Peroperační hypotenze

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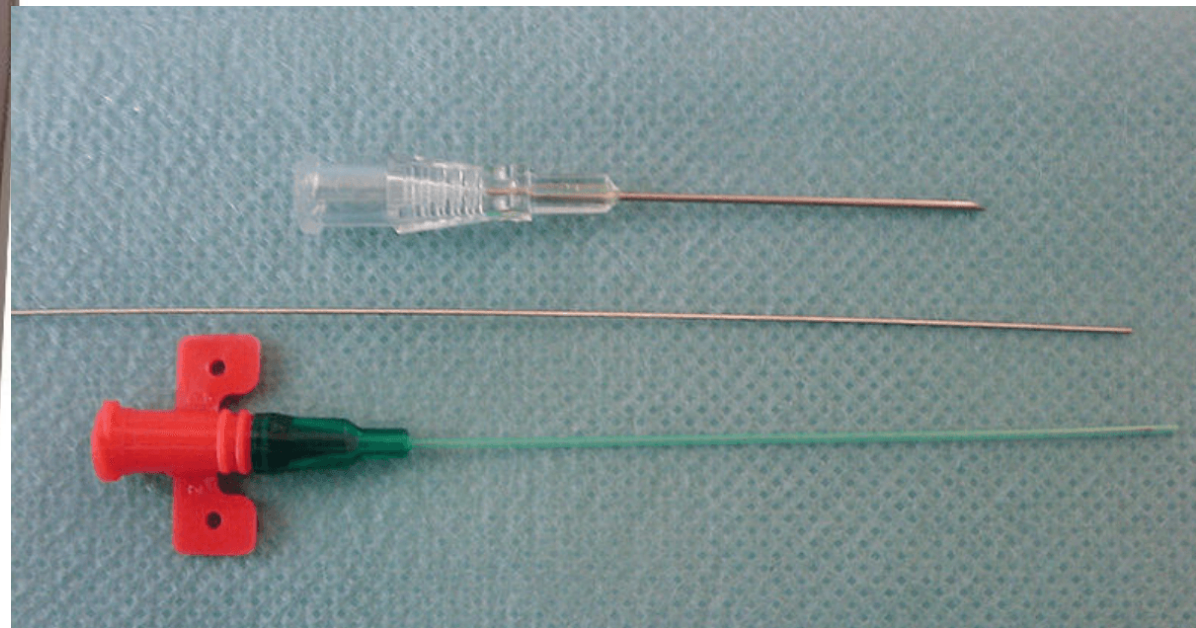
ČSARIM 2023

Konflikt zájmů

- Přednáška je honorována společností Edwards Lifesciences Czech Republic s.r.o.

Jak měříme krevní tlak?



Nezapomeňme, že IBP má také svá rizika

Complications following radial artery cannulation

Reference	Bleeding (*n*)
Mean incidenc	0.53 (2/375)

≈ 1 pacient z 1 000 bude mít permanentní ischemii

≈ 1 pacient ze 750 bude mít sepsi

Review > Crit Care. 2002 Jun;6(3):199-204. doi: 10.1186/cc1489. Epub 2002 Apr 18.

Clinical review: complications and risk factors of peripheral arterial catheters used for haemodynamic monitoring in anaesthesia and intensive care medicine

Bernd Scheer [1], Azriel Perel, Ulrich J Pfeiffer

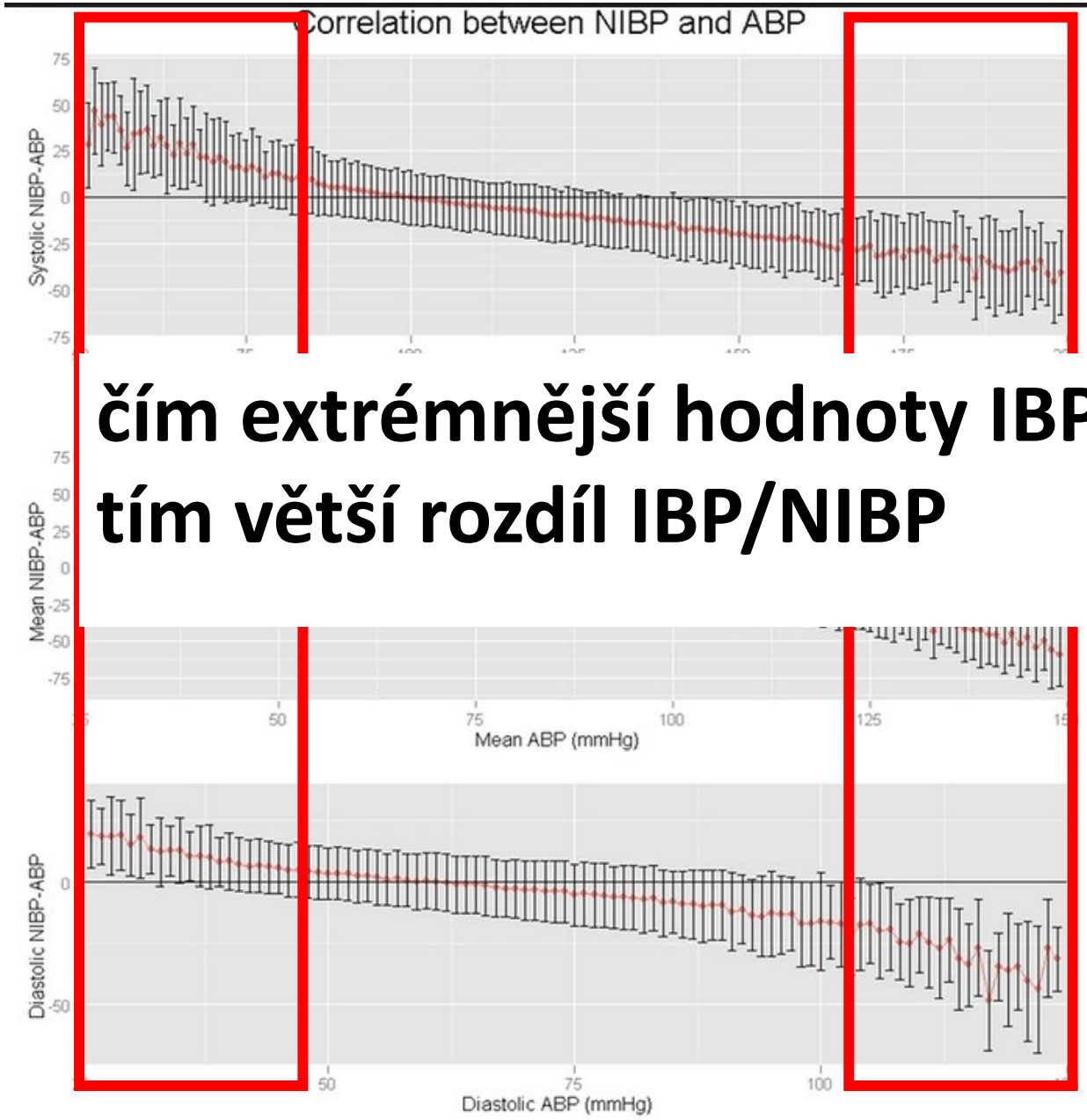


Figure 1
Graphical representation of the mean difference between NIBP and ABP across a physiologic range of systolic, mean, and diastolic blood pressures.

čím extrémnější hodnoty IBP, tím větší rozdíl IBP/NIBP

Anesthesiology. 2011 Nov;115(5):973-8. doi: 10.1097/ALN.0b013e3182330286.

Invasive and concomitant noninvasive intraoperative blood pressure monitoring: observed differences in measurements and associated therapeutic interventions

David B Wax [1], Hung-Mo Lin, Andrew B Leibowitz

Hemodynamic monitoring used for the management of high-risk surgery patients?.

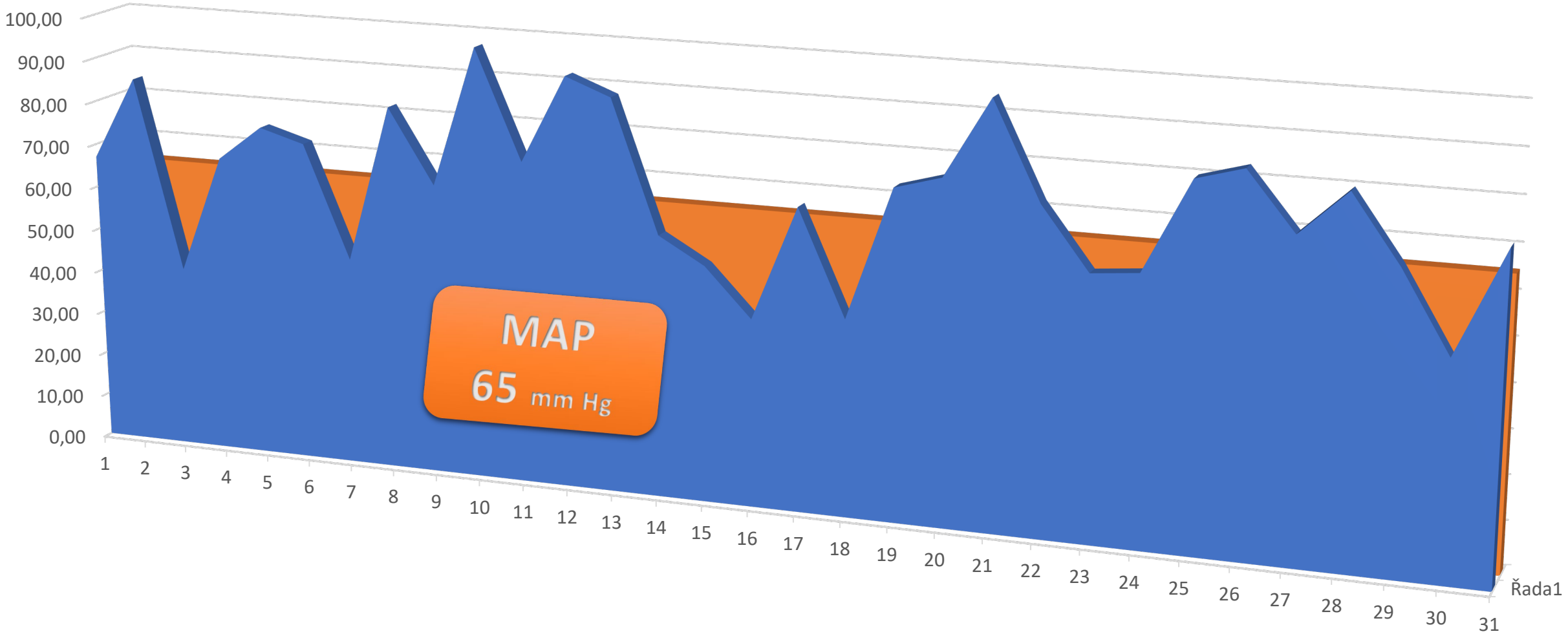
	ASA respondents (n = 237)	ESA respondents (n = 195)
Answer options	**Response percent**	**Response percent**
Invasive arterial pressure	95.4%	89.7%
Central venous pressure	72.6%	83.6%
Non-invasive arterial pressure	51.9%	53.8%
Cardiac output	35.4%	34.9%

› Crit Care. 2011 Aug 15;15(4):R197. doi: 10.1186/cc10364.

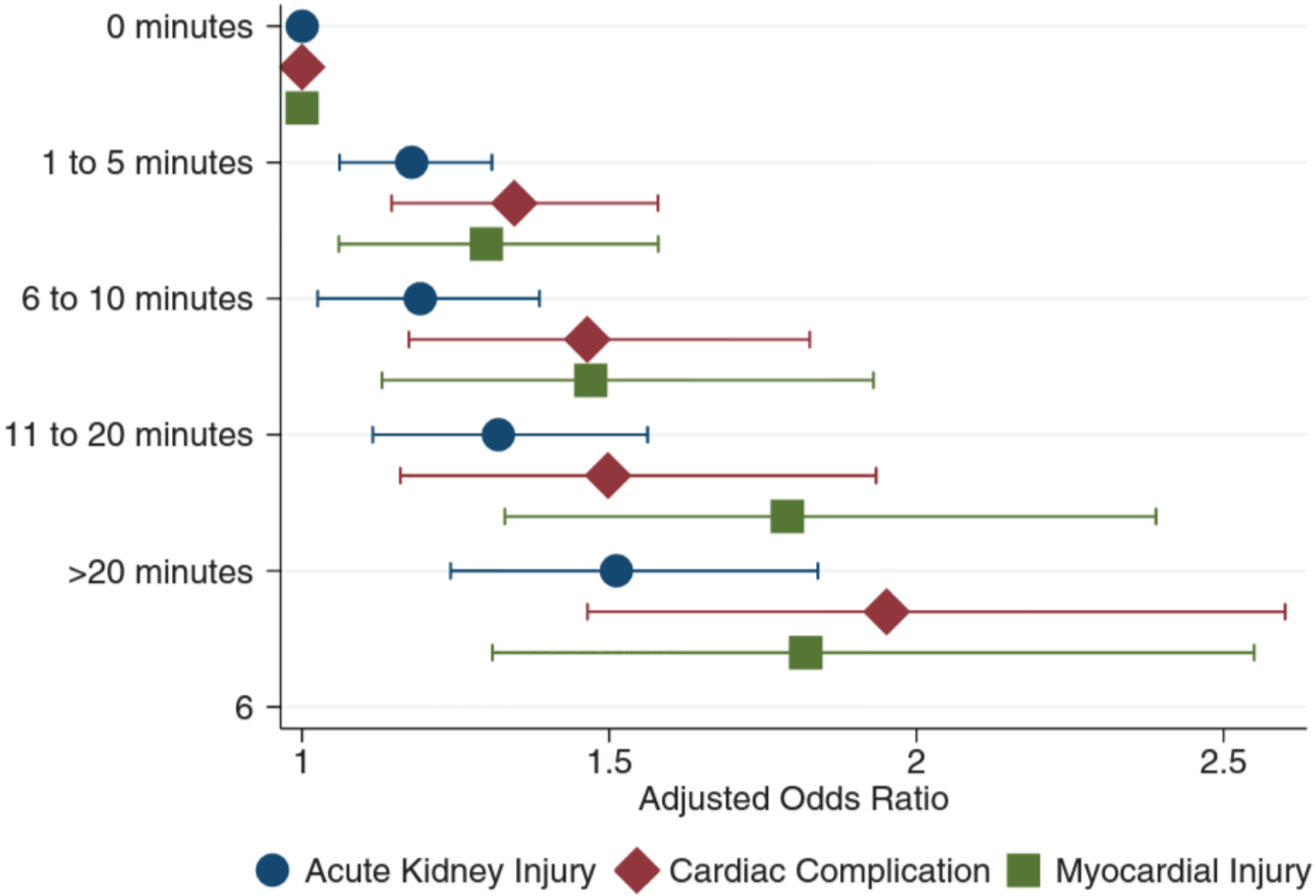
Hemodynamic monitoring and management in patients undergoing high risk surgery: a survey among North American and European anesthesiologists

Maxime Cannesson [1], Gunther Pestel, Cameron Ricks, Andreas Hoeft, Azriel Perel

Vypadá naše anestezie takto? A trápí nás to?



Mělo by!

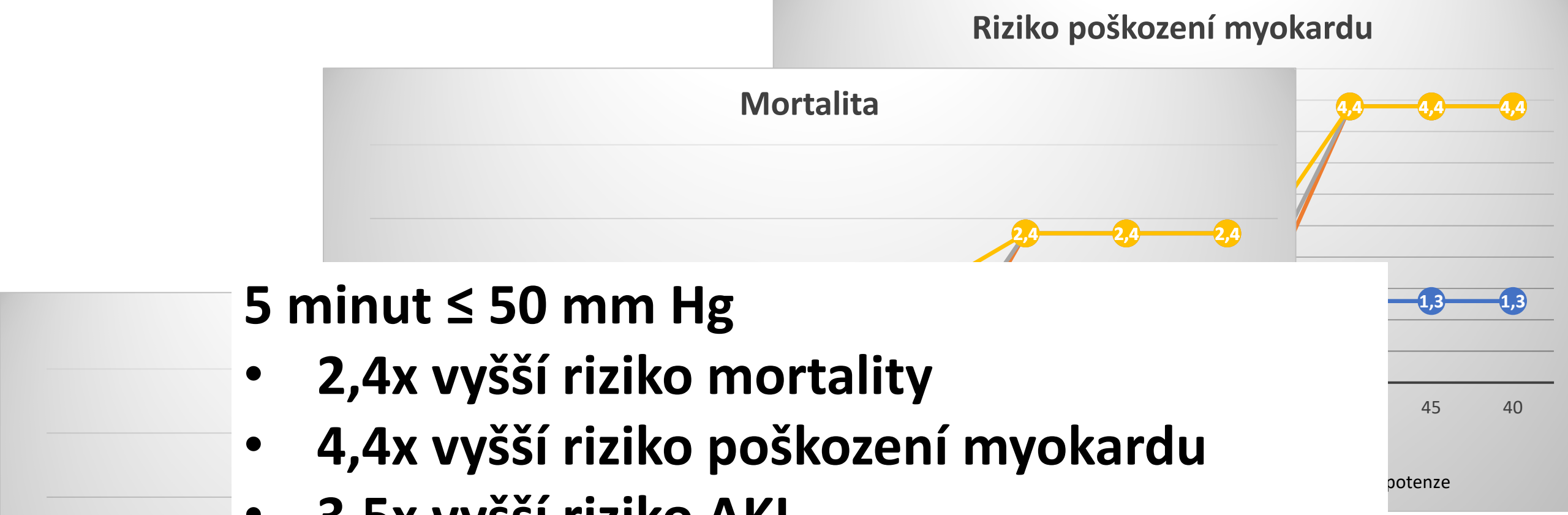


PERIOPERATIVE MEDICINE

Relationship between Intraoperative Mean Arterial Pressure and Clinical Outcomes after Noncardiac Surgery

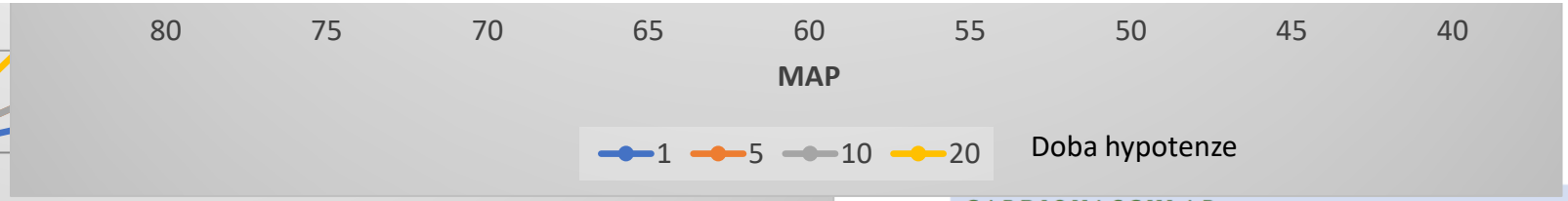
Toward an Empirical Definition of Hypotension

Michael Walsh, M.D.,* Philip J. Devereaux, M.D., Ph.D.,† Amit X. Garg, M.D., Ph.D.,‡ Andrea Kurz, M.D.,§ Alparslan Turan, M.D.,‖ Reitze N. Rodseth, M.D.,# Jacek Cywinski, M.D.,** Lehana Thabane, Ph.D.,†† Daniel I. Sessler, M.D.‡‡



5 minut ≤ 50 mm Hg

- 2,4x vyšší riziko mortality
- 4,4x vyšší riziko poškození myokardu
- 3,5x vyšší riziko AKI

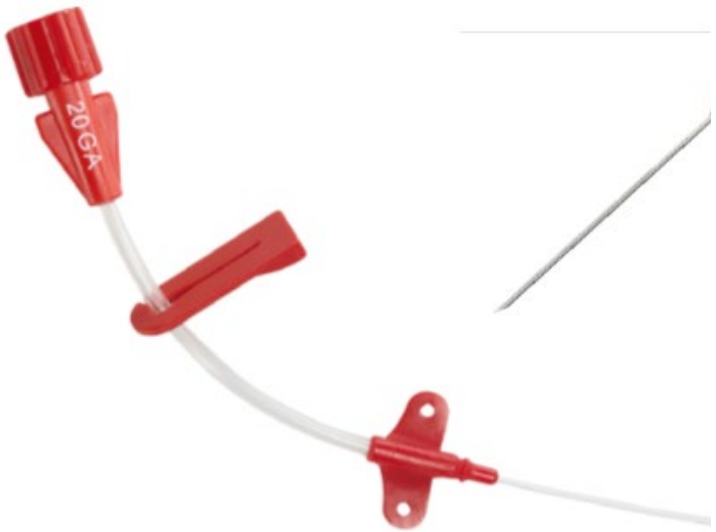


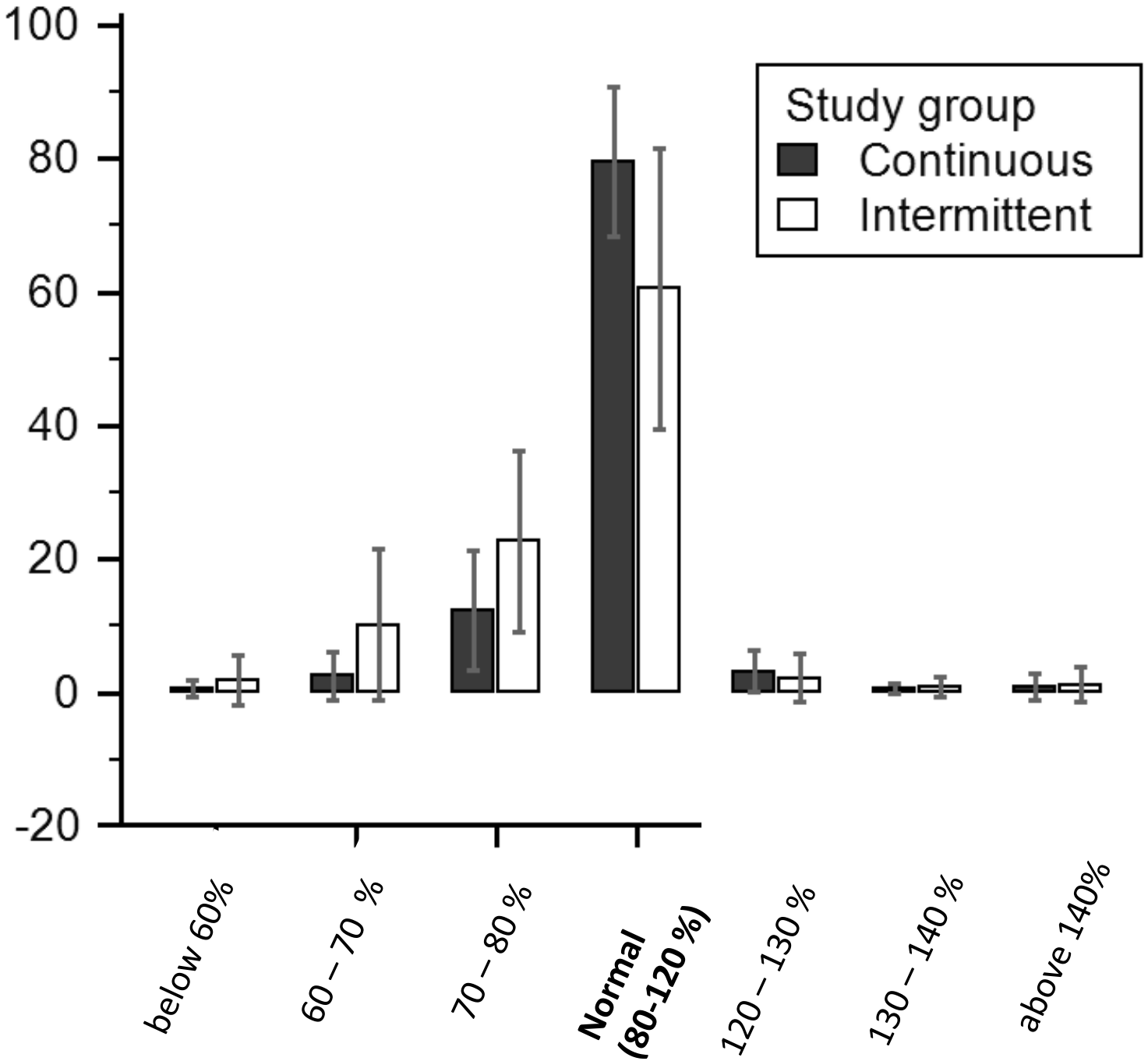
CARDIOVASCULAR

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]

Kontinuální monitorování





Absolutní a relativní trvání hypotenze bylo redukováno na 50 % a významné hypotenze na 25 %.

J Clin Monit Comput
DOI 10.1007/s10877-014-9586-2

ORIGINAL RESEARCH

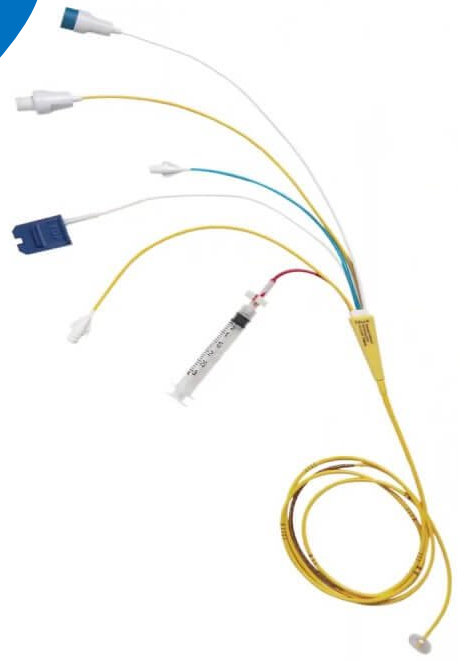
Continuous non-invasive monitoring improves blood pressure stability in upright position: randomized controlled trial

Jan Benes · Alena Simanova · Tereza Tovarnicka · Silvie Sevcikova · Jakub Kletecka · Jan Zatloukal · Richard Pradl · Ivan Chytra · Eduard Kasal

Můžeme se podívat na hypotenzi podrobněji?

Rozšířená monitorace hemodynamiky!

Swan-Ganz
Pulmonary Artery
Catheter




DON'T
PANIC
IT'S
NOT
THE TITANIC


Clinical Tools
Select Screens
Settings
Help
HPI 45 /100
% Change
5 min
MAP 82 ↓6% mmHg
CI 3.7 ↓5% L/min/m²
SVR 777 ↓2% dyne-s/cm⁵
PR ↓15% bpm
SVI 50 ↑12% mL/b/m²
PPV 11 ↑5% %
dP/dt 601 ↑11% mmHg/sec
Systolic Slope
Ea dyn 1.1 ↑24%
Preload
Kontraktilita
Afterload
113 / 62
(82)
mmHg
ART
25 mm/sec
HPI 45 /100
CI 3.7 L/min/m²
SVI 50 mL/b/m²
SVV 11 %

Hypovolemie jako příčina hypotenze?

	Day 0	Day 1	Δ D0 D1 % (95% CI)
SAP (mm Hg)	132 (19)	125 (17)	−4.9 (−7.0 to −2.8)
DAP (mm Hg)	77 (11)	76 (10)	−1.1 (−3.3 to 1.1)
HR (bpm)	76 (11)	72 (11)	−3.9 (−6.4 to −1.3)
E/Ea	6.14 (1.58)	6.13 (1.58)	1.4 (−2.3 to 5.1)

Lačnění 8 hodin před plánovaným výkonem (bez přípravy střeva) nevedlo k hypovolemii.

Conclusion: Preoperative fasting did not alter TTE dynamic and static preload indices in ASA I-III adult patients. These results suggest that preoperative fasting does not induce significant hypovolaemia.

British Journal of Anaesthesia 112 (5): 835–41 (2014)
Advance Access publication 3 February 2014 · doi:10.1093/bja/aet478

BJA

Preoperative fasting does not affect haemodynamic status: a prospective, non-inferiority, echocardiography study

L. Muller[1,3]*, M. Brière[1,3], S. Bastide[2], C. Roger[1,3], L. Zoric[1,3], G. Seni[2], J.-E. de La Coussaye[1,3], J. Ripart[1,3] and J.-Y. Lefrant[1,3]

Hypovolemie jako příčina hypotenze?

Table 1.
Effects of Bowel Preparation on Fluid Phases

	Day 1 Before Bowel Preparation	Day 4 After Bowel Preparation	*P* Value
Plasma volume (l)	2.94 (2.44–4.79)	3.05 (2.52–4.93)	0.48

Předoperační příprava střeva také nevede k významnému efektu na hemodynamiku, pokud jsou pacienti schopni p.o. přijímat adekvátní množství tekutin.

fluid intake.

Clinical Trial > Dis Colon Rectum. 2004 Aug;47(8):1397-402. doi: 10.1007/s10350-004-0592-1.

Physiologic effects of bowel preparation

Kathrine Holte [1], Kristine Grubbe Nielsen, Jan Lysgård Madsen, Henrik Kehlet

Affiliations + expand

PMID: 15484356 DOI: 10.1007/s10350-004-0592-1

Vstupní hypovolemie – zřejmě ne

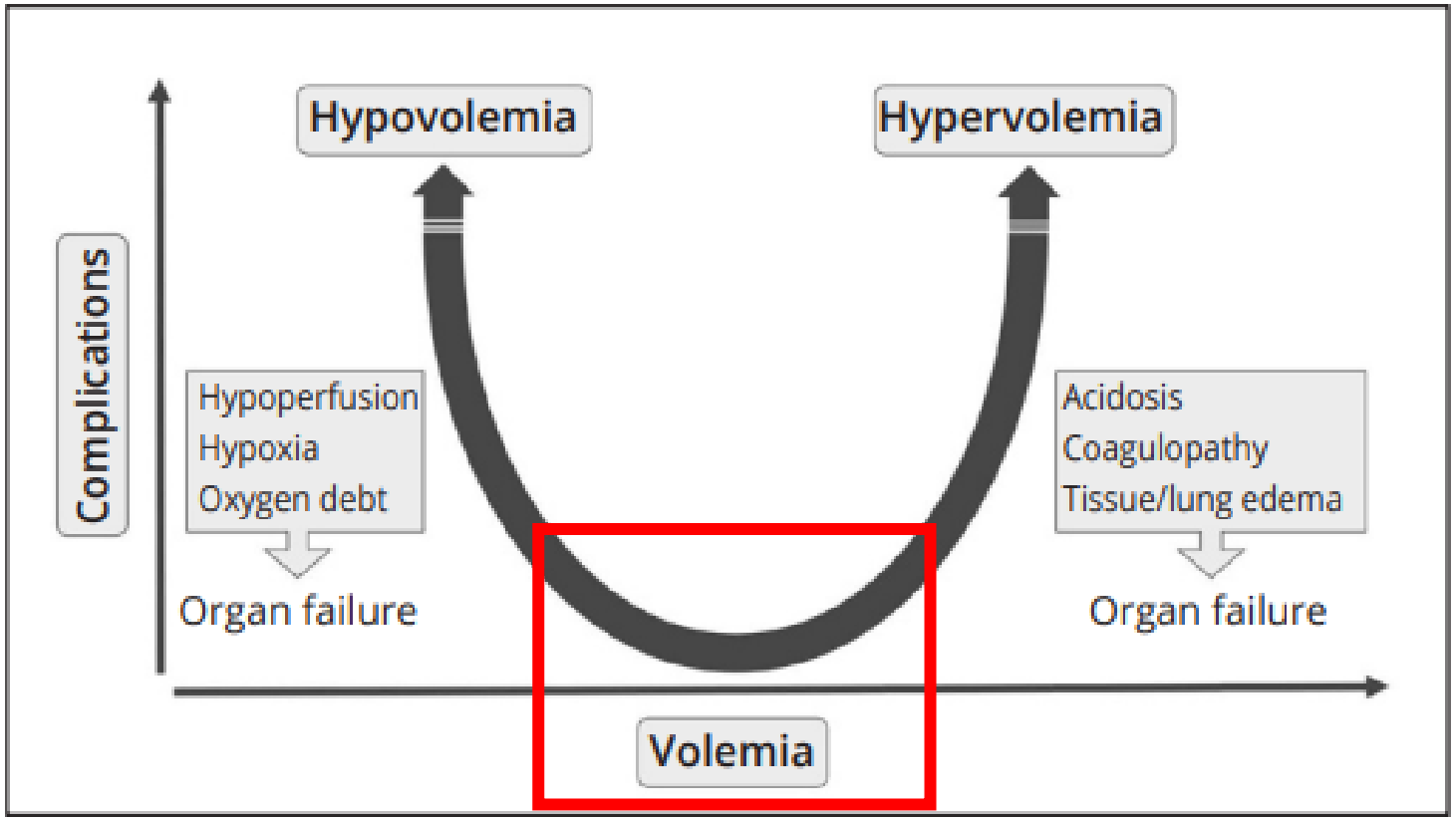


Figure 2.—U-shaped curve describing association of fluid therapy and postoperative complications. [Modified from Bellamy].[19]

5. Which fluid therapy strategy has a better impact on mortality and morbidity?

We suggest that in the perioperative period fluid strategy should aim to a near zero balance in patients considered normovolemic at the beginning of surgery. A slight positive fluid balance may be allowed in the first postoperative 24 hours in order to protect renal function.

Weak recommendation in favor. Quality of evidence: moderate. (2-B)

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Minerva Anestesiologica 2019 December;85(12):1315-33
DOI: 10.23736/S0375-9393.19.13584-5

REVIEW

Clinical guidelines for perioperative hemodynamic management of non cardiac surgical adult patients

Nicola BRIENZA [1] *, Giandomenico BIANCOFIORE [2], Franco CAVALIERE [3], Antonio CORCIONE [4], Andrea DE GASPERI [5], Rosanna C. DE ROSA [4], Roberto FUMAGALLI [6], Maria T. GIGLIO [1], Alessandro LOCATELLI [7], Ferdinando L. LORINI [8], Stefano ROMAGNOLI [9], Sabino SCOLLETTA [10], Luigi TRITAPEPE [11]


B BRAUN
Infusomat® Space
OK
BOL
Start
Stop
Avensys Resale
AMR4893
SERVICED
REPAIRED
ELECTRICAL SAFETY TESTED
NEXT CHECK
ENGINEER

Peroperační bilance tekutin?

GDFT založená na dynamických parametrech preloadu snížila výskyt komplikací o 49 %!

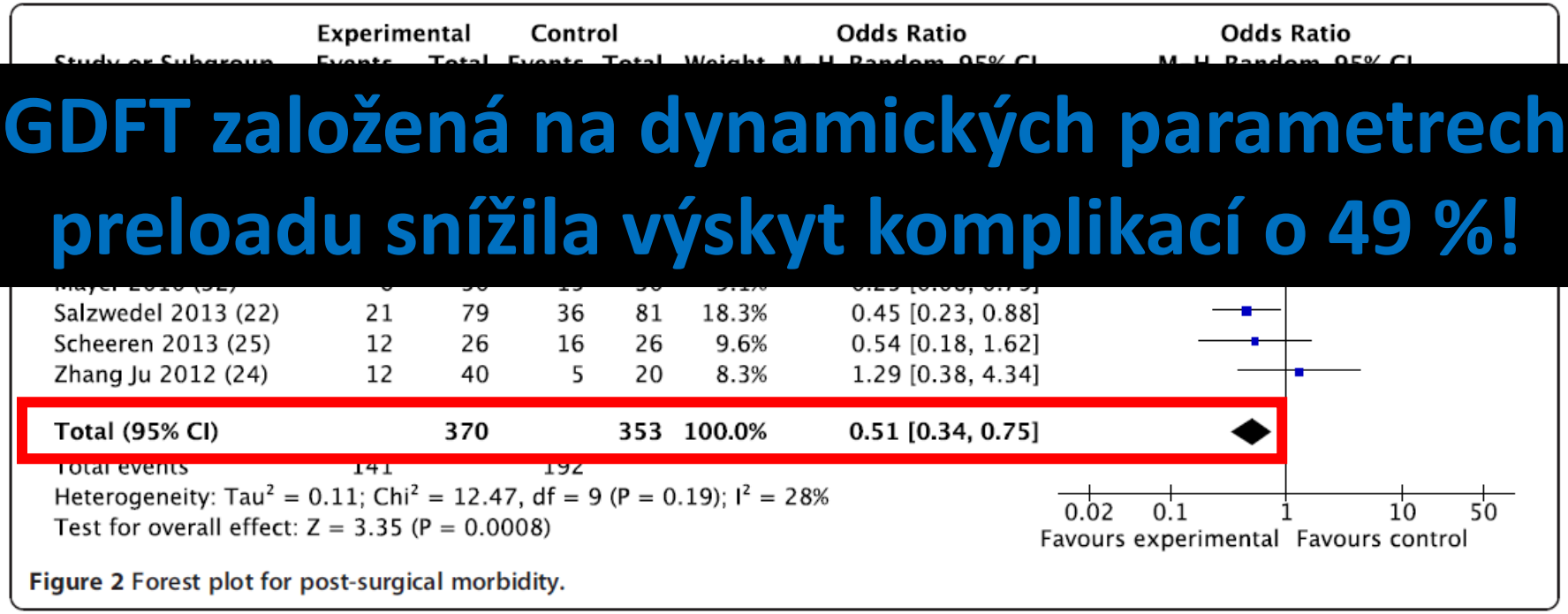


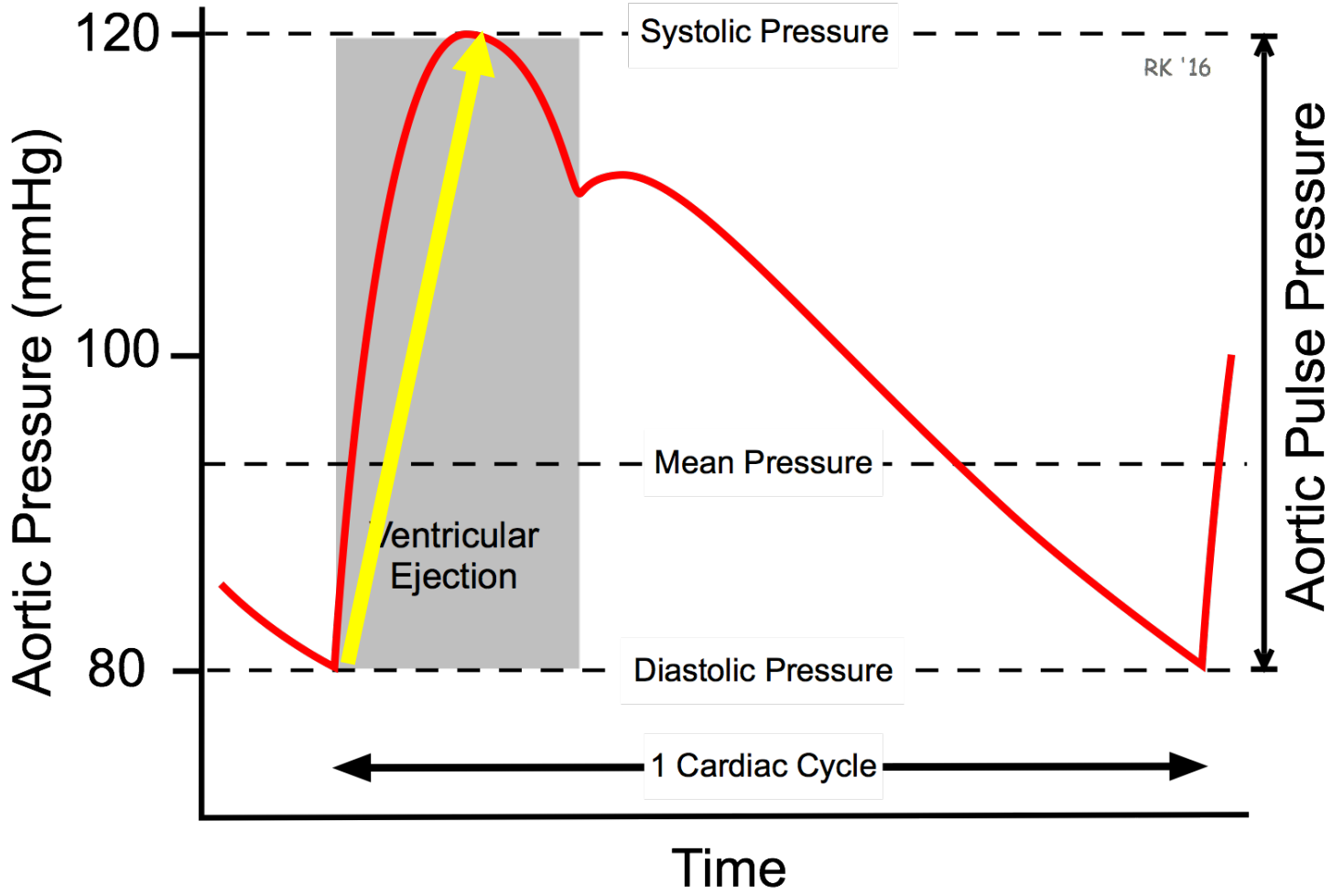
Figure 2 Forest plot for post-surgical morbidity.

Meta-Analysis › Crit Care. 2014 Oct 28;18(5):584. doi: 10.1186/s13054-014-0584-z.

The effects of goal-directed fluid therapy based on dynamic parameters on post-surgical outcome: a meta-analysis of randomized controlled trials

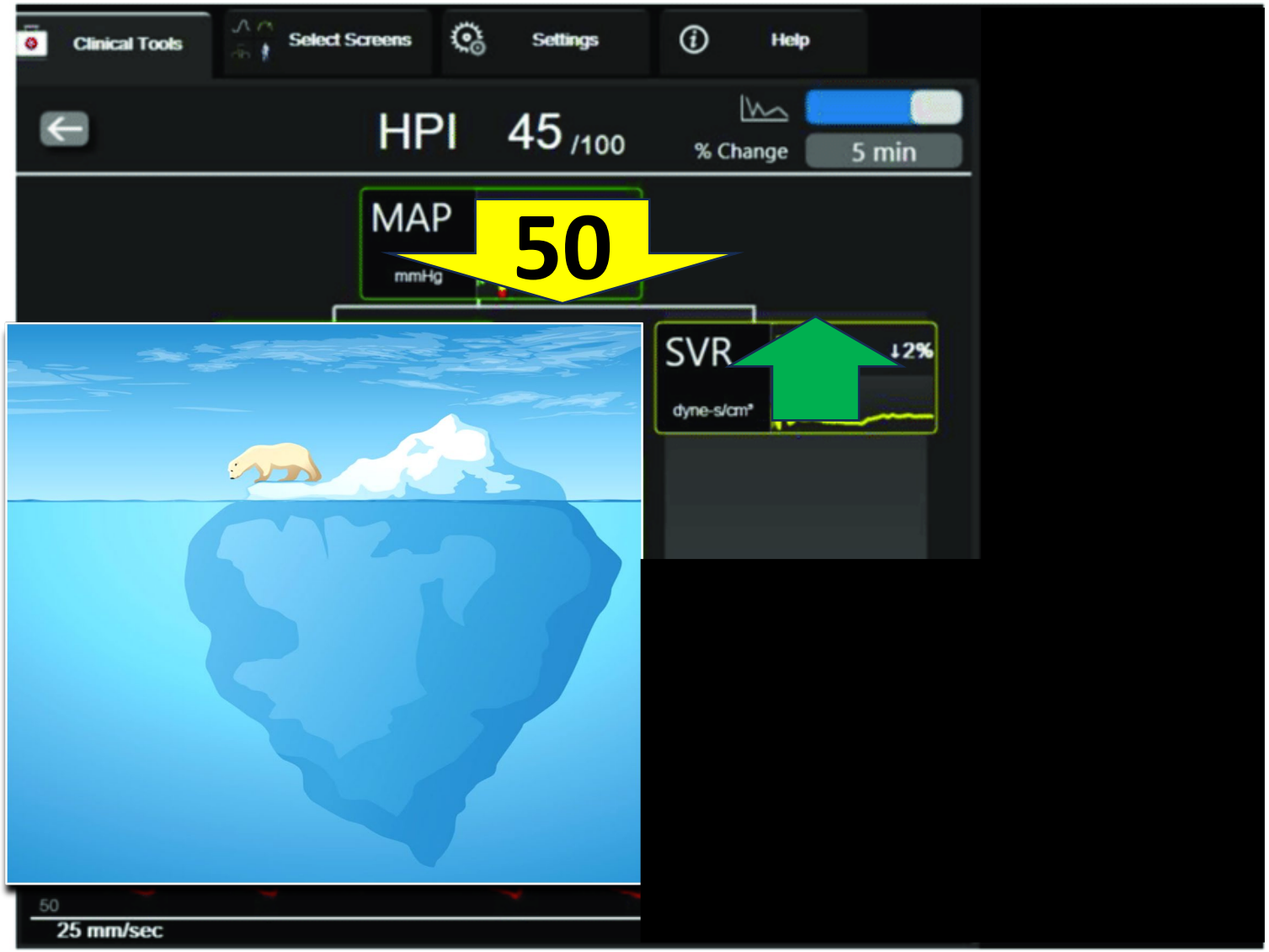
Jan Benes, Mariateresa Giglio, Nicola Brienza, Frederic Michard

Kontraktilita



Kontraktilita – vadí, když ji neznáme?

Kontraktilita – vadí, když ji neznáme?



Kontraktilita – vadí, když ji neznáme?

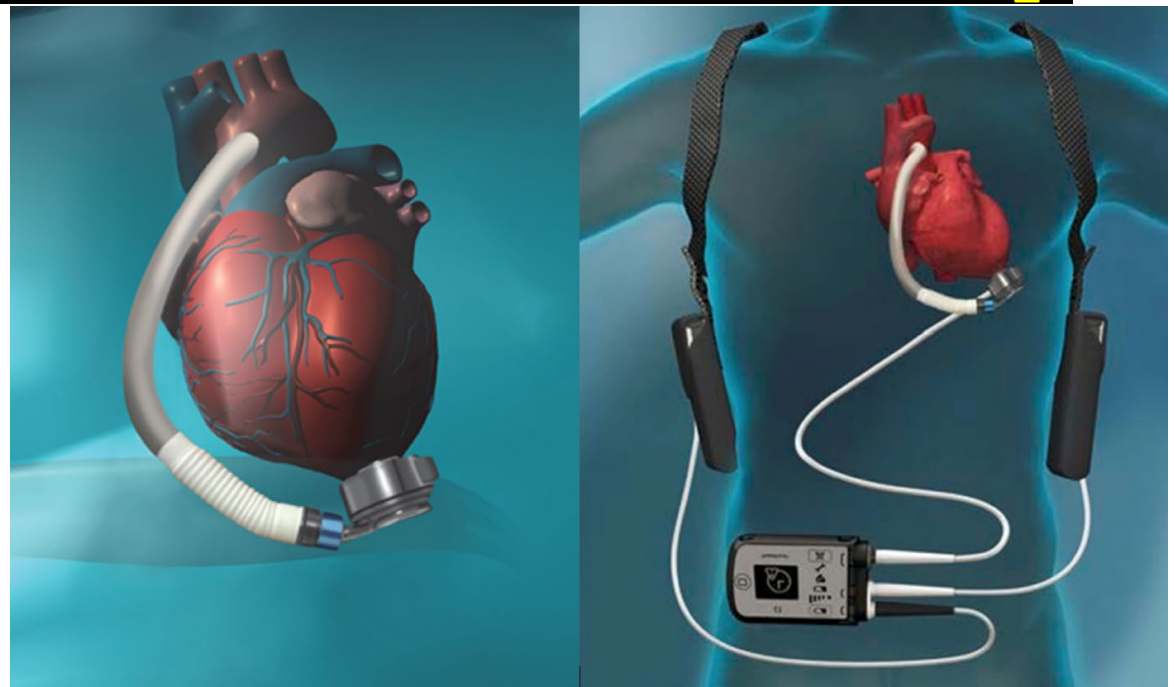
Zvýšení afterloadu u kardiálně limitovaných pacientů povede ke snížení CI a srdečnímu selhání.

Bez srdečního výdeje není dodávka O_2

DO_2 = **CO** x CaO_2

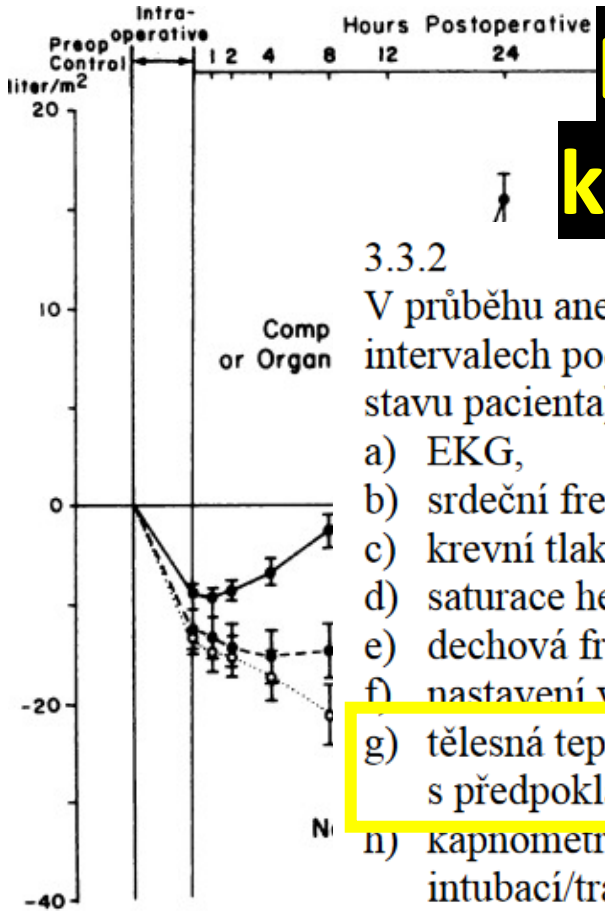
DO_2 = **CO** x (Hb x 1,34 x SaO_2)

DO_2 = **HR x EF x EDV** x (Hb x 1,34 x SaO_2)



Bez srdečního výdeje vznikne kyslíkový dluh

Kyslíkový dluh



Děláme vše proto, aby byl kyslíkový dluh co nejmenší?

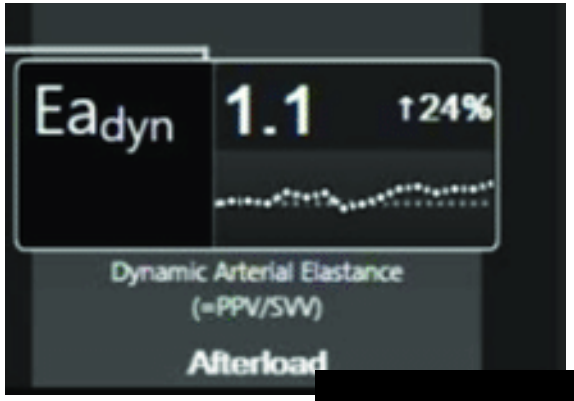
3.3.2
V průběhu anestezie jsou monitorovány (kontinuálně nebo v pravidelných přiměřených intervalech podle povahy operačního či diagnostického výkonu, sledovaného parametru a stavu pacienta) následující základní ukazatele:

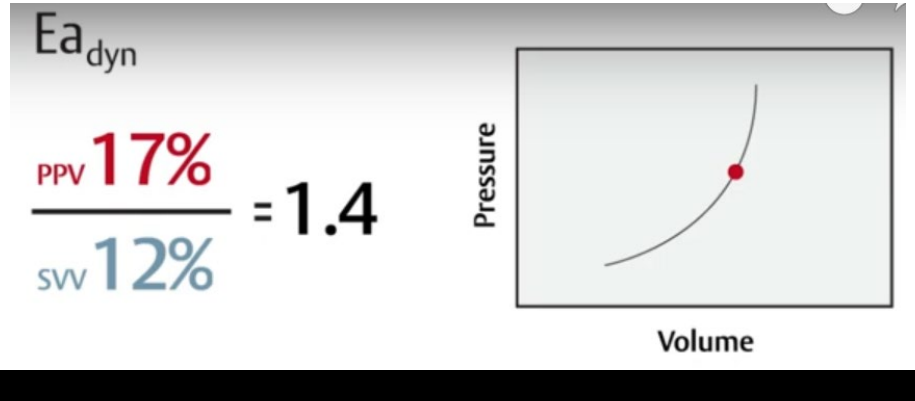
a) EKG,
b) srdeční frekvence,
c) krevní tlak (neinvazivní metoda),
d) saturace hemoglobinu kyslíkem metodou pulzní oxymetrie,
e) dechová frekvence spontánně dýchajících pacientů,
f) nastavení ventilátoru,
g) tělesná teplota (u novorozenců a kojenců vždy, u dospělých a dětí u výkonů s předpokladem doby trvání nad 30 minut),
h) kapnometrie (u všech výkonů, kde jsou zajištěny dýchací cesty tracheální intubací/tracheostomií, laryngeální maskou nebo jinou supraglotickou pomůckou)
i) hloubka nervosvalové blokády (NSB) u všech výkonů s použitím nedepolarizujících svalových relaxancií.

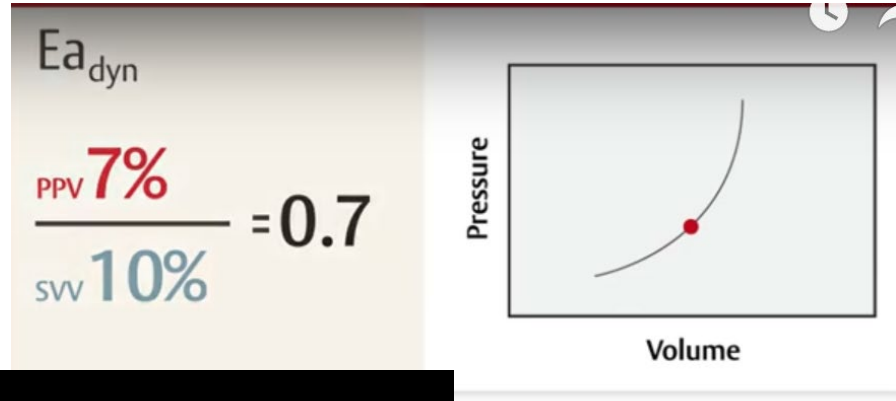
t in the Development of
s, and Death in High-Risk

William C. Shoemaker M.D. *, Paul L. Appel M.P.A. *, Harry B. Kram M.D. *

Dynamická arteriální elastance

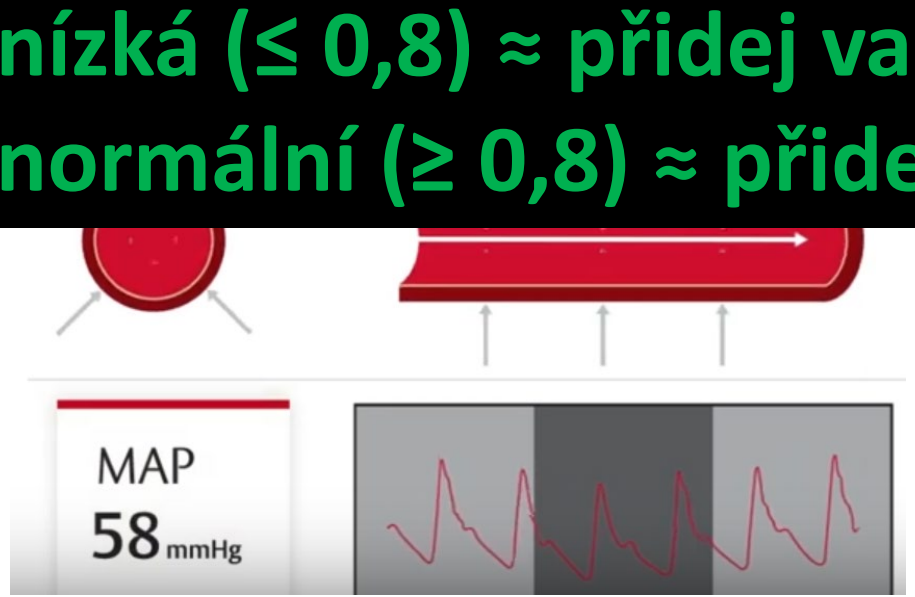


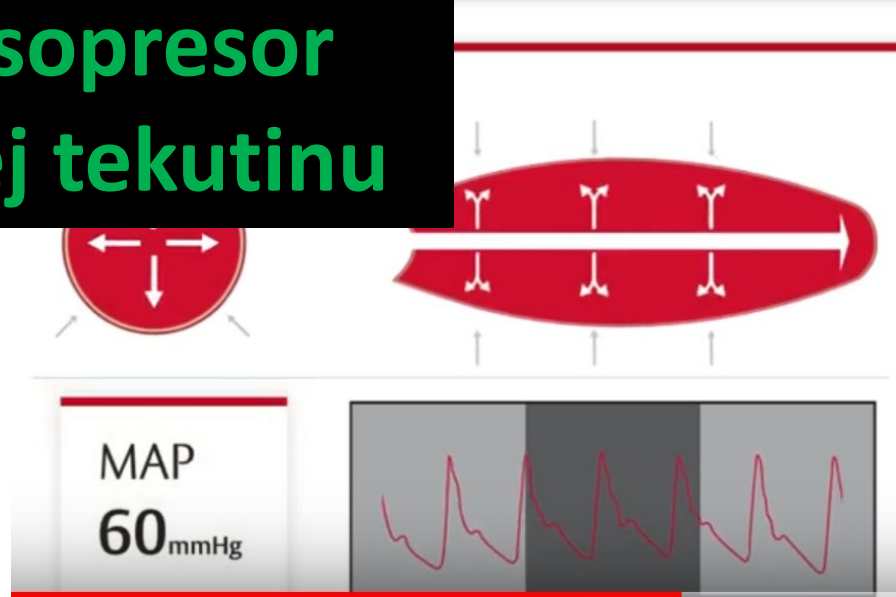




- Ea_{dyn} nízká (≤ 0,8) ≈ přidej vasopresor
- Ea_{dyn} normální (≥ 0,8) ≈ přidej tekutinu

Ea_{dyn} = PPV/SVV





Máme doporučení pro rozšířenou monitoraci hemodynamiky?

7.3. Perioperative goal-directed therapy

There is accumulating evidence underlining the advantages of goal-directed fluid therapy in non–cardiac-surgery patients. Goal-directed therapy aims to optimize cardiovascular performance in order to achieve normal or even supranormal oxygen delivery to tissues by optimizing preload and inotropic function using predefined haemodynamic goals. In contrast to clinical signs or arterial pressure-orientated standard therapy, goal-directed therapy is based on flow or fluid responsiveness of haemodynamic variables, such as stroke volume, response to fluid challenges, stroke volume or pulse pressure variation, or similar cardiac output optimization.

The mortality benefit of goal-directed fluid therapy was most pronounced in patients with an extremely high risk of death (>20%). All high-risk patients undergoing major surgery had a benefit from goal-directed fluid therapy in terms of complications.[263] A meta-analysis published in 2014 demonstrated that in patients with CVDs, goal-directed therapy decreased major morbidity without any increase in adverse cardiovascular events.[264]

EJA

Eur J Anaesthesiol 2014; **31**:517–573

GUIDELINES

2014 ESC/ESA Guidelines on non-cardiac surgery: cardiovascular assessment and management

The Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA)

Máme doporučení pro rozšířenou monitoraci hemodynamiky?

High risk patients seem to benefit from GDT.[11] Although representing a small percentage (12%) of total patients,[13] they contribute for 80% to global postoperative mortality.[14] In elective abdominal surgery mortality of high-risk patients amounts to 4.5%, rising up to 8% in intestinal resections.[13] In case of urgent and emergent surgery mortality increases up to 12% and 25%, respectively.[13] Risk depends on patient morbidity, type, duration and context of surgery, and/or combination of both.[15] In order to evaluate risk of mortality and morbidity, scores and calculators have been proposed.[13, 16]

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1b. Is mortality reduced by adoption of a perioperative GDT protocol in comparison with standard of care treatment in high risk adult non cardiac surgical patients?

We suggest adopting a perioperative GDT protocol in order to reduce mortality in high risk adult non cardiac surgical patients.

Weak recommendation in favor. Quality of evidence: moderate (2-B) (Table III).

1c. Is morbidity reduced by adoption of a perioperative GDT protocol in comparison with standard of care treatment in adult non cardiac surgical patients?

We recommend adoption of a perioperative GDT protocol to guide fluid therapy and reduce morbidity in adult non cardiac surgical patients.

We recommend adoption of a perioperative GDT protocol to reduce postoperative renal, gastrointestinal and infective complications

Strong recommendation in favor. Quality of evidence: high (1-A) (Table IV).

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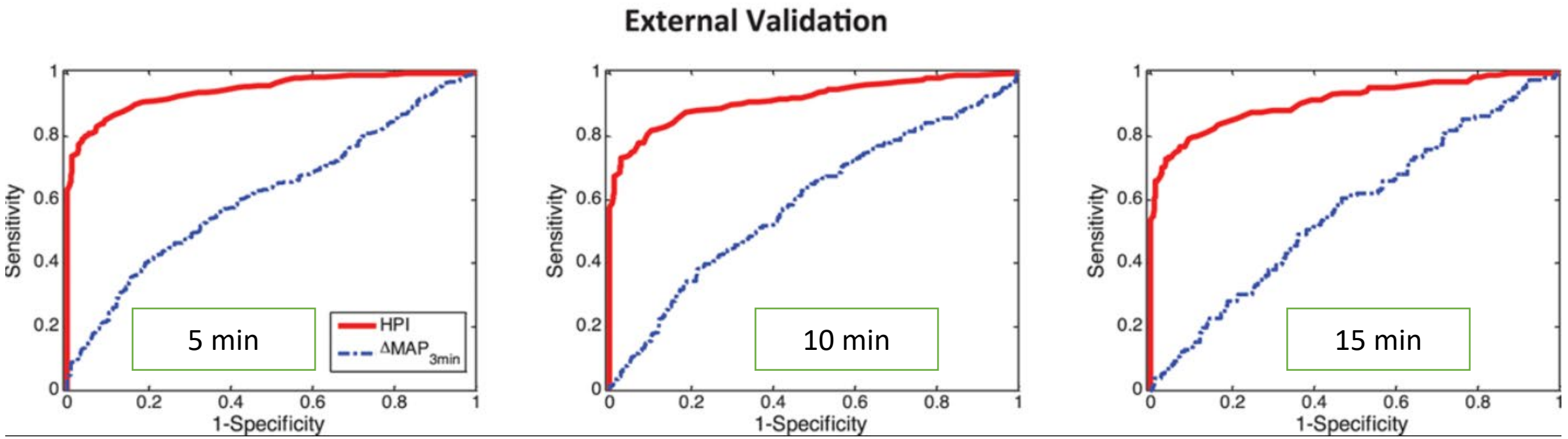
HPI - Hypotension Prediction Index

- HPI nabývá obnost hypotenze
- Hypotenze m Hg
- HPI dostupı
- HPI není jer hemodynar

HPI - Hypotension Prediction Index



Perioperative Medicine | October 2018

Machine-learning Algorithm to Predict Hypotension Based on High-fidelity Arterial Pressure Waveform Analysis FREE

Feras Hatib, Ph.D.; Zhongping Jian, Ph.D.; Sai Buddi, Ph.D.; Christine Lee, M.S.; Jos Settels, M.S.; Karen Sibert, M.D., F.A.S.A.; Joseph Rinehart, M.D.; Maxime Cannesson, M.D., Ph.D.

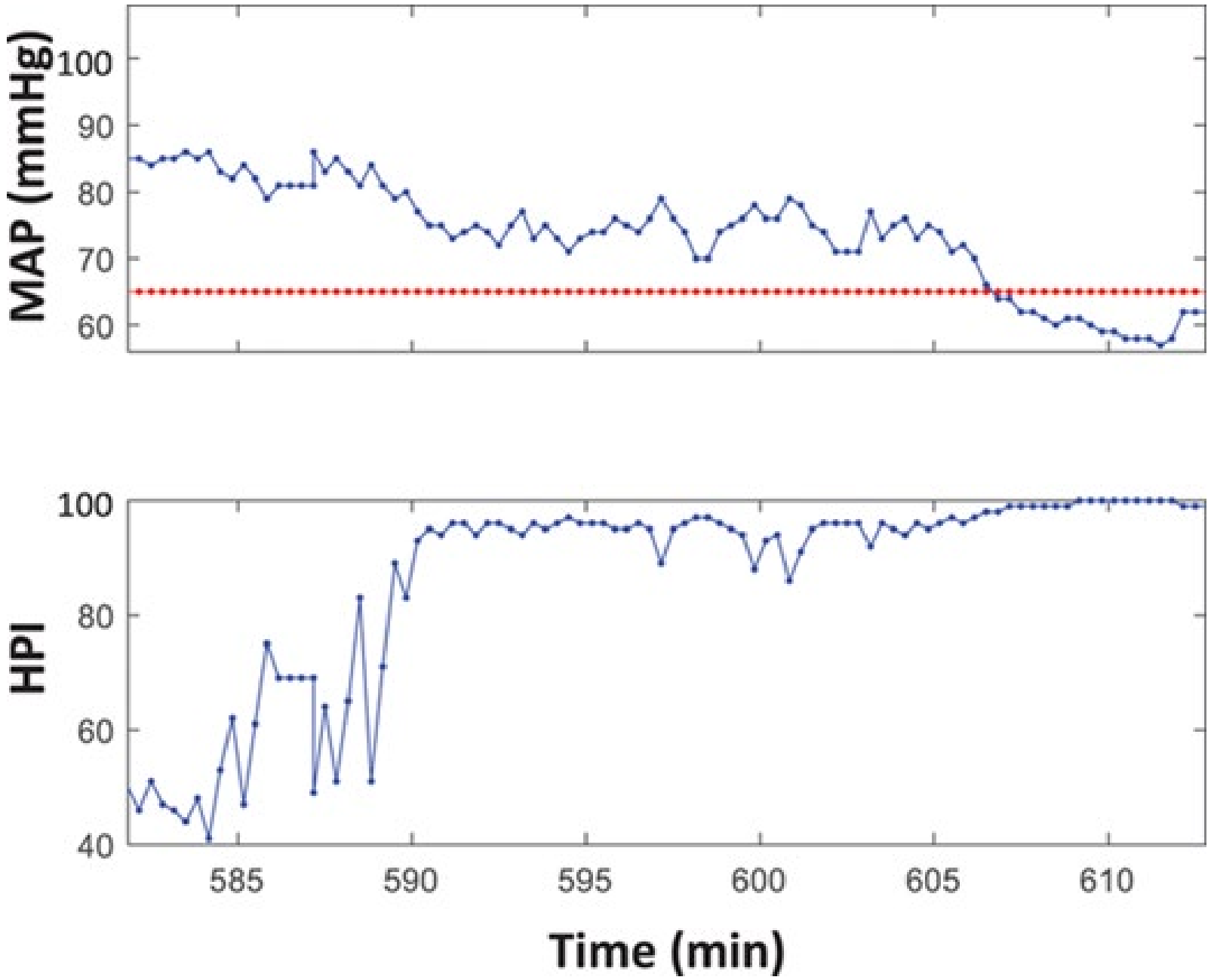
+ Author and Article Information

Anesthesiology October 2018, Vol. 129, 663–674.

https://doi.org/10.1097/ALN.0000000000002300

Parameter	Time to Event	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	Threshold
Internal validation cohort							
HPI	5 min	0.97 (0.971–0.977)	91.8 (89.7–94.0)	92.2 (90.3–94.0)	88.8 (87.9–89.7)	94.4 (93.8–94.9)	41
	10 min	0.9	8	5 (87.3–91.7)	76.7 (75.3–78.1)	95.6 (95.1–96.1)	38
	15 min	0.95 (0.940–0.952)	87.5 (85.1–89.9)	87.3 (84.8–89.8)	67.2 (65.6–68.9)	95.9 (95.4–96.4)	36
ΔMAP_{20s}	5 min			9.7–52.2)	—	—	0.05 mmHg
	10 min			9.3–51.7)	—	—	0.03 mmHg
	15 min			8.2–50.6)	—	—	−0.01 mmHg
ΔMAP_{1min}	5 min			0.9–53.4)	—	—	0.15 mmHg
	10 min			9.3–51.7)	—	—	0.08 mmHg
	15 min			9.3–51.7)	—	—	0.08 mmHg
ΔMAP_{3min}	5 min			3.0–55.9)	—	—	0.29 mmHg
	10 min			0.1–52.8)	—	—	0.14 mmHg
	15 min			9.6–52.2)	—	—	0.11 mmHg
ΔMAP_{5min}	5 min			3.5–56.3)	—	—	0.31 mmHg
	10 min			1.7–54.5)	—	—	0.19 mmHg
	15 min			1.0–53.8)	—	—	0.14 mmHg

Predikce přes 90 %


MAP (mmHg)
100
90
80
70
60
HPI
100
80
60
40
585
590
595
600
605
610
Time (min)

HPI nám umožní vyhnout se „alpine anestezii“

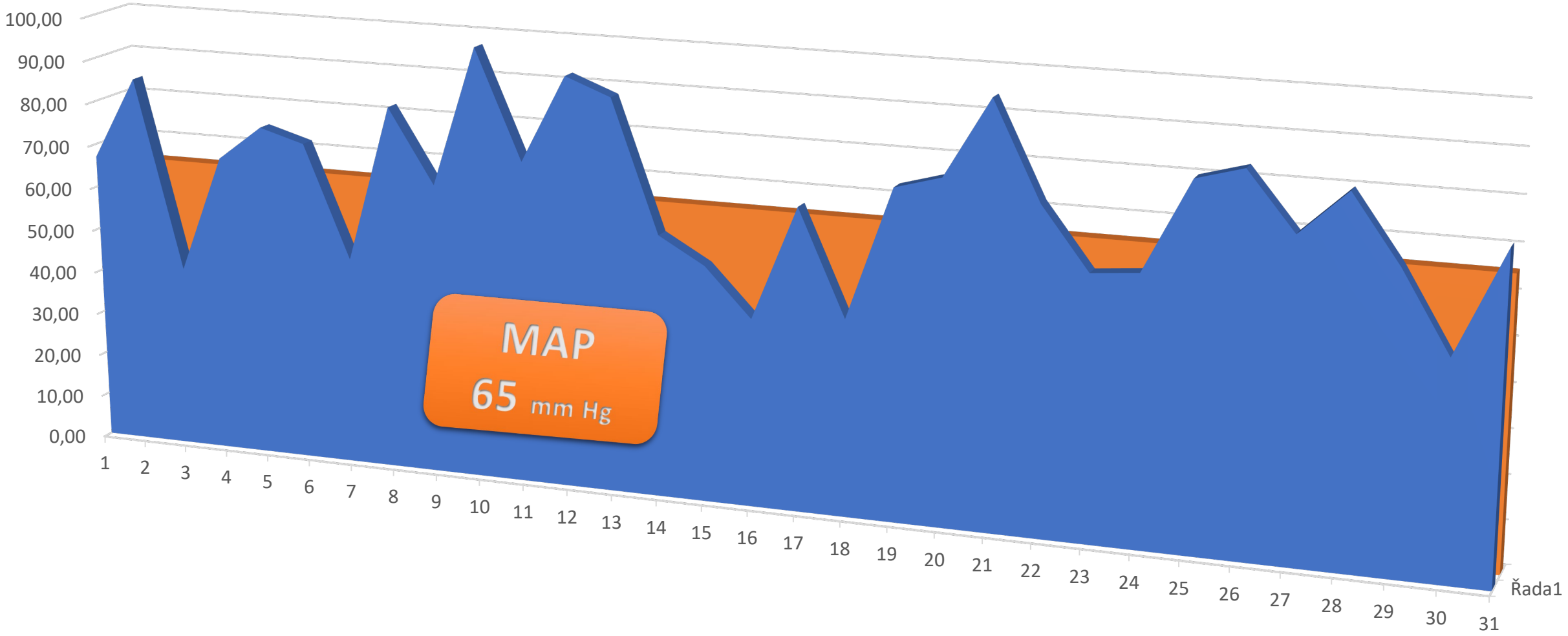


Table 2. Primary and Secondary End Points

	Median (Interquartile Range)[a]			
	Intervention (n = 31)	Control (n = 29)	Median Difference (95% CI)[b]	*P* Value[c]
Primary End Point				
Time-weighted average of hypotension, mm Hg	0.10 (0.01-0.43)	0.44 (0.23-0.72)	0.38 (0.14 to 0.43)	.001
Secondary End Points				
Hypotension				
Area under the threshold, mm Hg/min[d]	20.0 (2.2-148.3)	142.2 (64.67-258.92)	74.0 (33.0 to 137.7)	.002
Incidence	3.0 (1.0-8.0)	8.0 (3.5-12.0)	4.0 (1.0 to 7.0)	.004
Total time, min	8.0 (1.3-26.0)	32.7 (11.5-59.7)	16.7 (7.7 to 31.0)	.001
Surgery time, %	2.8 (0.8-6.6)	10.3 (4.6-15.6)	5.6 (3.0 to 9.4)	<.001

JAMA | Preliminary Communication | CARING FOR THE CRITICALLY ILL PATIENT

Effect of a Machine Learning–Derived Early Warning System for Intraoperative Hypotension vs Standard Care on Depth and Duration of Intraoperative Hypotension During Elective Noncardiac Surgery
The HYPE Randomized Clinical Trial

Marije Wijnberge, MD; Bart F. Geerts, MD, PhD, MSc, MBA; Liselotte Hol, MD; Nikki Lemmers, MD; Marijn P. Mulder, BSc; Patrick Berge, MD; Jimmy Schenk, MSc; Lotte E. Terwindt, MD; Markus W. Hollmann, MD, PhD; Alexander P. Vlaar, MD, PhD, MBA; Denise P. Veelo, MD, PhD

HPI v Plzni

HPI	kontrola
20	20
50 %	80 %
0,4 mm Hg x min	17,5 mm Hg x min

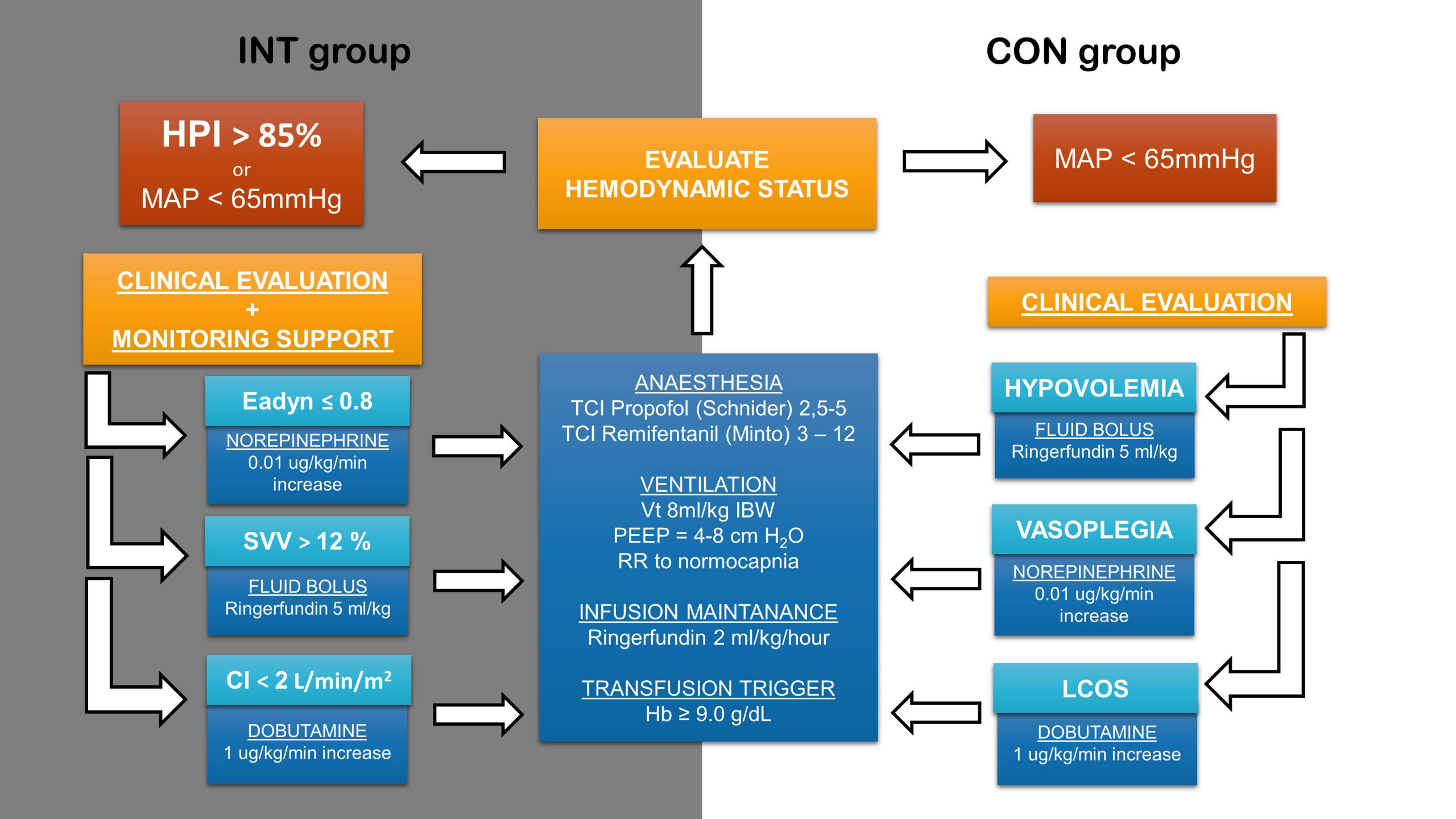
Minerva Anestesiologica 2023 June;89(6):510-9

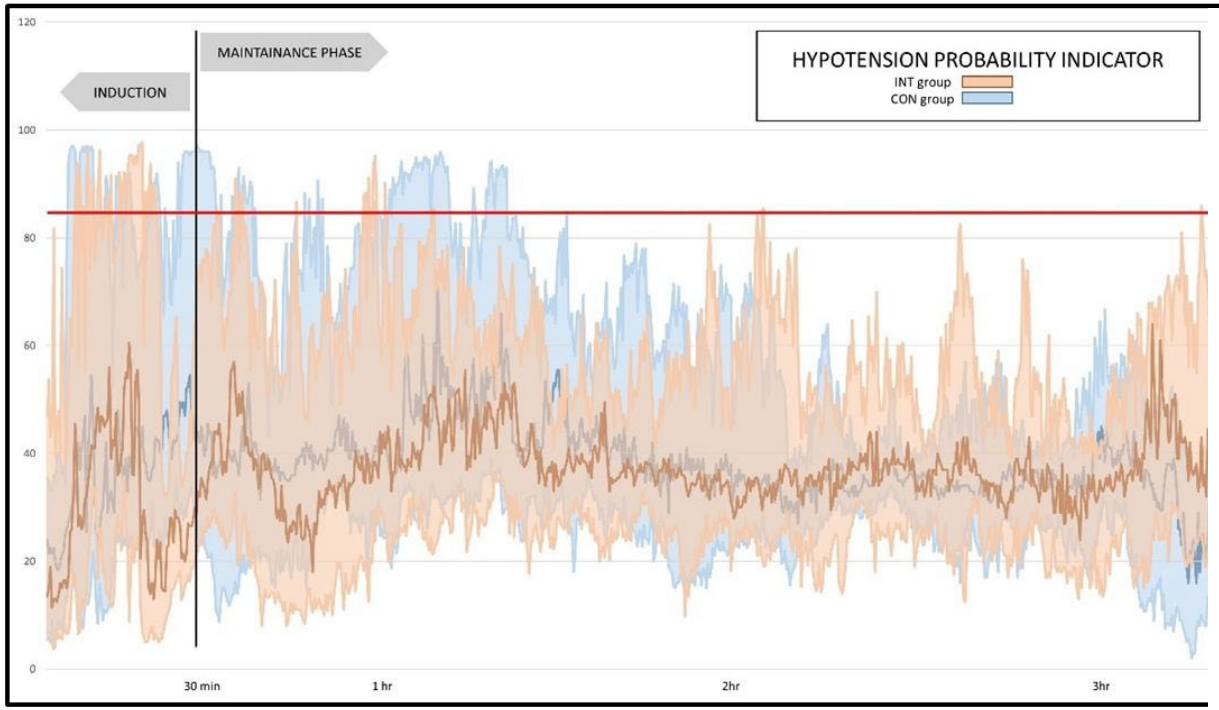
DOI: **10.23736/S0375-9393.23.17197-5**

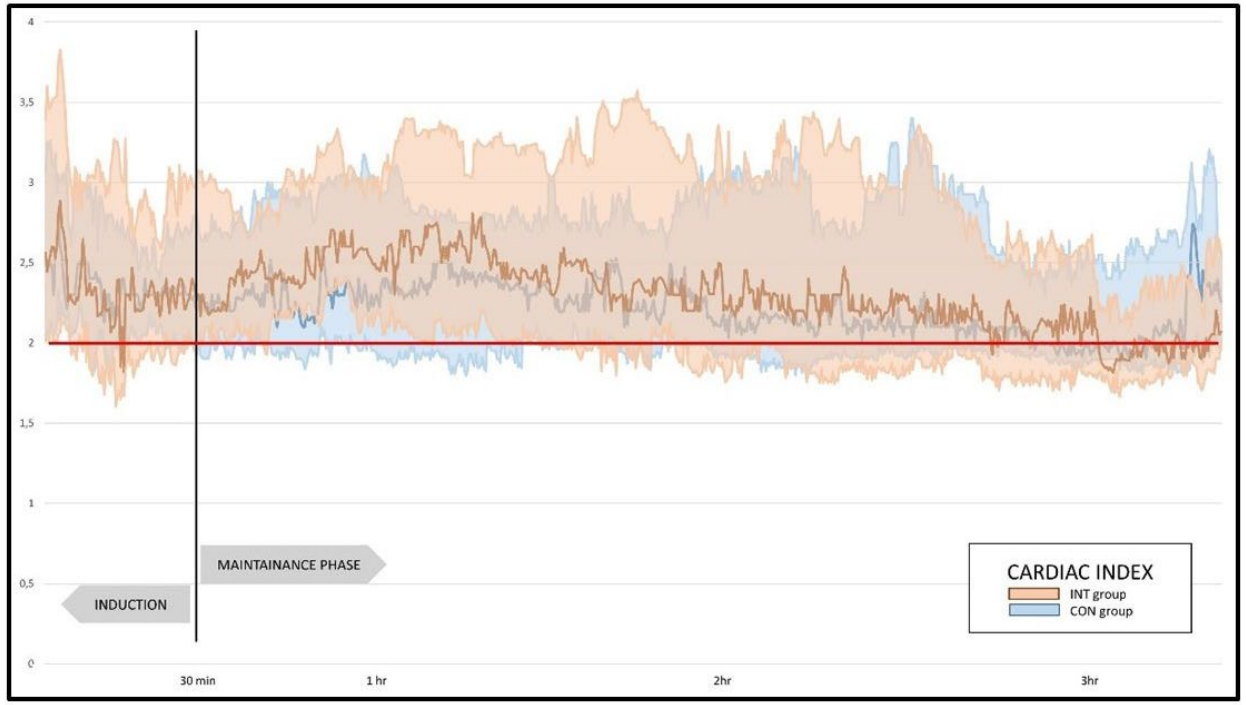
language: English

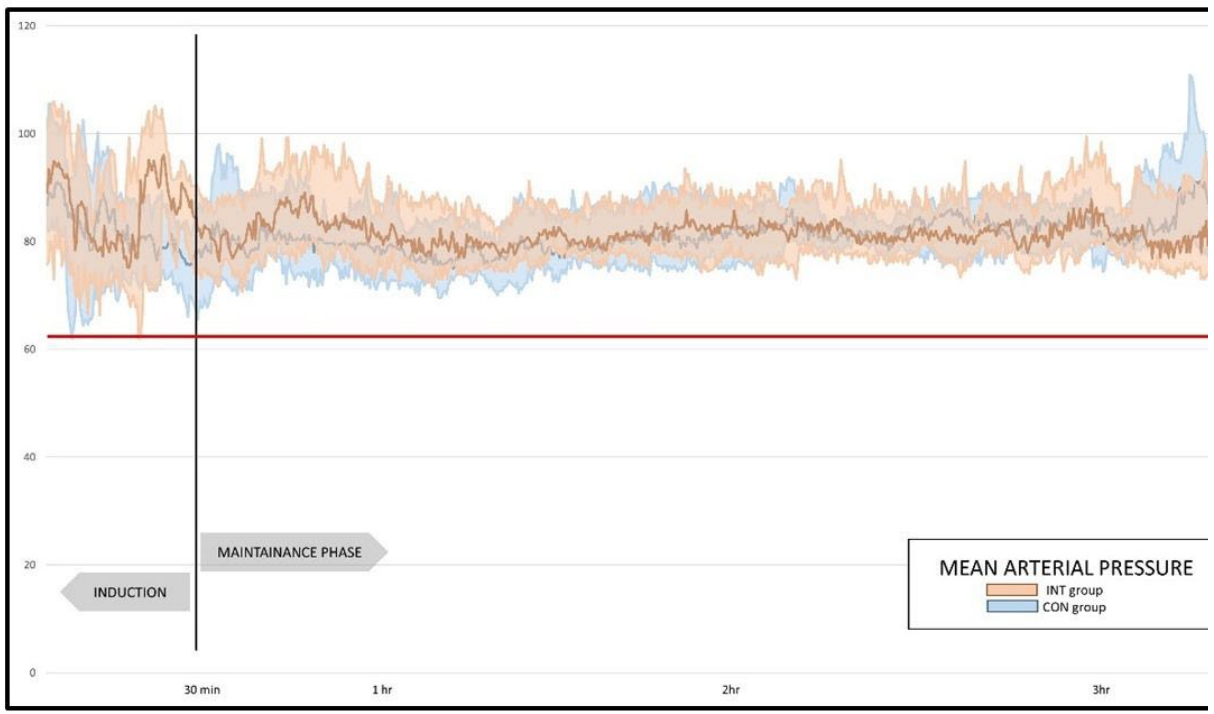
A protocol based on hypotension probability indicator vs. standard care to prevent intraoperative hypotension during supratentorial brain surgery: a prospective randomized pilot trial

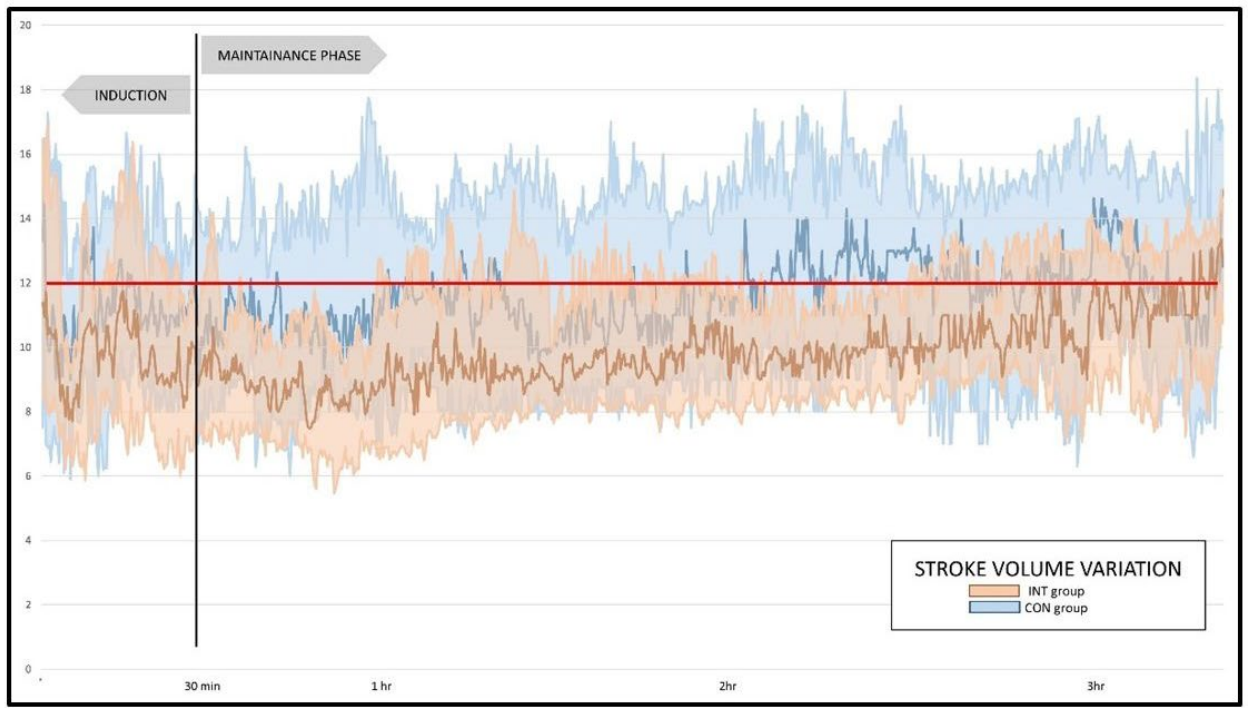
Jiri POUSKA [1, 2], Jakub KLETECKA [1, 2], Jan ZATLOUKAL [1, 2], Vaclav CERVENY [1], Jan BENES [1, 2, 3]


INT group
CON group
HPI > 85%
or
MAP < 65mmHg
EVALUATE HEMODYNAMIC STATUS
MAP < 65mmHg
CLINICAL EVALUATION + MONITORING SUPPORT
CLINICAL EVALUATION
Eadyn ≤ 0.8
NOREPINEPHRINE
0.01 ug/kg/min increase
SVV > 12 %
FLUID BOLUS
Ringerfundin 5 ml/kg
CI < 2 L/min/m²
DOBUTAMINE
1 ug/kg/min increase
ANAESTHESIA
TCI Propofol (Schnider) 2,5-5
TCI Remifentanil (Minto) 3 – 12
VENTILATION
Vt 8ml/kg IBW
PEEP = 4-8 cm H2O
RR to normocapnia
INFUSION MAINTANANCE
Ringerfundin 2 ml/kg/hour
TRANSFUSION TRIGGER
Hb ≥ 9.0 g/dL
HYPOVOLEMIA
FLUID BOLUS
Ringerfundin 5 ml/kg
VASOPLEGIA
NOREPINEPHRINE
0.01 ug/kg/min increase
LCOS
DOBUTAMINE
1 ug/kg/min increase


HYPOTENSION PROBABILITY INDICATOR
INT group
CON group
INDUCTION
MAINTAINANCE PHASE
120
100
80
60
40
20
0
30 min
1 hr
2hr
3hr


CARDIAC INDEX
INT group
CON group
INDUCTION
MAINTAINANCE PHASE
4
3,5
3
2,5
2
1,5
1
0,5
0
30 min
1 hr
2hr
3hr


MEAN ARTERIAL PRESSURE
INT group
CON group
INDUCTION
MAINTAINANCE PHASE
120
100
80
60
40
20
0
30 min
1 hr
2hr
3hr


STROKE VOLUME VARIATION
INT group
CON group
INDUCTION
MAINTAINANCE PHASE
20
18
16
14
12
10
8
6
4
2
0
30 min
1 hr
2hr
3hr

Klíčové sdělení

- **MAP < 65 mm Hg poškozuje naše pacienty**
- **Rizikoví pacienti profitují z rozšířené monitorace hemodynamiky**
- **HPI nám může pomoci ještě snížit výskyt peroperační hypotenze**

Výhled do budoucna

- Umožnit přenastavení definice hypotenze jako individualizace pro konkrétního pacienta (např. definovat hypotenzi jako MAP ≤ 70)?
- HPI v intenzivní péči?

Děkuji za pozornost