Něco na tom CVP je...

Jan Beneš
KARIM LFP UK a FN Plzen
Simulační centrum (SIM/PL) - LFP UK
Biomedicínské centrum LFP UK
SepsEast initiative

SepsEast
Central and Eastern European Sepsis Forum

FAKULTNÍ NEMOCNICE PLZEŇ

Univerzita Karlova

SIM PL

LÉKAŘSKÁ FAKULTA V PLZNI
UNIVERZITA KARLOVA

BIOMEDICÍNSKÉ CENTRUM

C-O-I

- Dlouhodobá spolupráce (incl. speaker-fee nebo konzultace) s
  - Edwards Lifesciences Inc.
  - CNSystems Graz
  - Pulsion Munich / Getinge

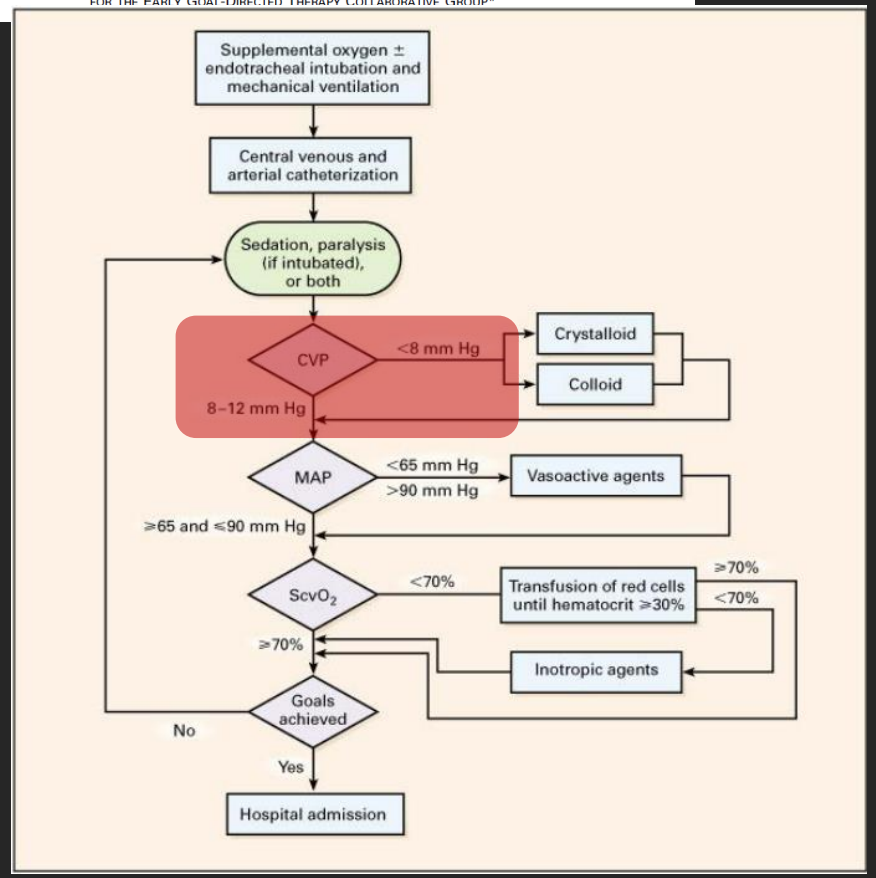
IF ONLY I HAD THE LECTURE 20 YEARS AGO...

2001

The New England Journal of Medicine

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

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



2004

Intensive Care Med (2004) 30:536–555
DOI 10.1007/s00134-004-2210-z

SPECIAL ARTICLE

R. Phillip Dellinger
Jean M. Carlet
Henry Masur
Herwig Gerlach
Thierry Calandra
Jonathan Cohen
Juan Gea-Banacloche
Didier Keh
John C. Marshall
Margaret M. Parker
Graham Ramsay
Janice L. Zimmerman
Jean-Louis Vincent
M. M. Levy

Surviving Sepsis Campaign guidelines for management of severe sepsis and septic shock

A. Initial resuscitation

1. The resuscitation of a patient in severe sepsis or sepsis-induced tissue hypoperfusion (hypotension or lactic acidosis) should begin as soon as the syndrome is recognized and should not be delayed pending ICU admission. An elevated serum lactate level identifies tissue hypoperfusion in patients at risk who are not hypotensive. During the first 6 h of resuscitation, the goals of initial resuscitation of sepsis-induced hypoperfusion should include all of the following as one part of a treatment protocol:

- Central venous pressure (CVP) 8–12 mmHg
- Mean arterial pressure (MAP) ≥65 mmHg
- Urine output ≥0.5 ml/kg h^{-1}
- Central venous (superior vena cava) or mixed venous oxygen saturation ≥70%.

Grade B.

status. In mechanically ventilated patients a higher target CVP of 12–15 mmHg is recommended to account for the increased intrathoracic pressure. Similar considerations

CVP MŮŽE (MÁ) SLOUŽIT

JAKO INDIKÁTOR (pod limitem)

A CÍL (8-12/12-15 mmHg)

TEKUTINOVÉ LÉČBY

+ UMOŽŇUJE MONITORACI $ScvO_2$

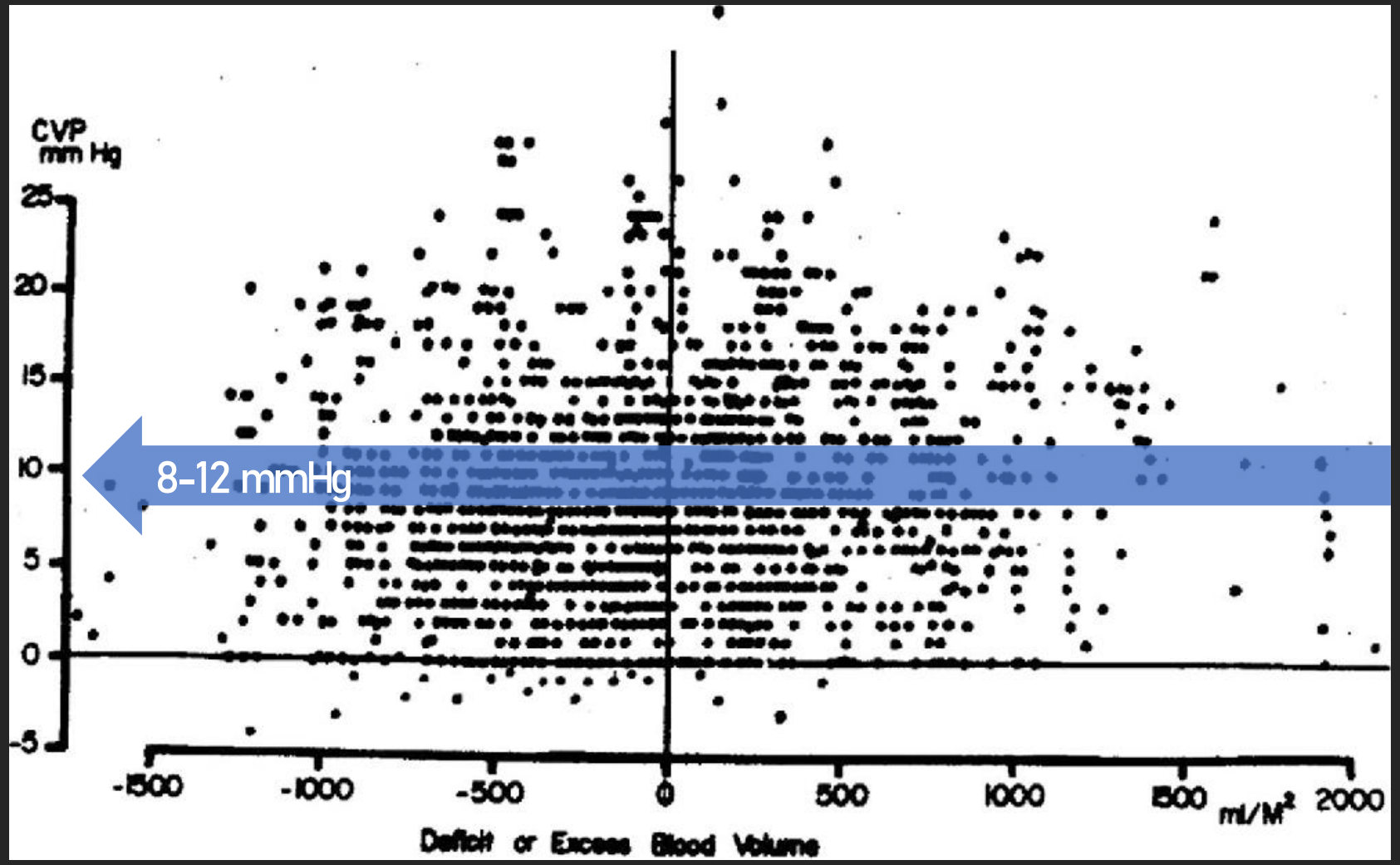
S CÍLEM MANIPULACE DODÁVKY O_2

Does Central Venous Pressure Predict Fluid Responsiveness?*: A Systematic Review of the Literature and the Tale of Seven Mares

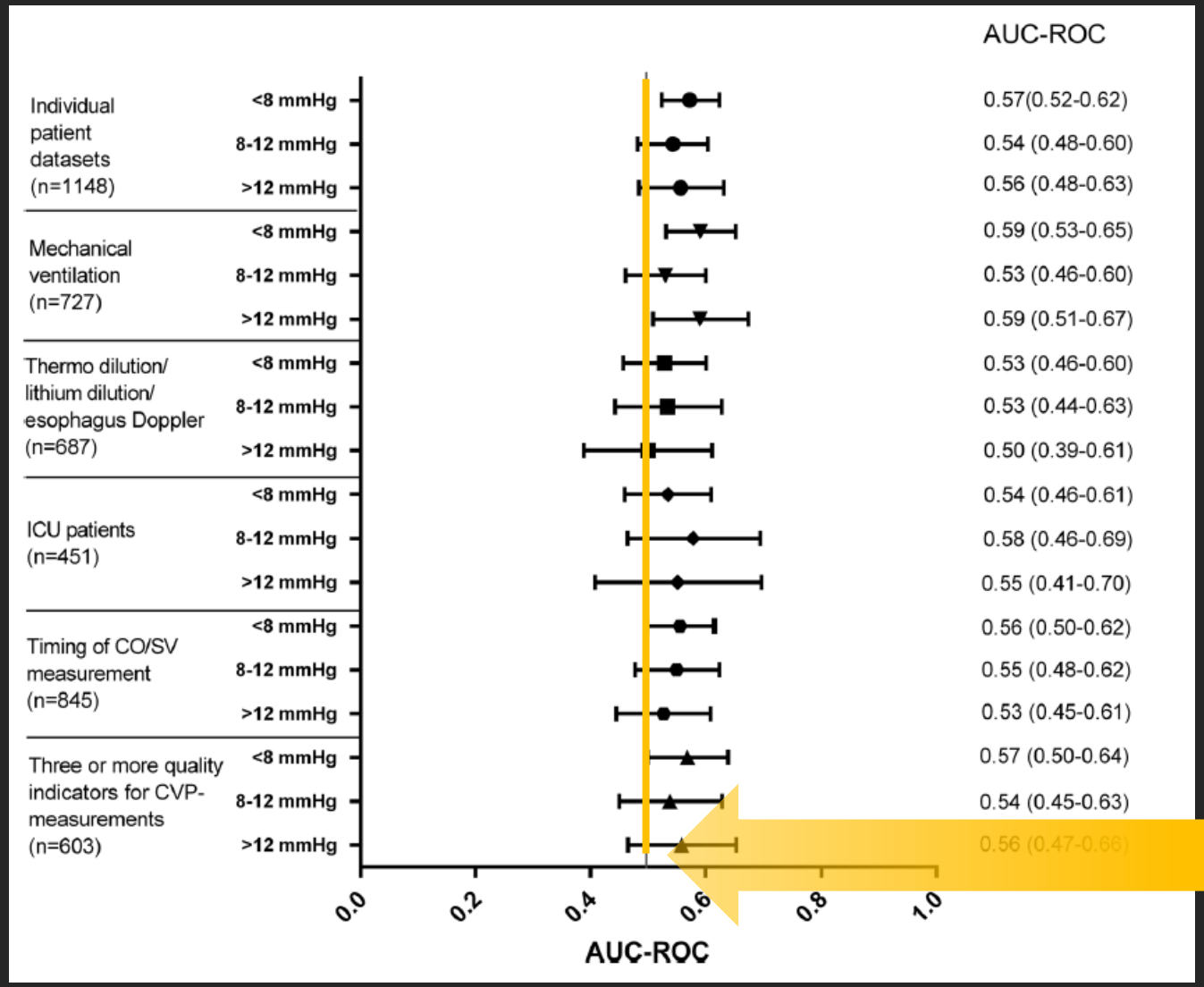
Paul E. Marik, MD, FCCP • Michael Baram, MD, FCCP • Bobbak Vahid, MD

DOI: https://doi.org/10.1378/chest.07-2331

2008



PRELOAD RESPONSIVENESS

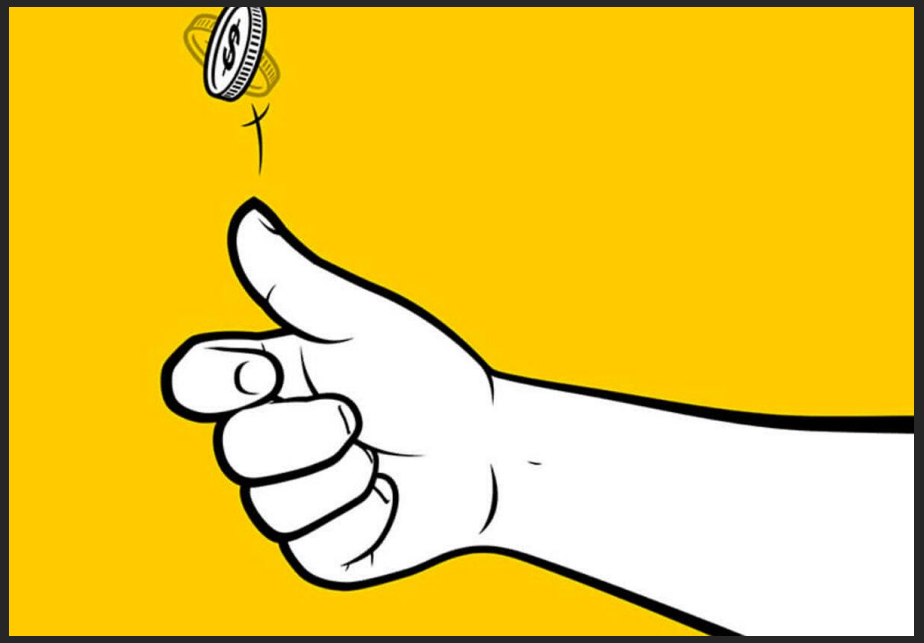


Intensive Care Med (2016) 42:324–332
DOI 10.1007/s00134-015-4168-4

SYSTEMATIC REVIEW

T. G. Eskesen
M. Wetterslev
A. Perner

Systematic review including re-analyses of 1148 individual data sets of central venous pressure as a predictor of fluid responsiveness



LINIE HODU MINCÍ

Intensive Care Med
DOI 10.1007/s00134-015-3850-x

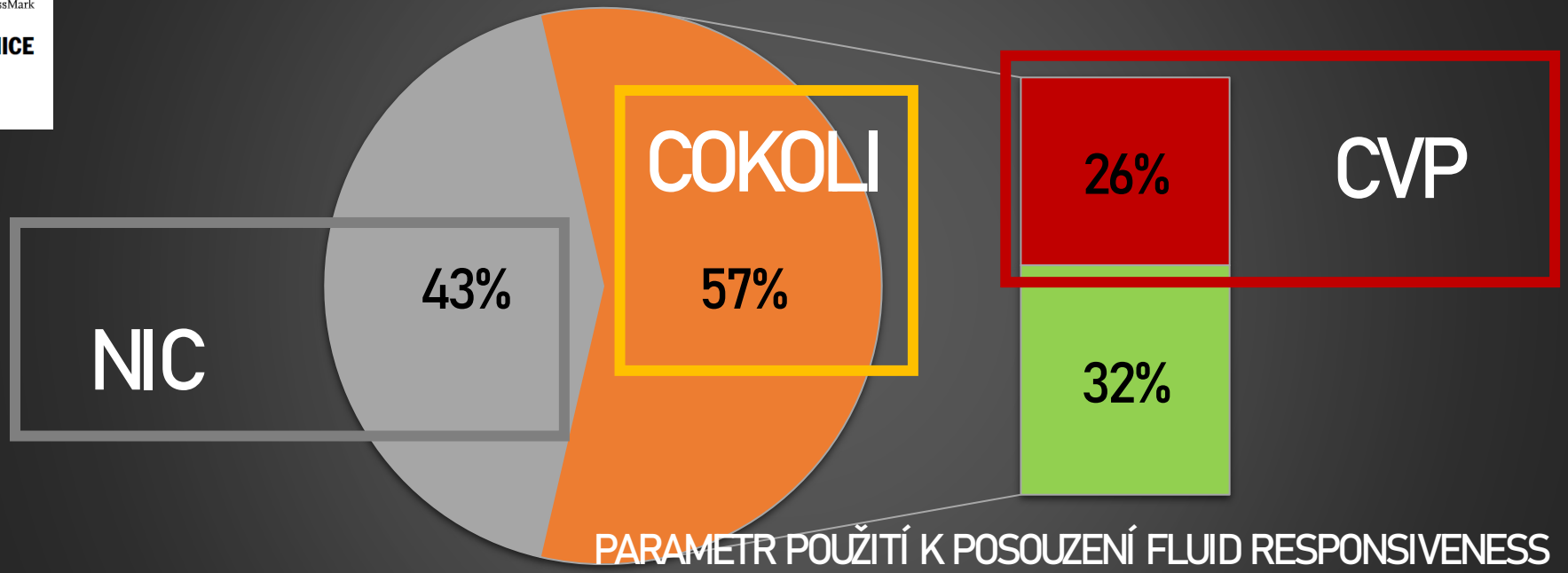
SEVEN-DAY PROFILE PUBLICATION

Maurizio Cecconi
Christoph Hofer
Jean-Louis Teboul
Ville Pettila
Erika Wilkman
Zsolt Molnar

Fluid challenges in intensive care: the FENICE study

A global inception cohort study

2015



Indication	*n* (%)
Hypotension	1211 (58.7 [56.7–60.8])
Weaning vasopressor	146 (7.1 [6.0–8.2])
Cardiac output	62 (3.0) [2.3–3.7]
Oliguria	372 (18.0 [16.4–19.6])
Skin mottling	36 (1.7 [1.2–2.2])
Lactate	128 (6.2 [5.2–7.2])
$SvO_2/ScvO_2$	10 (0.5 [0.2–0.8])
SVV/PPV	37 (1.8 [1.3–2.4])
CVP/PAOP	60 (2.9 [2.2–3.6])

CVP JAKO INDIKÁTOR PRO FLUID CHALLENGE –

2,9 %

CVP NEMÁ SLOUŽIT

ANI JAKO INDIKÁTOR

ANI JAKO CÍL TEKUTINOVÉ LÉČBY

ANI JAKO PREDIKTOR

TEKUTINOVÉ REAKTIVITY

PROMISE


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Trial of Early, Goal-Directed Resuscitation for Septic Shock

Paul R. Mouncey, M.Sc., Tiffany M. Osborn, M.D., G. Sarah Power, M.Sc., David A. Harrison, Ph.D., M. Zia Sadique, Ph.D., Richard D. Grieve, Ph.D., Rahi Jahan, B.A., Sheila E. Harvey, Ph.D., Derek Bell, M.D., Julian F. Bion, M.D., Timothy J. Coats, M.D., Mervyn Singer, M.D., J. Duncan Young, D.M., and Kathryn M. Rowan, Ph.D., for the ProMISe Trial Investigators*

ARISE

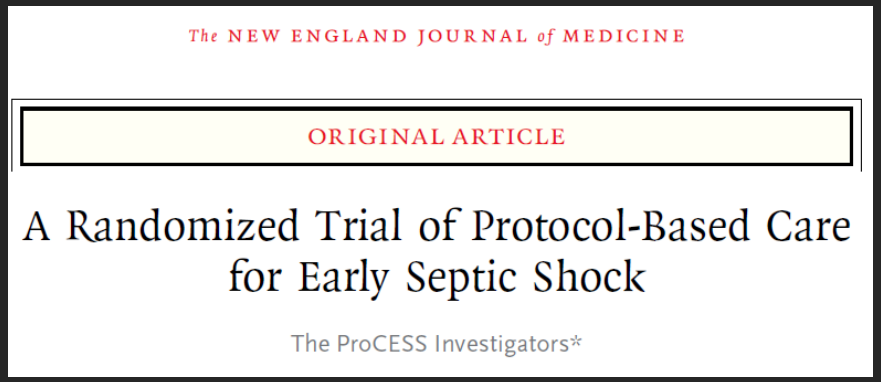

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Goal-Directed Resuscitation for Patients with Early Septic Shock

The ARISE Investigators and the ANZICS Clinical Trials Group*

PROCESS


The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

A Randomized Trial of Protocol-Based Care for Early Septic Shock

The ProCESS Investigators*

PROMISE

to

ARISE

the

PROCESS

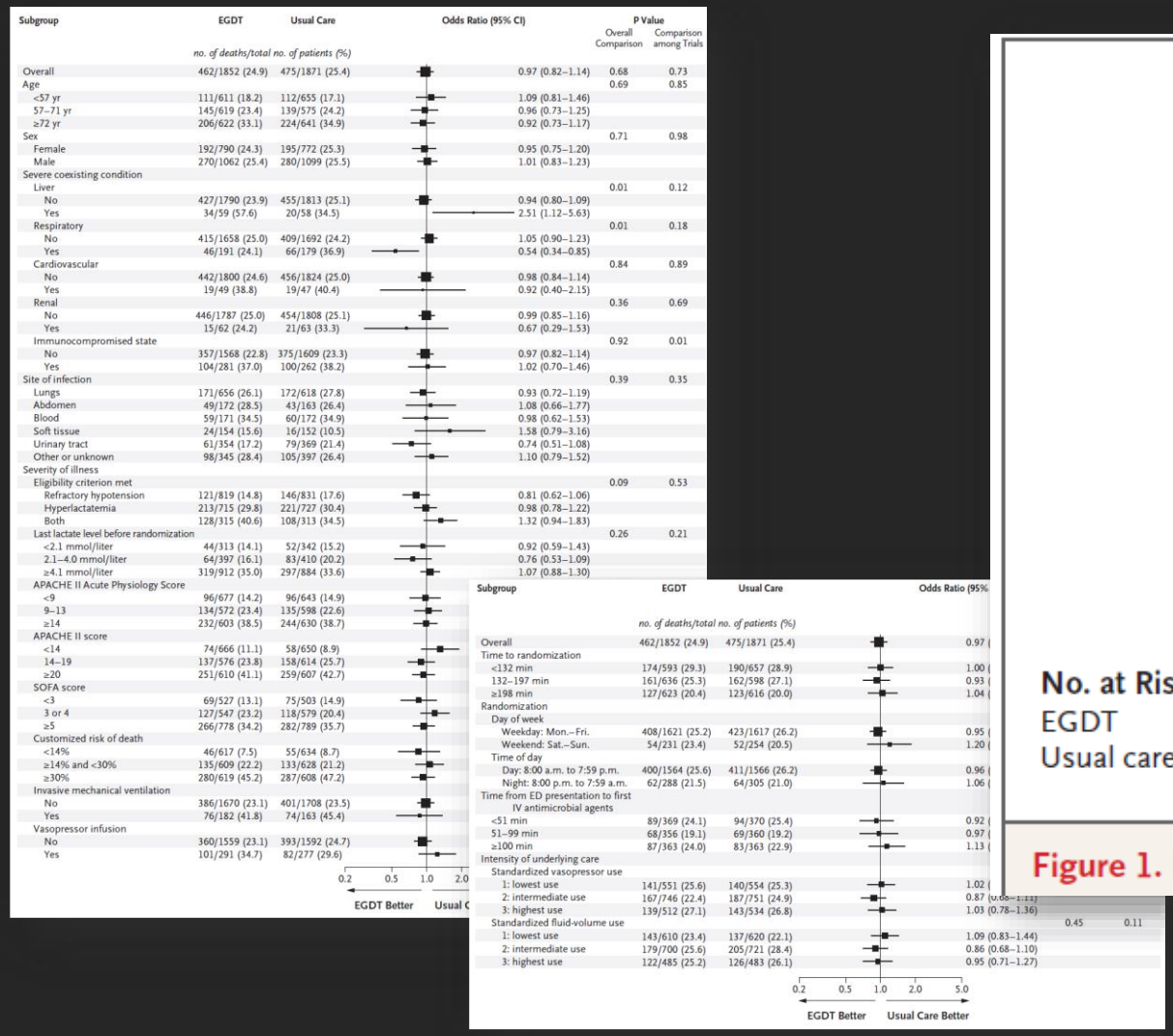
EGDT POROVNÁNÍ..

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Early, Goal-Directed Therapy for Septic Shock — A Patient-Level Meta-Analysis

The PRISM Investigators*



Subgroup	EGDT	Usual Care	Odds Ratio (95% CI)	P Value: Overall Comparison	P Value: Comparison among Trials
	no. of deaths/total no. of patients (%)				
Overall	462/1852 (24.9)	475/1871 (25.4)	0.97 (0.82–1.14)	0.68	0.73
Age				0.69	0.85
<57 yr	111/611 (18.2)	112/655 (17.1)	1.09 (0.81–1.46)		
57–71 yr	145/619 (23.4)	139/575 (24.2)	0.96 (0.73–1.25)		
≥72 yr	206/622 (33.1)	224/641 (34.9)	0.92 (0.73–1.17)		
Sex				0.71	0.98
Female	192/790 (24.3)	195/772 (25.3)	0.95 (0.75–1.20)		
Male	270/1062 (25.4)	280/1099 (25.5)	1.01 (0.83–1.23)		
Severe coexisting condition					
Liver				0.01	0.12
No	427/1790 (23.9)	455/1813 (25.1)	0.94 (0.80–1.09)		
Yes	34/59 (57.6)	20/58 (34.5)	2.51 (1.12–5.63)		
Respiratory				0.01	0.18
No	415/1658 (25.0)	409/1692 (24.2)	1.05 (0.90–1.23)		
Yes	46/191 (24.1)	66/179 (36.9)	0.54 (0.34–0.85)		
Cardiovascular				0.84	0.89
No	442/1800 (24.6)	456/1824 (25.0)	0.98 (0.84–1.14)		
Yes	19/49 (38.8)	19/47 (40.4)	0.92 (0.40–2.15)		
Renal				0.36	0.69
No	446/1787 (25.0)	454/1808 (25.1)	0.99 (0.85–1.16)		
Yes	15/62 (24.2)	21/63 (33.3)	0.67 (0.29–1.53)		
Immunocompromised state				0.92	0.01
No	357/1568 (22.8)	375/1609 (23.3)	0.97 (0.82–1.14)		
Yes	104/281 (37.0)	100/262 (38.2)	1.02 (0.70–1.46)		
Site of infection				0.39	0.35
Lungs	171/656 (26.1)	172/618 (27.8)	0.93 (0.72–1.19)		
Abdomen	49/172 (28.5)	43/163 (26.4)	1.08 (0.66–1.77)		
Blood	59/171 (34.5)	60/172 (34.9)	0.98 (0.62–1.53)		
Soft tissue	24/154 (15.6)	16/152 (10.5)	1.58 (0.79–3.16)		
Urinary tract	61/354 (17.2)	79/369 (21.4)	0.74 (0.51–1.08)		
Other or unknown	98/345 (28.4)	105/397 (26.4)	1.10 (0.79–1.52)		
Severity of illness					
Eligibility criterion met				0.09	0.53
Refractory hypotension	121/819 (14.8)	146/831 (17.6)	0.81 (0.62–1.06)		
Hyperlactatemia	213/715 (29.8)	221/727 (30.4)	0.98 (0.78–1.22)		
Both	128/315 (40.6)	108/313 (34.5)	1.32 (0.94–1.83)		
Last lactate level before randomization				0.26	0.21
<2.1 mmol/liter	44/313 (14.1)	52/342 (15.2)	0.92 (0.59–1.43)		
2.1–4.0 mmol/liter	64/397 (16.1)	83/410 (20.2)	0.76 (0.53–1.09)		
≥4.1 mmol/liter	319/912 (35.0)	297/884 (33.6)	1.07 (0.88–1.30)		
APACHE II Acute Physiology Score					
<9	96/677 (14.2)	96/643 (14.9)			
9–13	134/572 (23.4)	135/598 (22.6)			
≥14	232/603 (38.5)	244/630 (38.7)			
APACHE II score					
<14	74/666 (11.1)	58/650 (8.9)			
14–19	137/576 (23.8)	158/614 (25.7)			
≥20	251/610 (41.1)	259/607 (42.7)			
SOFA score					
<3	69/527 (13.1)	75/503 (14.9)			
3 or 4	127/547 (23.2)	118/579 (20.4)			
≥5	266/778 (34.2)	282/789 (35.7)			
Customized risk of death					
<14%	46/617 (7.5)	55/634 (8.7)			
≥14% and <30%	135/609 (22.2)	133/628 (21.2)			
≥30%	280/619 (45.2)	287/608 (47.2)			
Invasive mechanical ventilation					
No	386/1670 (23.1)	401/1708 (23.5)			
Yes	76/182 (41.8)	74/163 (45.4)			
Vasopressor infusion					
No	360/1559 (23.1)	393/1592 (24.7)			
Yes	101/291 (34.7)	82/277 (29.6)			

0.2 0.5 1.0 2.0

EGDT Better Usual C

Subgroup	EGDT	Usual Care	Odds Ratio (95%
	no. of deaths/total no. of patients (%)		
Overall	462/1852 (24.9)	475/1871 (25.4)	0.97
Time to randomization			
<132 min	174/593 (29.3)	190/657 (28.9)	1.00
132–197 min	161/636 (25.3)	162/598 (27.1)	0.93
≥198 min	127/623 (20.4)	123/616 (20.0)	1.04
Randomization			
Day of week			
Weekday: Mon.–Fri.	408/1621 (25.2)	423/1617 (26.2)	0.95
Weekend: Sat.–Sun.	54/231 (23.4)	52/254 (20.5)	1.20
Time of day			
Day: 8:00 a.m. to 7:59 p.m.	400/1564 (25.6)	411/1566 (26.2)	0.96
Night: 8:00 p.m. to 7:59 a.m.	62/288 (21.5)	64/305 (21.0)	1.06
Time from ED presentation to first IV antimicrobial agents			
<51 min	89/369 (24.1)	94/370 (25.4)	0.92
51–99 min	68/356 (19.1)	69/360 (19.2)	0.97
≥100 min	87/363 (24.0)	83/363 (22.9)	1.13
Intensity of underlying care			
Standardized vasopressor use			
1: lowest use	141/551 (25.6)	140/554 (25.3)	1.02
2: intermediate use	167/746 (22.4)	187/751 (24.9)	0.87
3: highest use	139/512 (27.1)	143/534 (26.8)	1.03 (0.78–1.36)
Standardized fluid-volume use			
1: lowest use	143/610 (23.4)	137/620 (22.1)	1.09 (0.83–1.44)
2: intermediate use	179/700 (25.6)	205/721 (28.4)	0.86 (0.68–1.10)
3: highest use	122/485 (25.2)	126/483 (26.1)	0.95 (0.71–1.27)

0.45 0.11

0.2 0.5 1.0 2.0 5.0

EGDT Better Usual Care Better

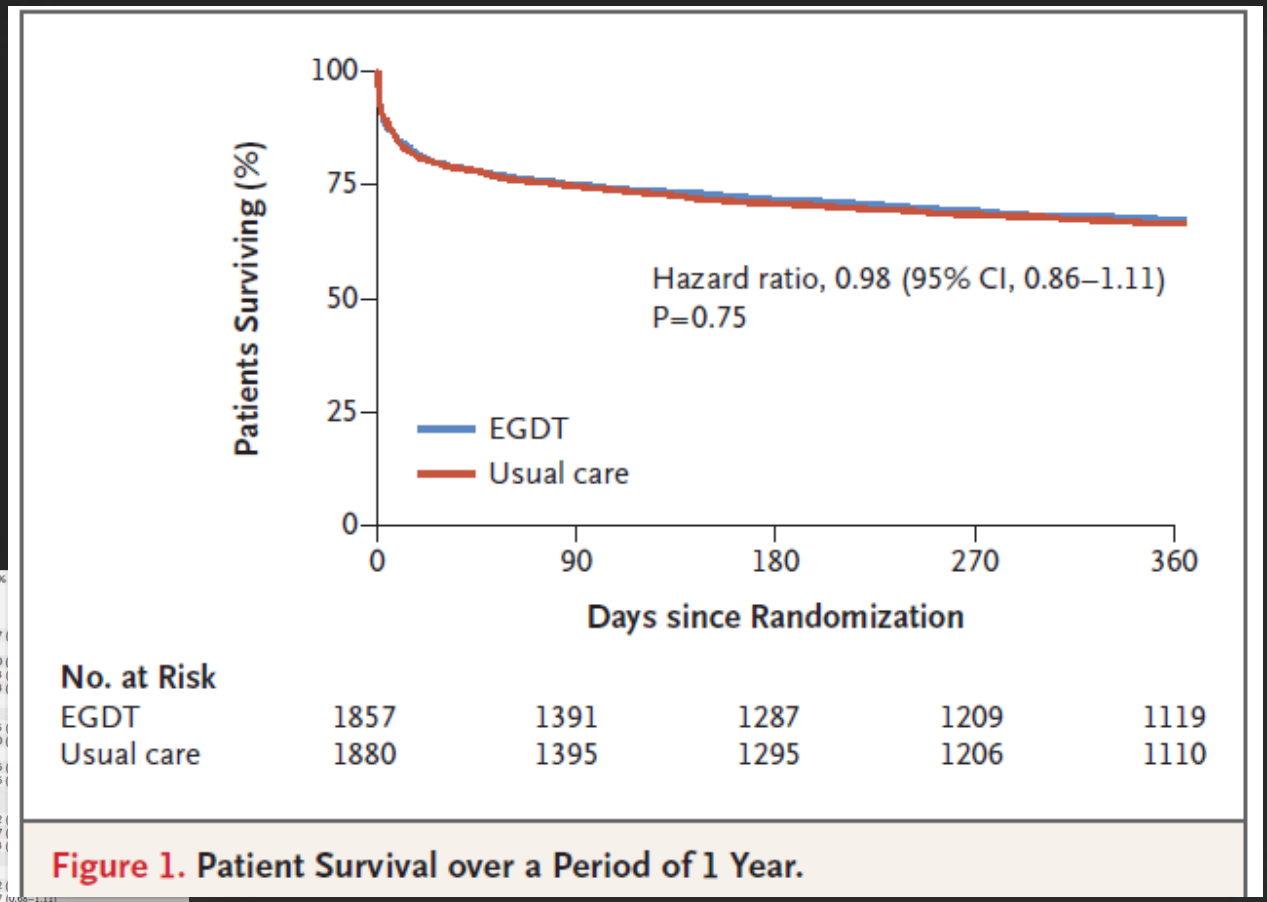


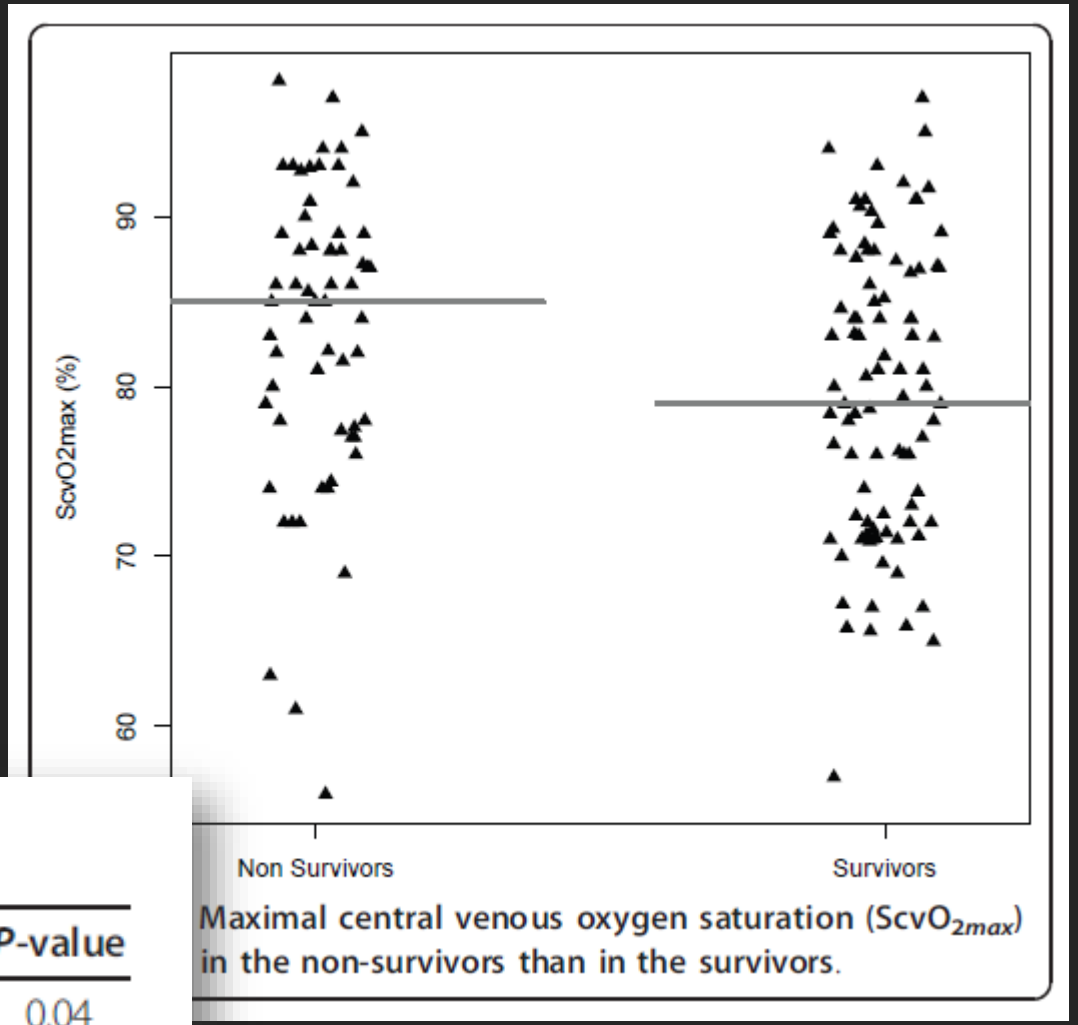
Figure 1. Patient Survival over a Period of 1 Year.

Textoris et al. Critical Care 2011, 15:R176
http://ccforum.com/content/15/4/R176

CRITICAL CARE

RESEARCH Open Access

High central venous oxygen saturation in the latter stages of septic shock is associated with increased mortality



Maximal central venous oxygen saturation ($ScvO_{2max}$) in the non-survivors than in the survivors.

Table 2 Contingency table of mortality among a $ScvO_{2max}$ cut-off of 80%

		Non survivors	Survivors	Mortality (%)	*P*-value
$ScvO_{2max}$	< 80%	20	46	30	0.04
	≥ 80%	41	45	48	

$ScvO_2$ ŘÍZENÁ HEMODYNAMICKA OPTIMALIZACE (EGDT) NENÍ LEPŠÍ NEŽ BĚŽNÁ PÉČE

„NORMÁLNÍ" NEBO VYSOKÉ HODNOTY MOHOU FALEŠNĚ UKOLÉBAT.

„CV“
IS OUT OF FASHION AND WANISHING...

Něco na tom CVP je...
ALE SKUTEČNĚ!

2025

Jan Benes
KARIM LFP UK a FN Plzen
Simulační centrum (SIM/PL) - LFP UK
Biomedicínské centrum LFP UK
SepsEast initiative

SepsEast
Central and Eastern European Sepsis Forum

FAKULTNÍ NEMOCNICE PLZEŇ

Univerzita Karlova

SIM PL

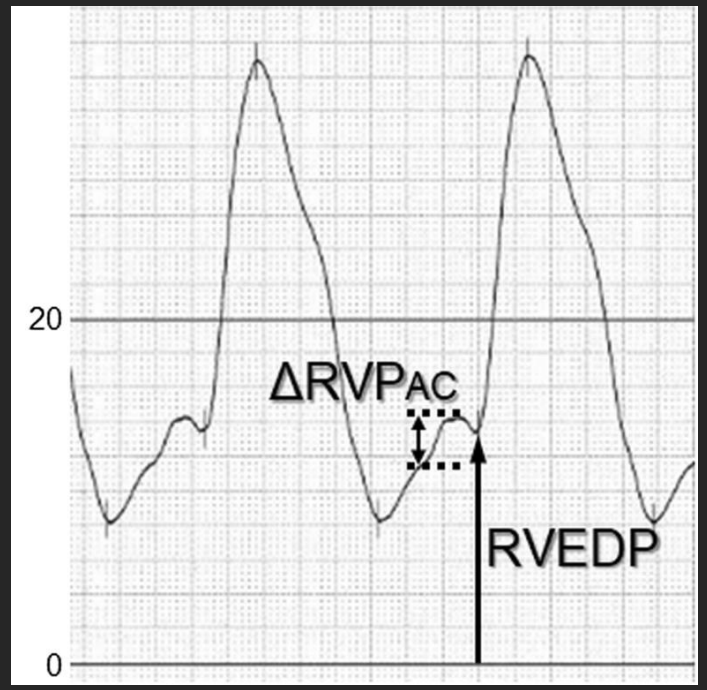
LÉKAŘSKÁ FAKULTA V PLZNI
UNIVERZITA KARLOVA

BIOMEDICÍNSKÉ CENTRUM

CO je to CVP?

CVP = TLAK V CENTRÁLNÍM ŽILNÍM SYSTÉMU

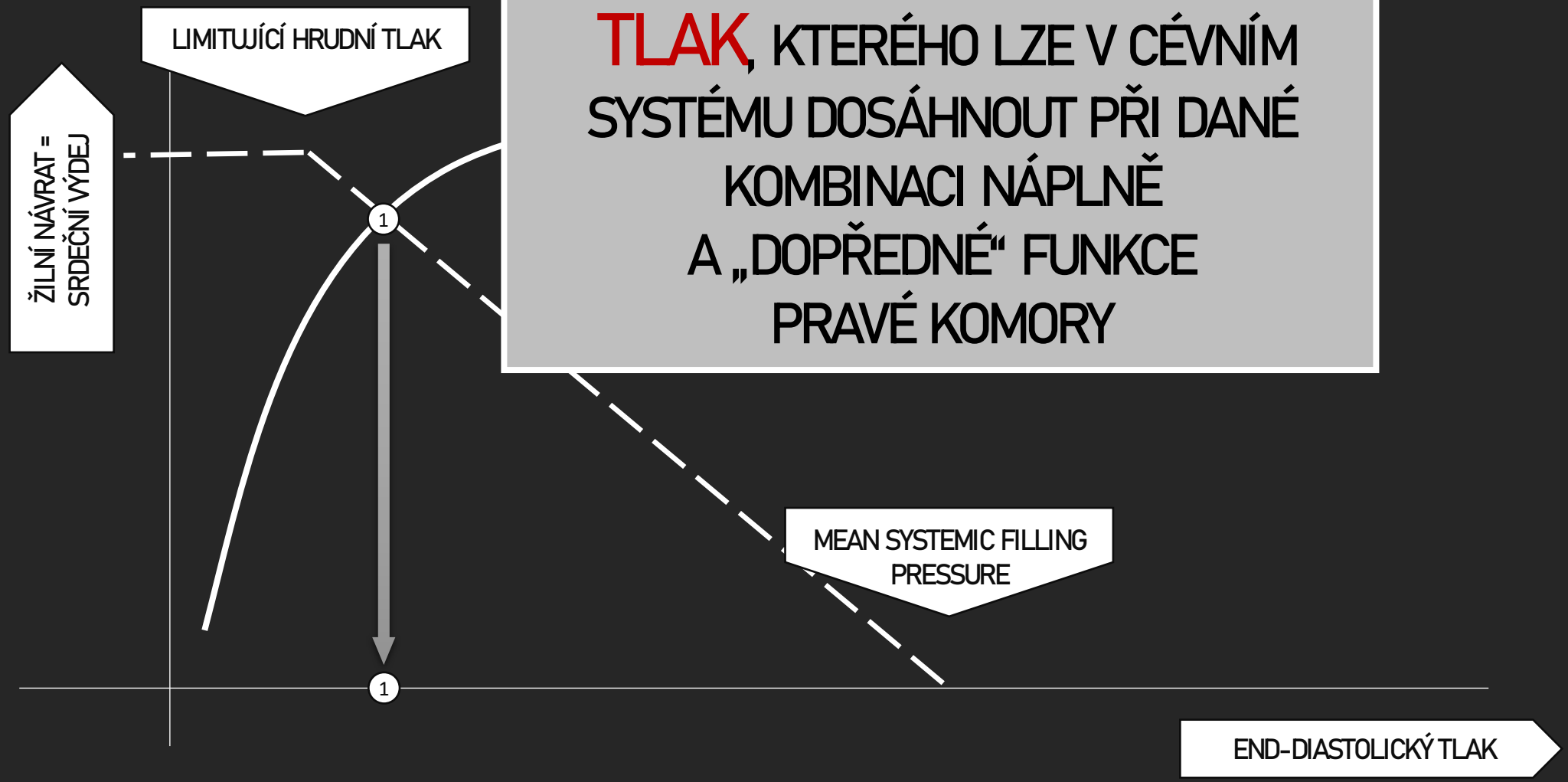
= RAP = TLAK V PRAVÉ SÍNI



≈ RVEDP = END-DIASTOLICKÝ TLAK V PRAVÉ KOMOŘE

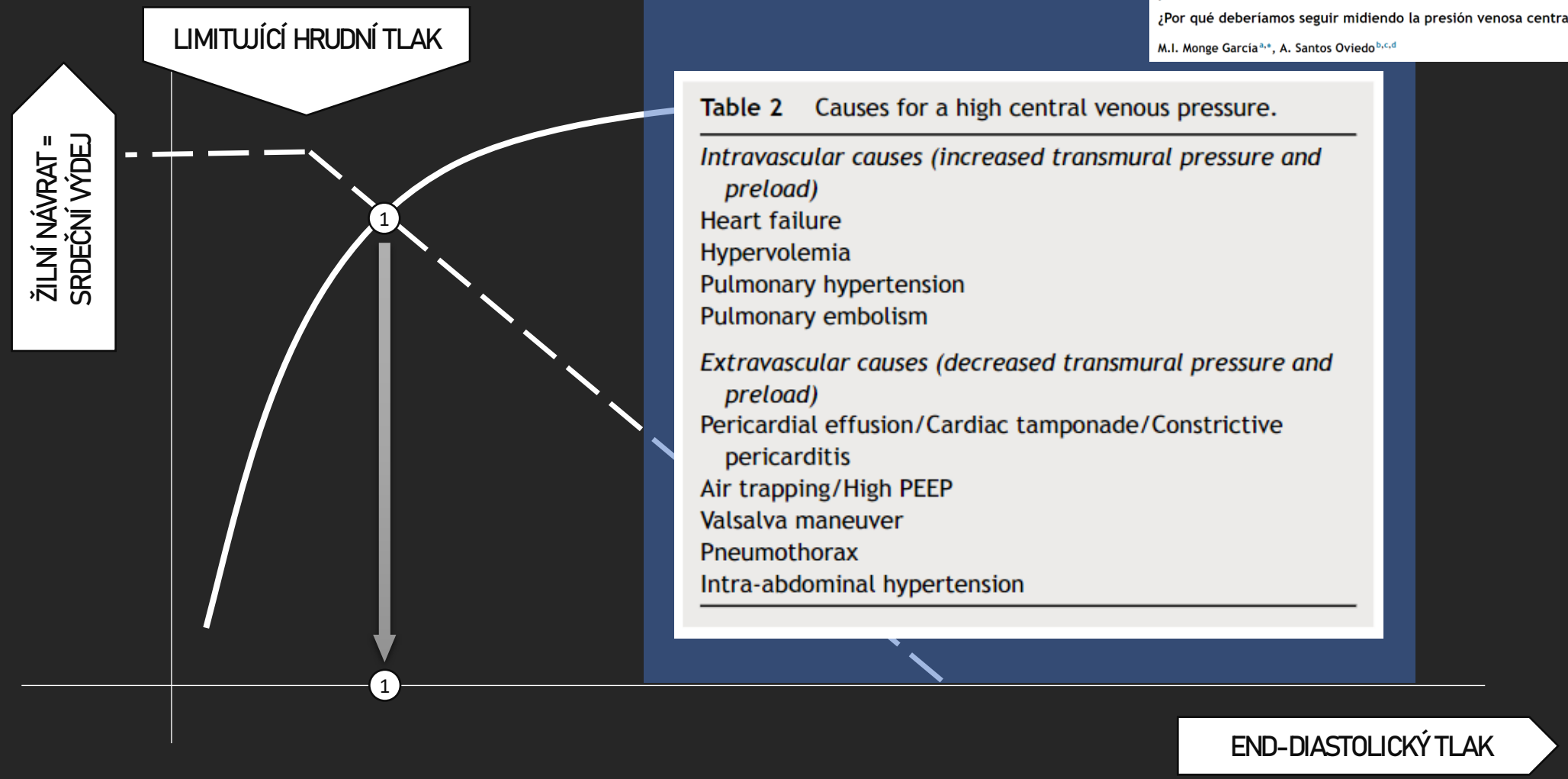
Co je to CVP

NEJNIŽŠÍ HYDROSTATICKÝ **TLAK**, KTERÉHO LZE V CÉVNÍM SYSTÉMU DOSÁHNOUT PŘI DANÉ KOMBINACI NÁPLNĚ A „DOPŘEDNÉ“ FUNKCE PRAVÉ KOMORY



Co s tím CVP

VYSOKÉ HODNOTY JSOU VŽDY ŠPATNÉ



POINT OF VIEW

Why should we continue measuring central venous pressure?

¿Por qué deberíamos seguir midiendo la presión venosa central?

M.I. Monge García[a,*], A. Santos Oviedo[b,c,d]

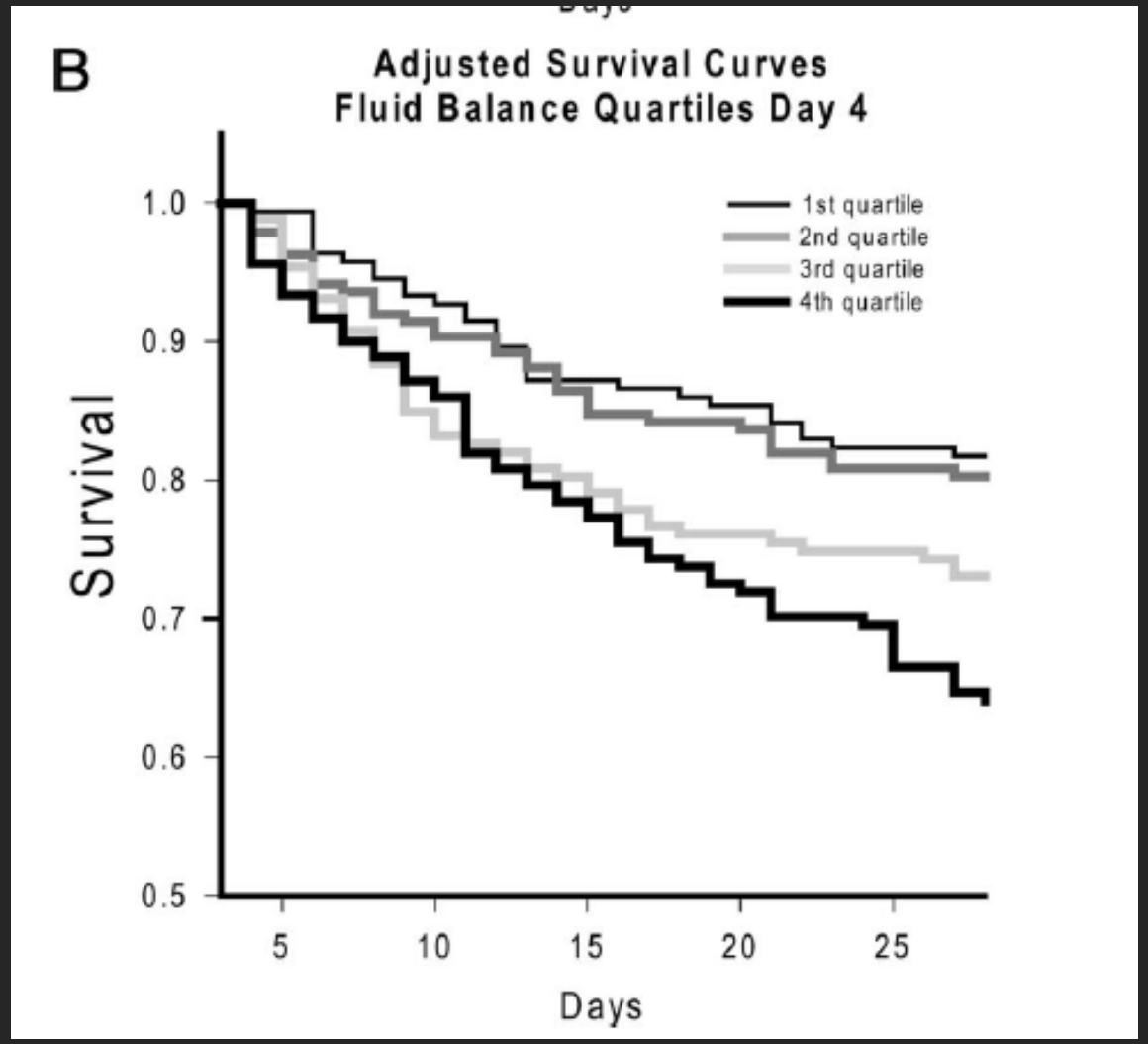
Table 2 Causes for a high central venous pressure.

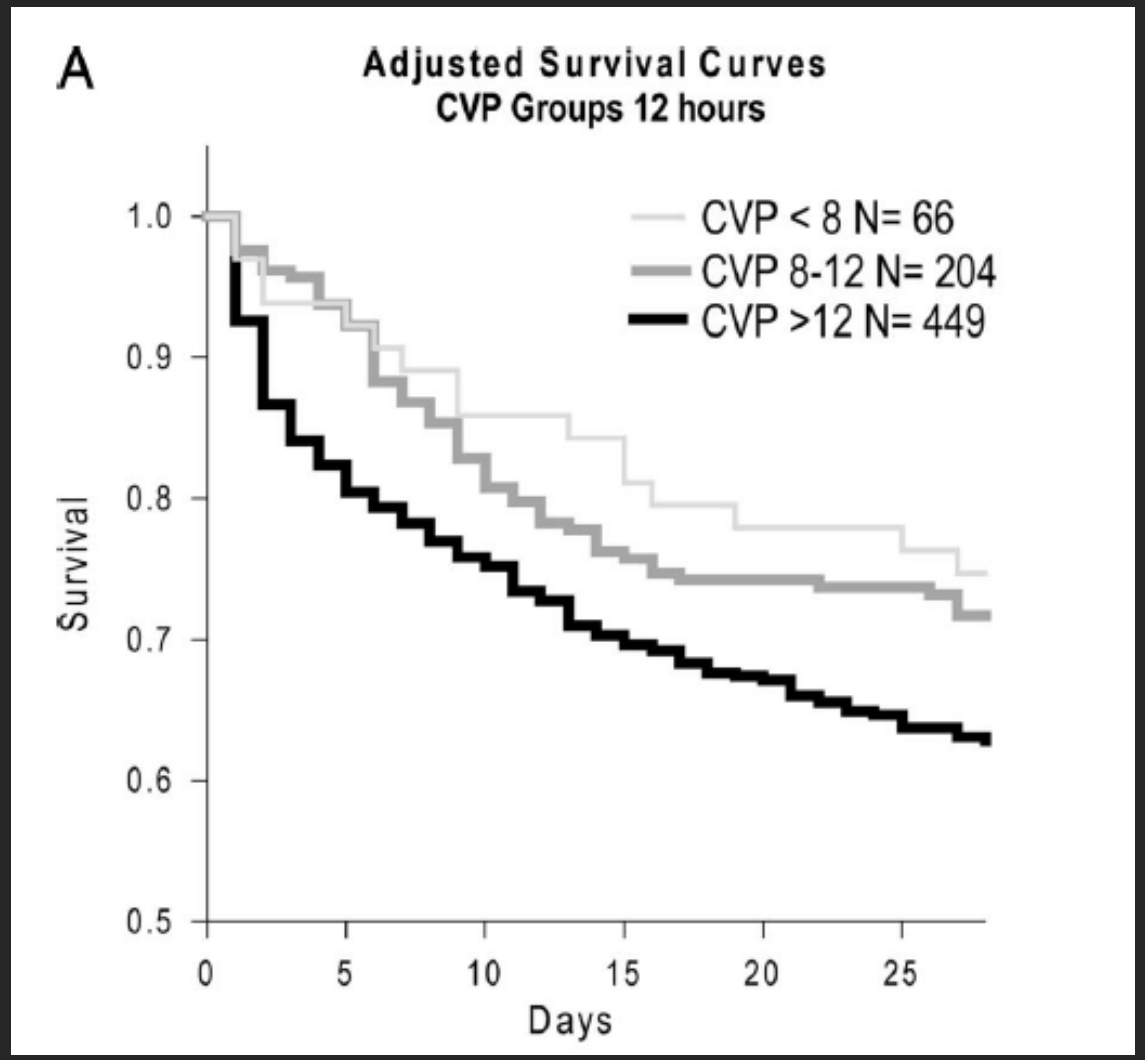
Intravascular causes (increased transmural pressure and preload)
Heart failure
Hypervolemia
Pulmonary hypertension
Pulmonary embolism
Extravascular causes (decreased transmural pressure and preload)
Pericardial effusion/Cardiac tamponade/Constrictive pericarditis
Air trapping/High PEEP
Valsalva maneuver
Pneumothorax
Intra-abdominal hypertension

Fluid resuscitation in septic shock: A positive fluid balance and elevated central venous pressure are associated with increased mortality

Crit Care Med 2011 Vol. 39, No. 2

John H. Boyd, MD, FRCP(C); Jason Forbes, MD; Taka-aki Nakada, MD, PhD; Keith R. Walley, MD, FRCP(C); James A. Russell, MD, FRCP(C)



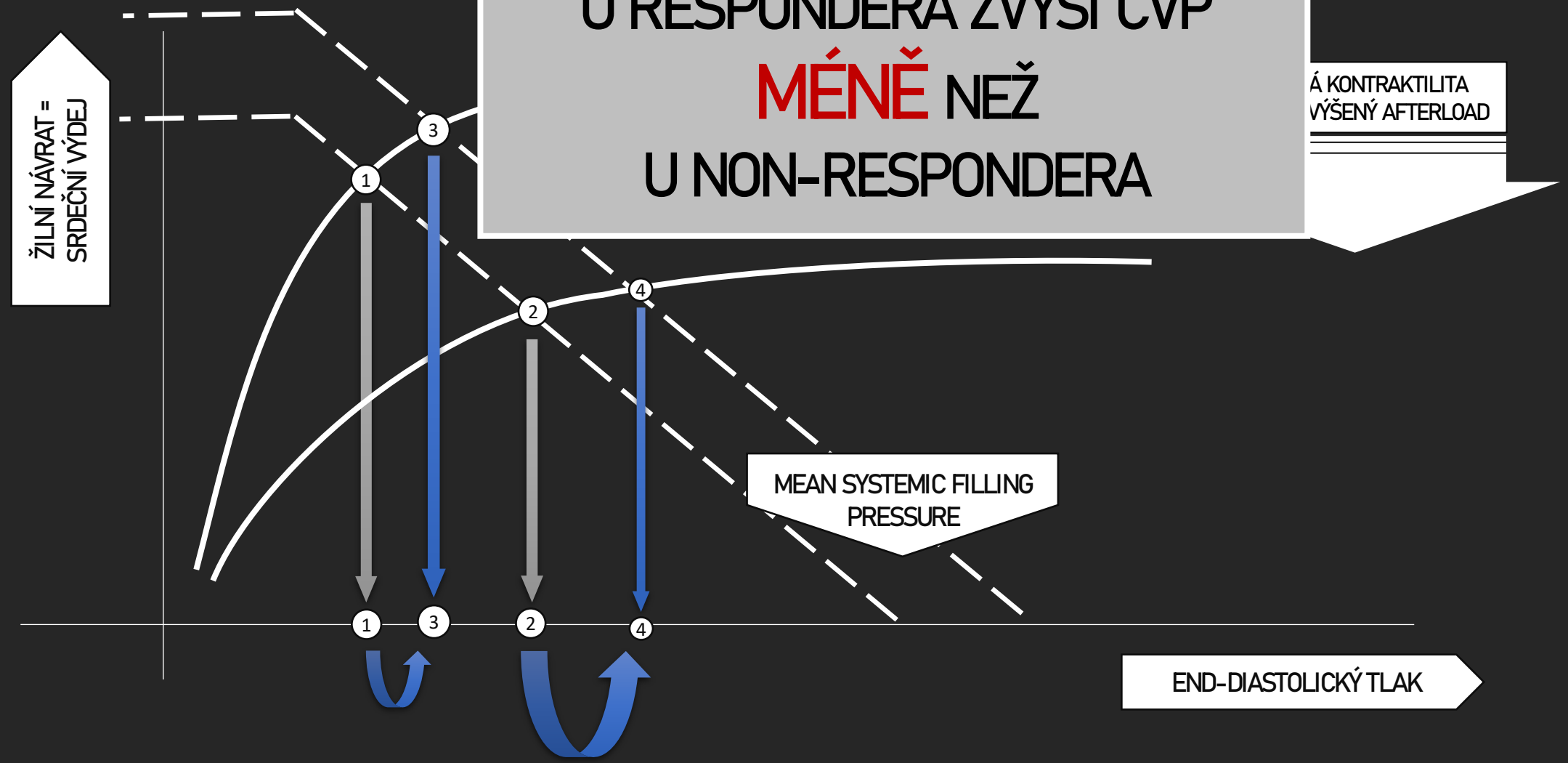


Co je to CVP


LIMITUJÍCÍ HRUDNÍ TLAK
ŽILNÍ NÁVRAT = SRDEČNÍ VÝDEJ
ZHORŠENÍ „DOPŘEDNÉ“ FUNKCE PRAVÉHO SRDCE VEDE KE ZVÝŠENÍ CVP
SNÍŽENÁ KONTRAKTILITA A/NEBO ZVÝŠENÝ AFTERLOAD
1
2
MEAN SYSTEMIC FILLING PRESSURE
1
2
END-DIASTOLICKÝ TLAK

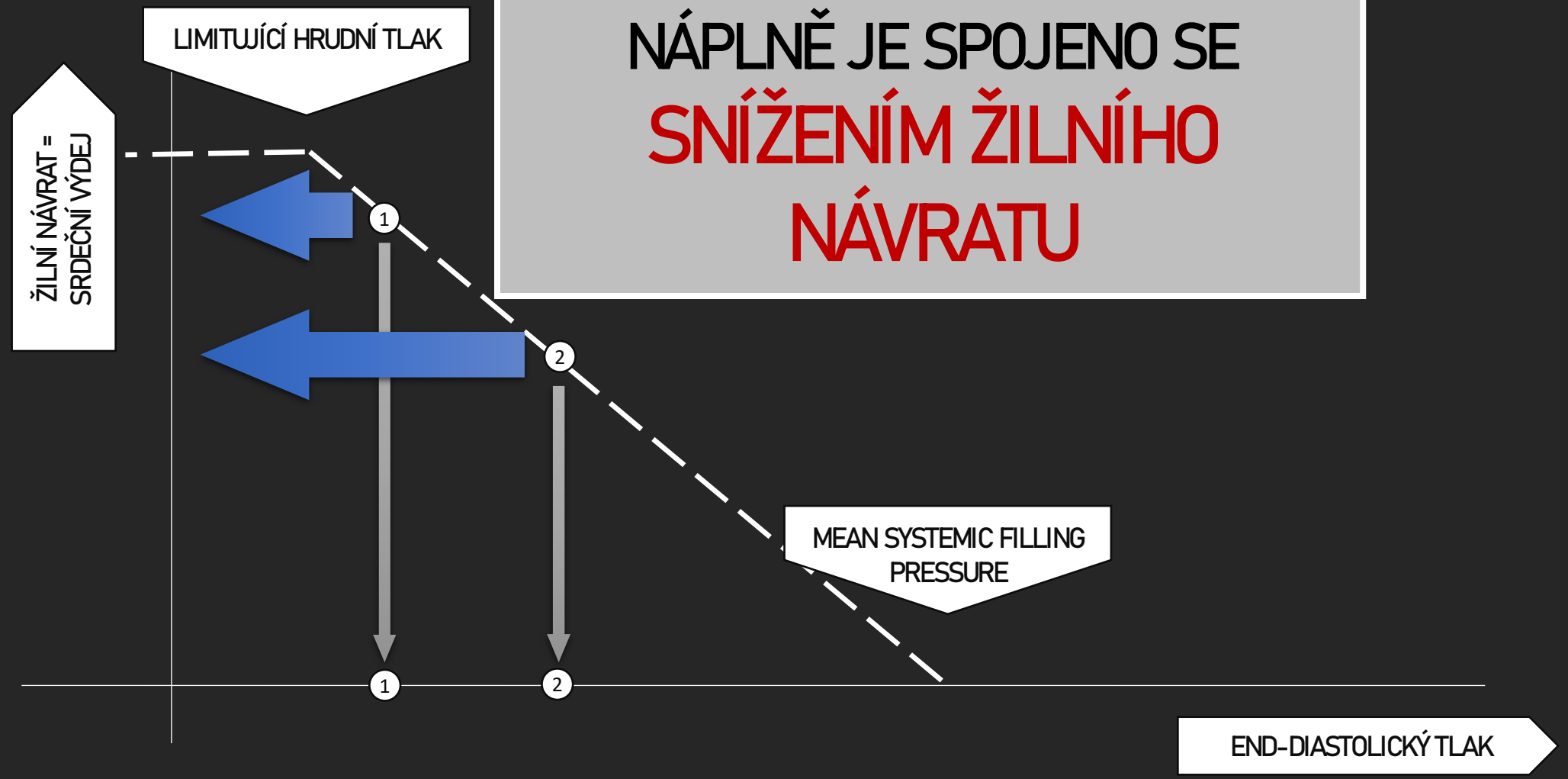
CVP a TEKUTINOVÁ REAKTIVITA

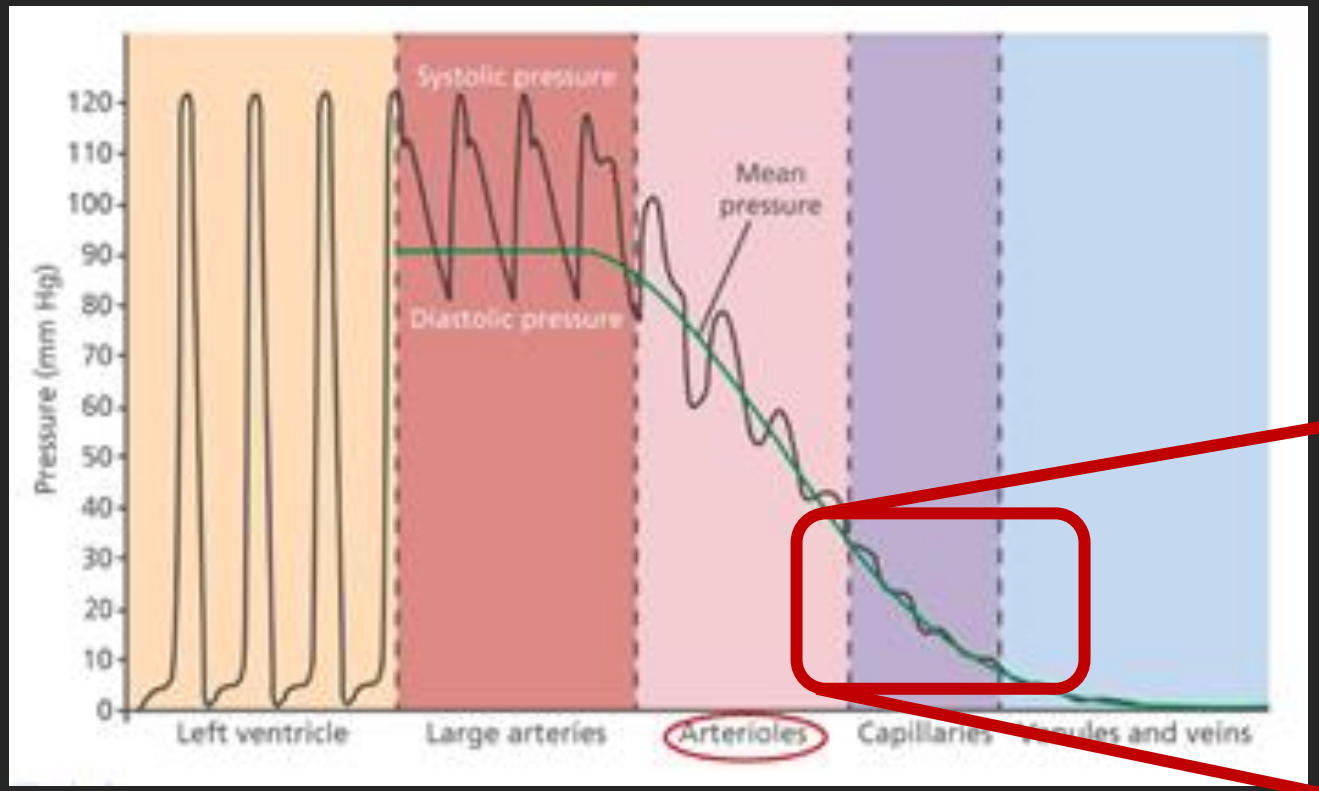
ZVÝŠENÍ CÉVNÍ NÁPLNĚ
U RESPONDERA ZVÝŠÍ CVP
MÉNĚ NEŽ
U NON-RESPONDERA

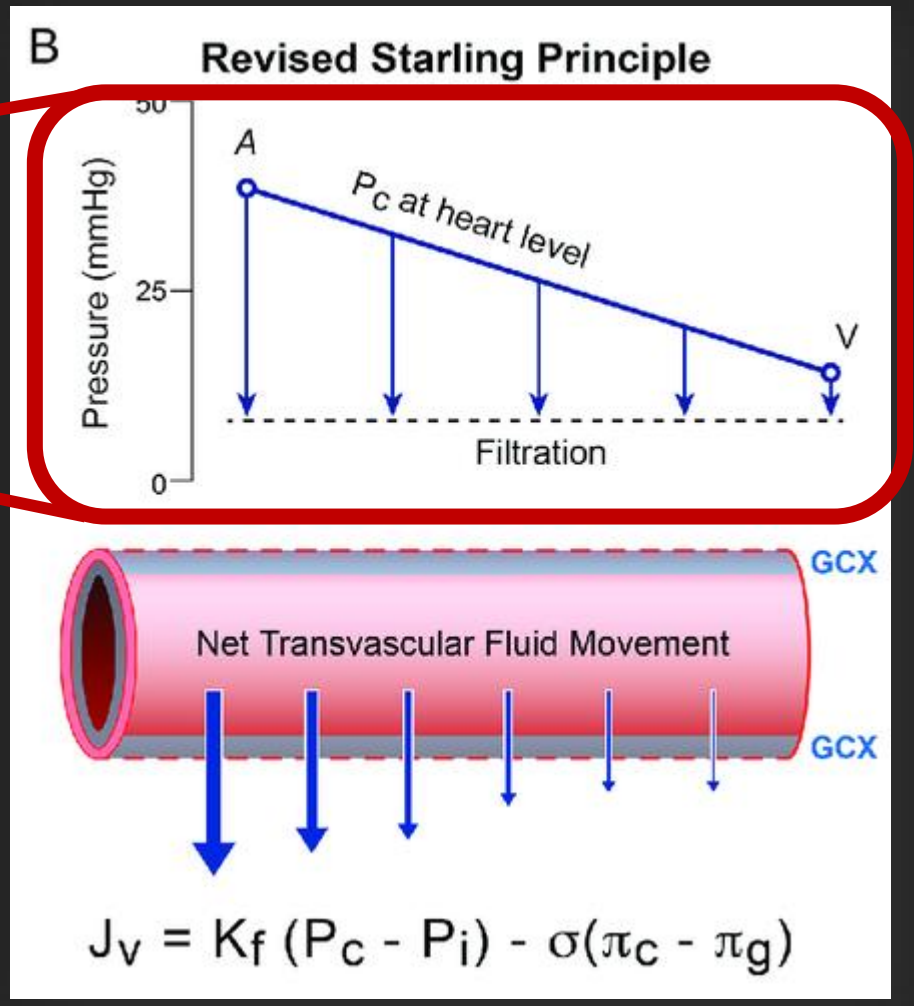


CVP je „BACK-PRESSURE“

ZVÝŠENÍ CVP BEZE ZMĚNY NÁPLNĚ JE SPOJENO SE **SNÍŽENÍM ŽILNÍHO NÁVRATU**




Systolic pressure
Mean pressure
Diastolic pressure
Pressure (mm Hg)
120
110
100
90
80
70
60
50
40
30
20
10
0
Left ventricle
Large arteries
Arterioles
Capillaries

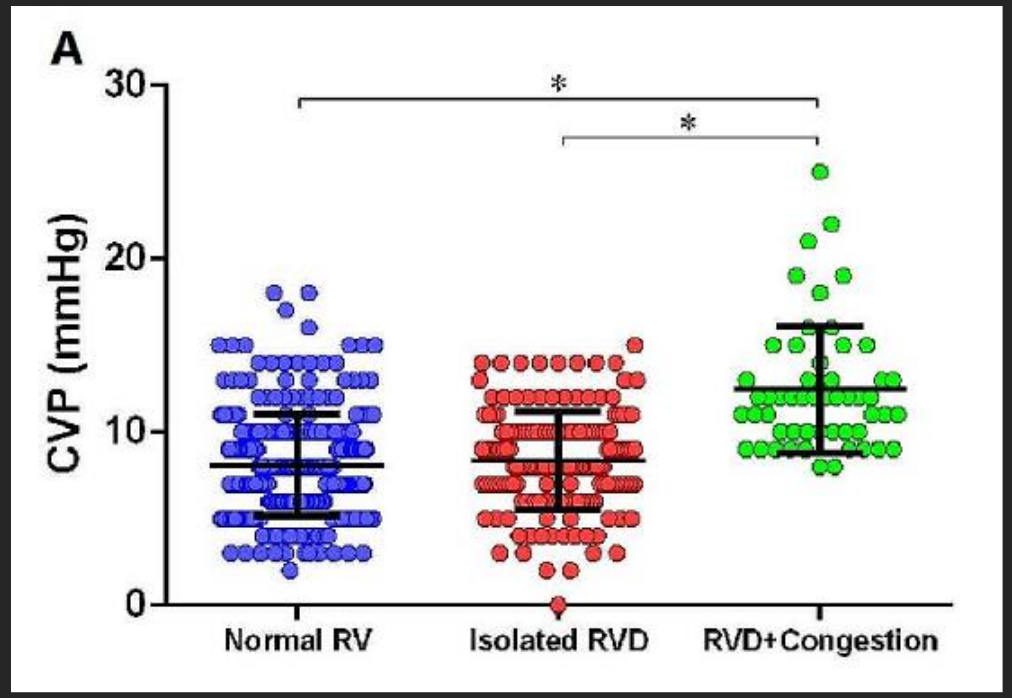

B
Revised Starling Principle
Pressure (mmHg)
50
25
0
A
Pc at heart level
V
Filtration
GCX
Net Transvascular Fluid Movement
GCX
$J_V = K_f (P_c - P_i) - \sigma(\pi_c - \pi_g)$

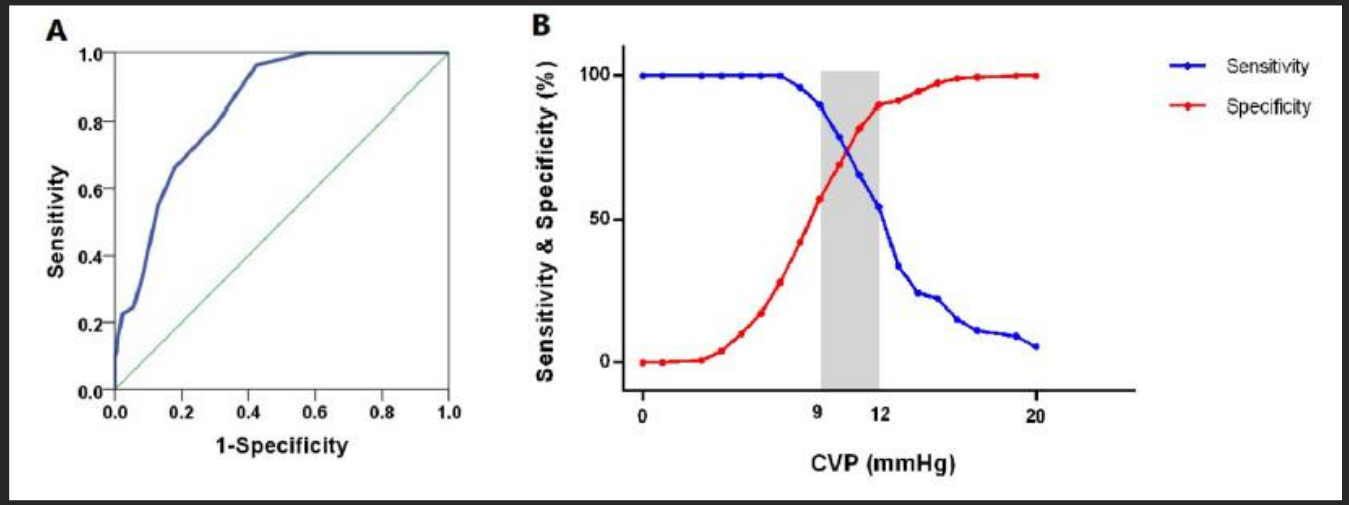
Zhang et al. Annals of Intensive Care (2024) 14:114
https://doi.org/10.1186/s13613-024-01352-9

Annals of Intensive Care

RESEARCH Open Access

Can central venous pressure help identify acute right ventricular dysfunction in mechanically ventilated critically ill patients?





Conclusions CVP may be a helpful indicator of acute RV dysfunction patients with systemic venous congestion in mechanically ventilated critically ill, but its accuracy is limited. A CVP less than10 mm Hg can almost rule out RV dysfunction with congestion. In contrast, CVP should not be used to identify general RV dysfunction.

CVP PRO ZHODNOCENÍ RIZIKA

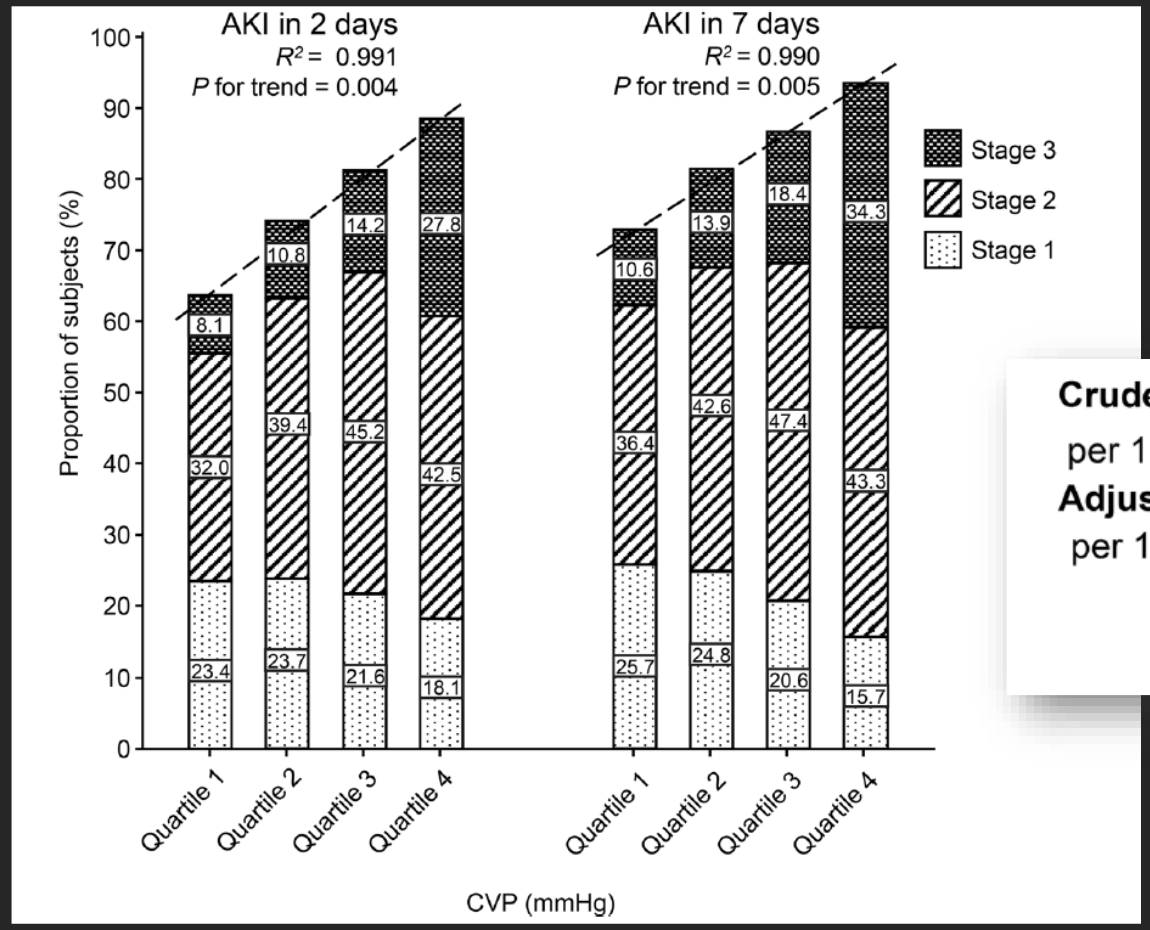
MIMIC III
11 135 pts

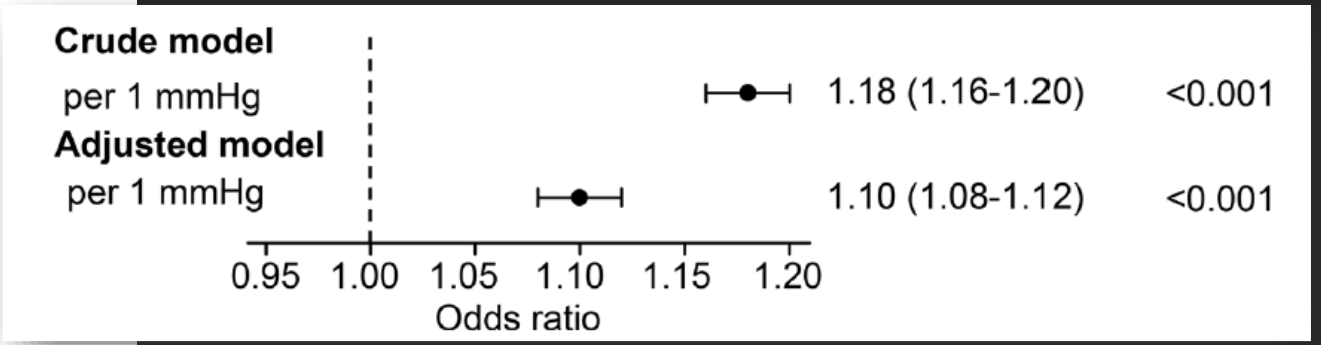
Sun et al. BMC Nephrology (2022) 23:83
https://doi.org/10.1186/s12882-022-02715-9

BMC Nephrology

RESEARCH Open Access

Central venous pressure and acute kidney injury in critically ill patients with multiple comorbidities: a large retrospective cohort study





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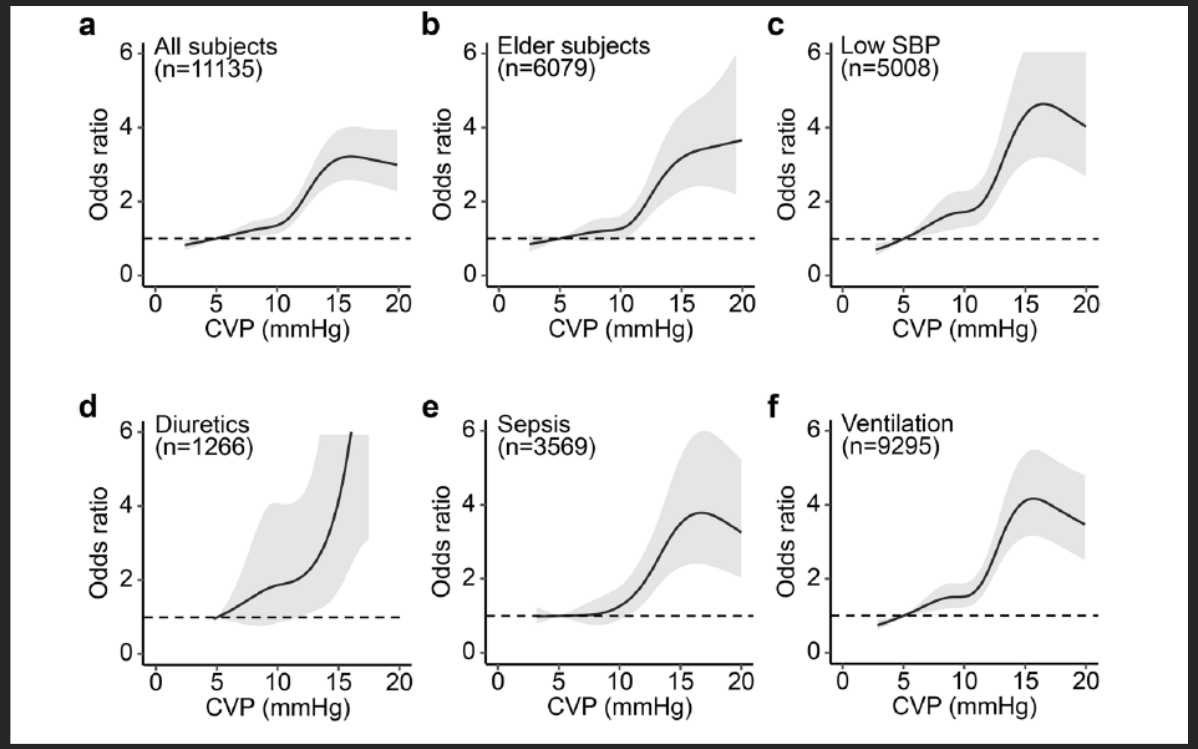
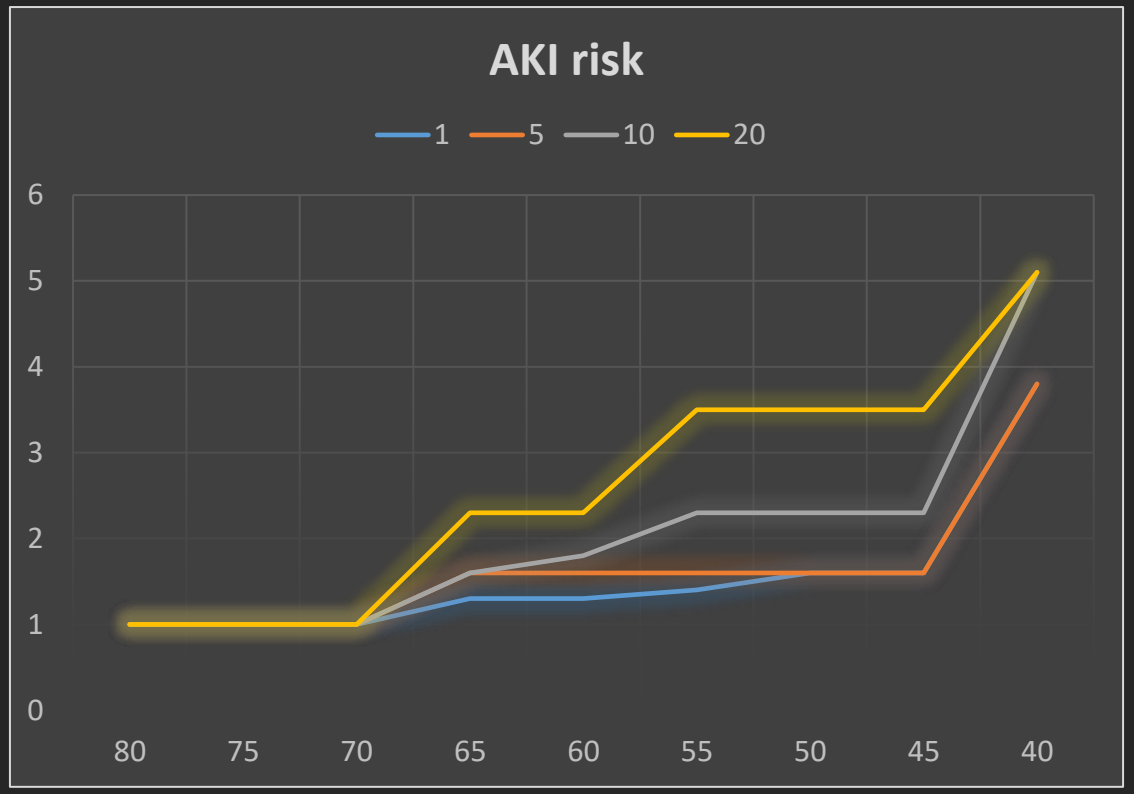


CARDIOVASCULAR

Intraoperative hypotension and the risk of postoperative adverse outcomes: a systematic review

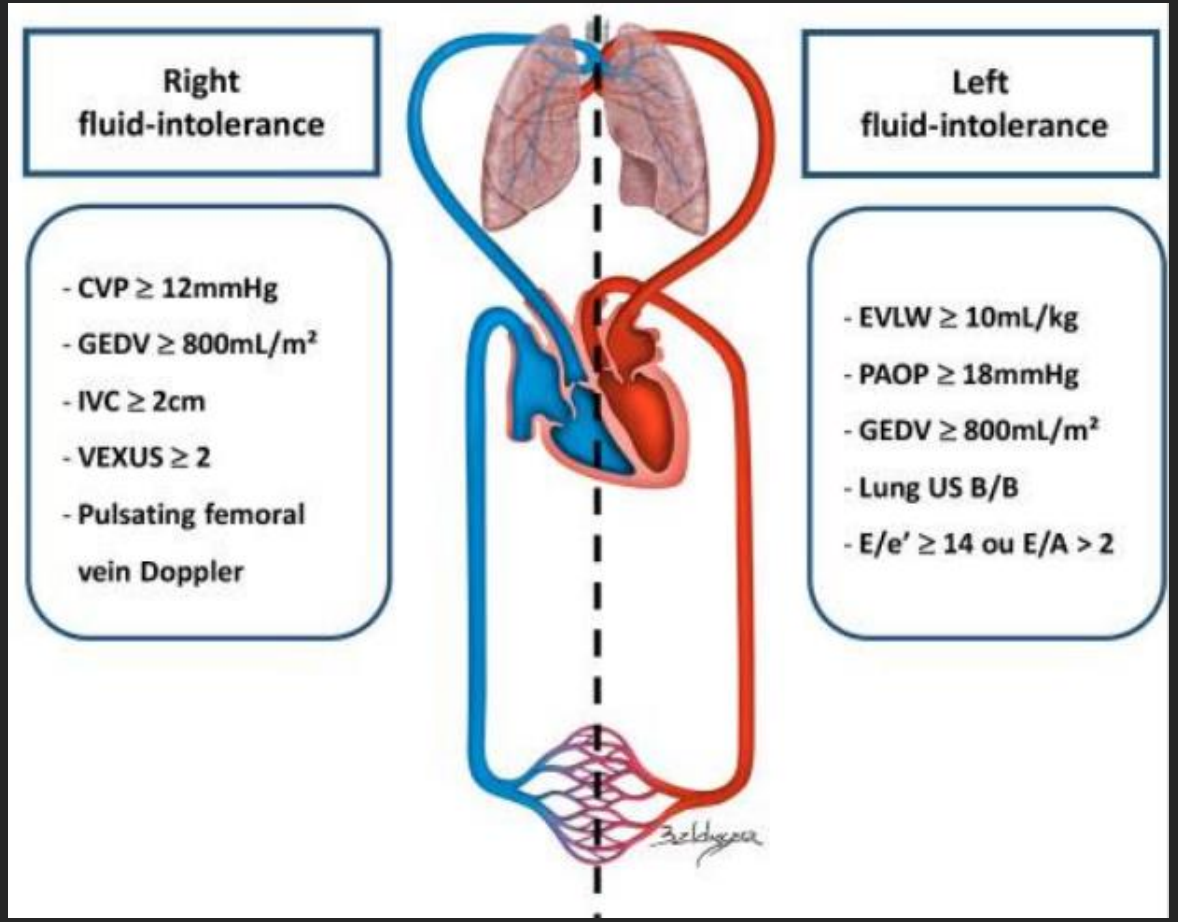
E. M. Wesselink[1,*], T. H. Kappen[1], H. M. Torn[1], A. J. C. Slooter[2] and W. A. van Klei[1]

785 806 pts
42 std

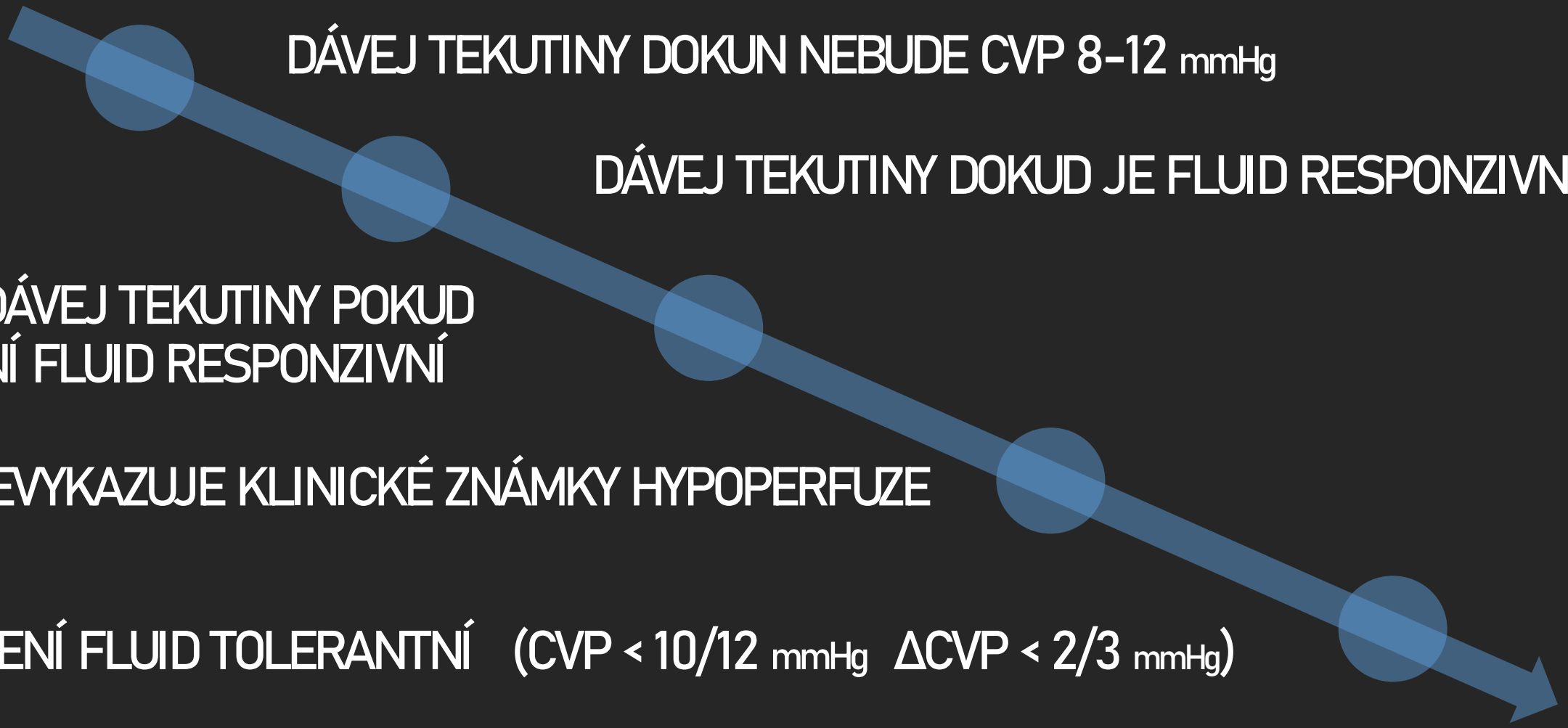


FLUID TOLERANCE ...

MONITOROVATELNÉ PARAMETRY, KTERÉ POUKAZUJÍ NA **ABSENCI RIZIKA** PODÁNÍ TEKUTINY



JAK NA CVP a TEKUTINY



DÁVEJ TEKUTINY DOKUN NEBUDE CVP 8-12 mmHg

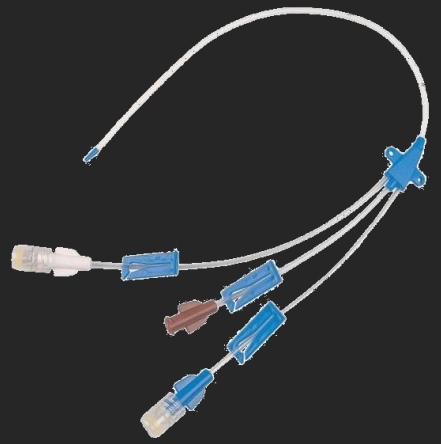
DÁVEJ TEKUTINY DOKUD JE FLUID RESPONZIVNÍ

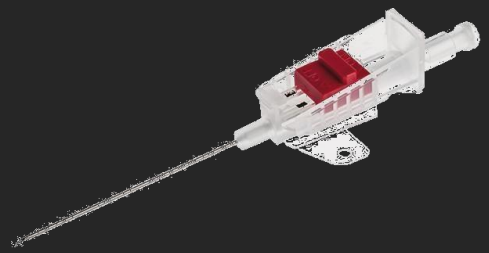
NEDÁVEJ TEKUTINY POKUD
NENÍ FLUID RESPONZIVNÍ

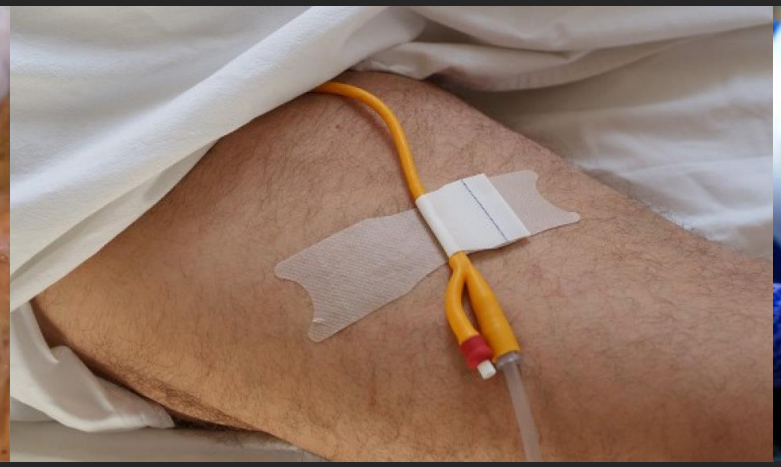
A NEVYKAZUJE KLINICKÉ ZNÁMKY HYPOPERFUZE

A NENÍ FLUID TOLERANTNÍ (CVP < 10/12 mmHg ΔCVP < 2/3 mmHg)


It shouldn't be this hard







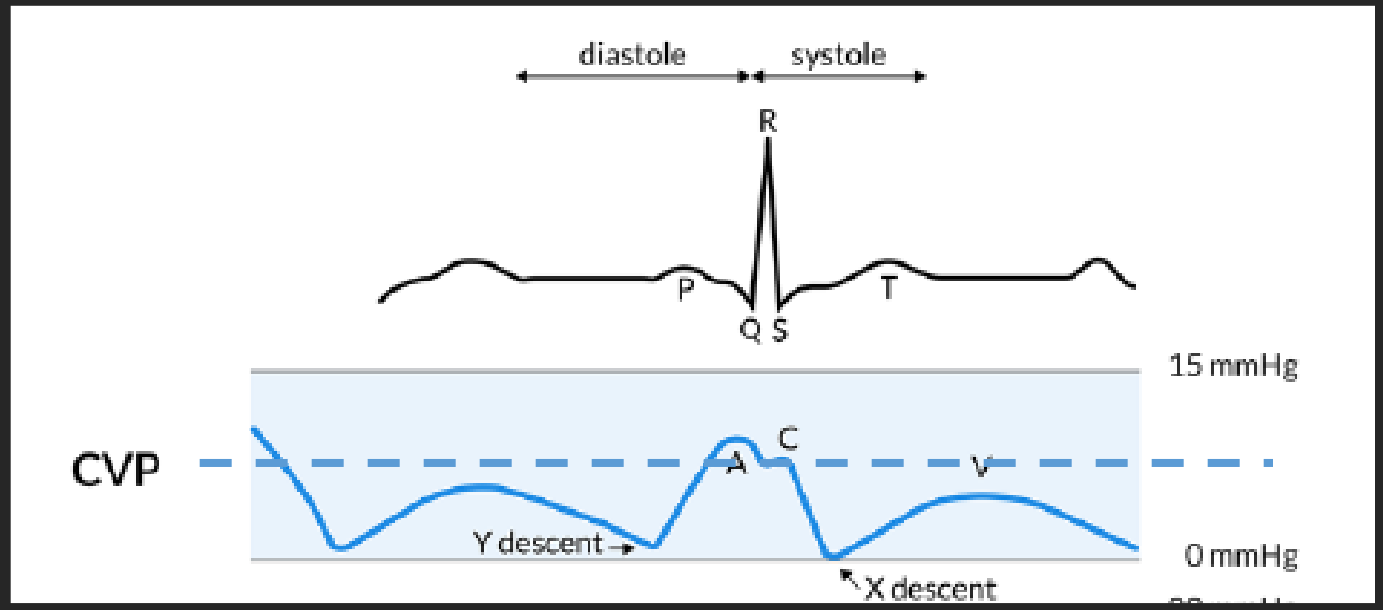
Soooou ísy...

Journal of Clinical Monitoring and Computing (2022) 36:5–15
https://doi.org/10.1007/s10877-021-00662-8

REVIEW PAPER

The contemporary pulmonary artery catheter. Part 1: placement and waveform analysis

I. T. Bootsma[1] · E. C. Boerma[1] · F. de Lange[1] · T. W. L. Scheeren[2]



1. LEVELING (FLEBOSTATICKÁ OSA)
2. ZEROING
3. DUMPING
4. SPRÁVNÝ ČAS
    1. END EXPIRATORY
    2. END DIASTOLIC (C-BASE)

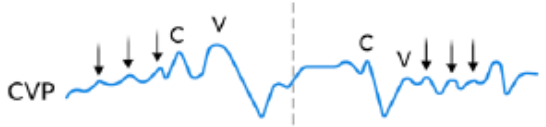
a = síňová kontrakce
c = uzávěr a vyklenutí trikuspidální chlopně
x = síňová relaxace, s distálním pohybem trikuspidální chlopně při kontrak
v = pasivní plnění síně (trikuspidální chlopeň stále uzavřena)
y = plnění komor s otevřenou trikuspidální chlopní

$10\ cmH_2O \approx 7{,}5\ mmHg$

A jen tak na okraj ... INTERPRETACE KŘIVKY

H. Atrial fibrillation/flutter

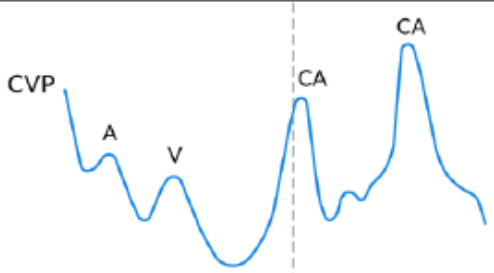
Characteristics:
- *Absence of A-wave;*
- *C and V-waves most prominent peaks;*
- *Beat to beat changing morphologies;*
- *Small amplitude pressure waves (fibrillation/flutter waves)*



I. AV dissociation

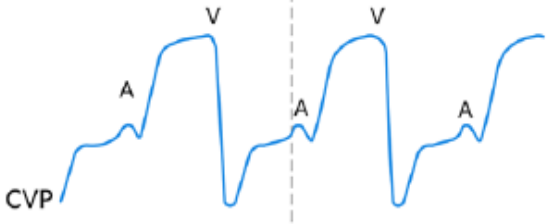
Ventricular tachycardia, AVNRT, Complete heart block

Characteristics:
- *Cannon A-wave during ventricular systole*



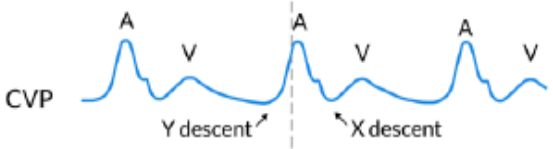
J. Tricuspid insufficiency

Characteristics:
- *Early holosystolig large V-wave;*
- *Merge with the C-wave;*
- *Disappearance of X-descent*



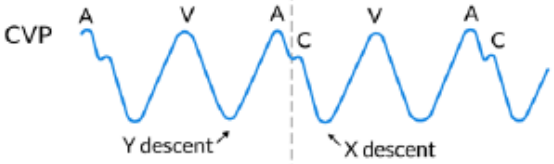
L. Tricuspid valve stenosis

Characteristics:
- *Large A-wave;*
- *Slow Y-descent*



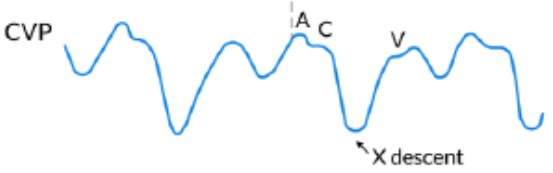
N. Pericardial constriction, RV infarction or restrictive cardiomyopathy

Characteristics:
- *Tall A-wave*
- *Tall V-wave*
- *Steep X-descent*
- *Steep Y-descent*



O. Tamponade

Characteristics:
- *Tall A-wave*
- *Tall V-wave*
- *Absent or diminished Y-descent*



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REVIEW PAPER

The contemporary pulmonary artery catheter. Part 1: placement and waveform analysis

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CVP IS A ~~RED~~ BLUE FLAG !!!

SUMMING UP

„CVP“ NENÍ „OUT-OF-FESHION“ ZKRATKA

- STÁLE OBSAHUJE DŮLEŽITÉ „HEMODYNAMICKÉ“ INFORMACE
- PRO ZAČÁTEK „KEEP IT LOW“
- KDYŽ ROSTE – PTEJ SE „PROČ ?“ A „CO JE ŠPATNĚ ?“
- VŽDY VYHODNOCUJ VE VZTAHU K SRDEČNÍMU VÝDEJI (A VENTILACI, A...)
- SLEDUJ PŘED, PŘI A PO PODÁNÍ TEKUTINY = FLUID TOLERANCE
- POKUD JE KŘIVKA DIVNÁ – UDĚLEJ POŘÁDNÝ ECHO
- ... a skoro nic to nestojí...

Česká anesteziologická cesta 2025

- Od posledního průzkumu uplynulo 15 let.
- Léky, přístroje i postupy se změnily — pojďme zjistit jak!
- Zapojte se do nového celonárodního průzkumu.
- Vyplňte krátký dotazník a pomozte ukázat, jak dnes opravdu podáváme anestezii.

Mockrát děkujeme

Výbor ČSARIM