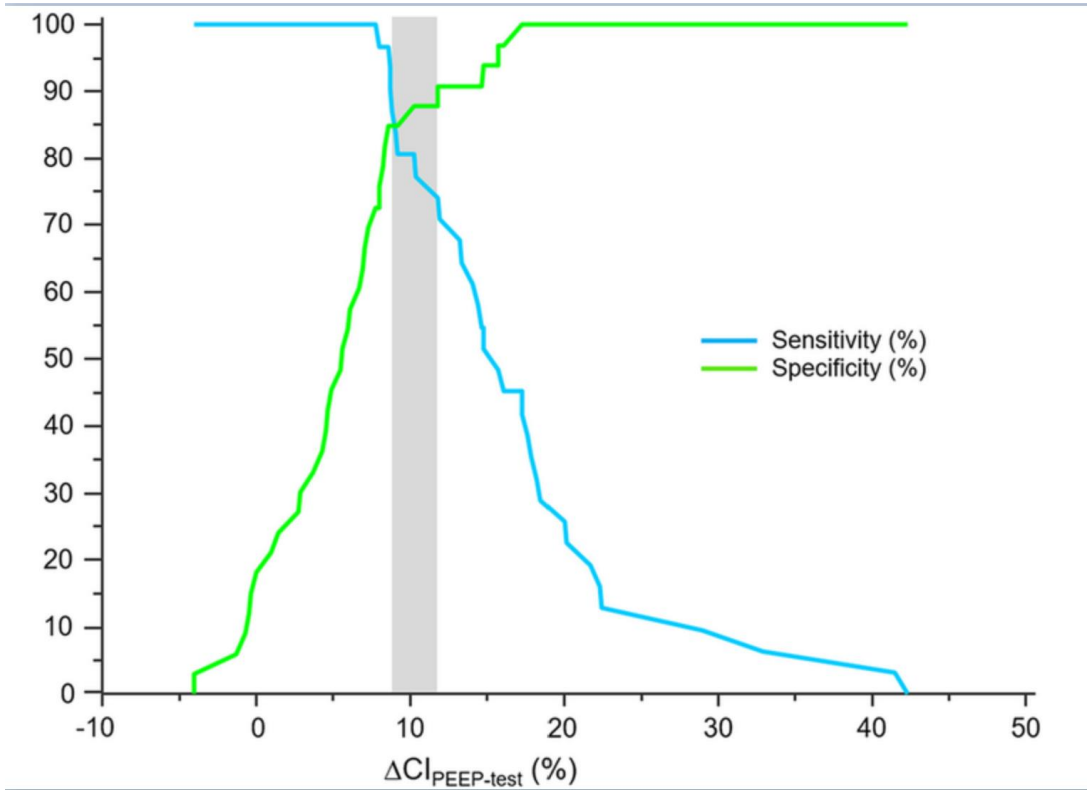

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End-exp. occlusion test

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Prédiction de la réponse au remplissage vasculaire

20 ans de recherche clinique

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FHU SEPSIS Personalized Interventions

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