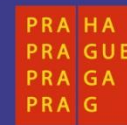




OPERAČNÍ PROGRAM PRAHA
KONKURENCESCHOPNOST



EVROPSKÝ FOND PRO REGIONÁLNÍ ROZVOJ



NIRS pro neonatology

současné možnosti klinického využití

PRAHA & EU

INVESTUJEME DO VAŠÍ BUDOUCNOSTI

NIRS odhaľuje jasnejšiu budúcnosť – stretnutie expertov

Oponice , 15.–16.ledna 2018

Prpf. MUDr. Richard PLAVKA, CSc.,

Neonatologické oddělení GPK VFN v Praze a 1. LF UK

Projekt „Péče o nezralé novorozence“, reg. Č. CZ.2.16/3.1.00/21564

Základní principy NIRS

Měření cerebrální oxygenace a průtoku u nezralých novorozenců

- Absolutní hodnoty vs. dynamické hodnoty
- Randomizované studie – SafeBoocS Trial, COSGOT
- Observační studie: autoregulace průtoku mozkem, stabilizace na PS, IVH, PDA, hypotenze

Jaké je klinické využití?

Blízká budoucnost

Relativní změny HbO₂ a Hb

- HbO₂, oxyhemoglobin, TO
- Hb, deoxyhemoglobin, TOI
- HbT, totální hemoglobin (Hb+HbO₂=HbT), CBF

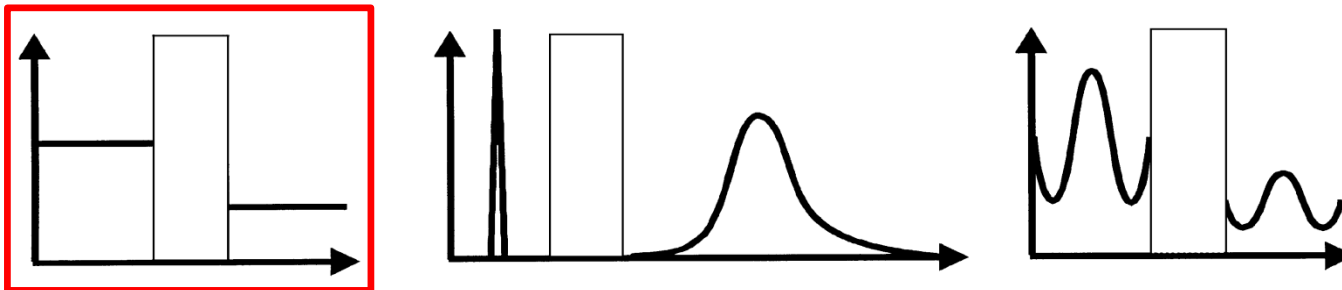
NIRO 200: 775, 810, 850 (nm)

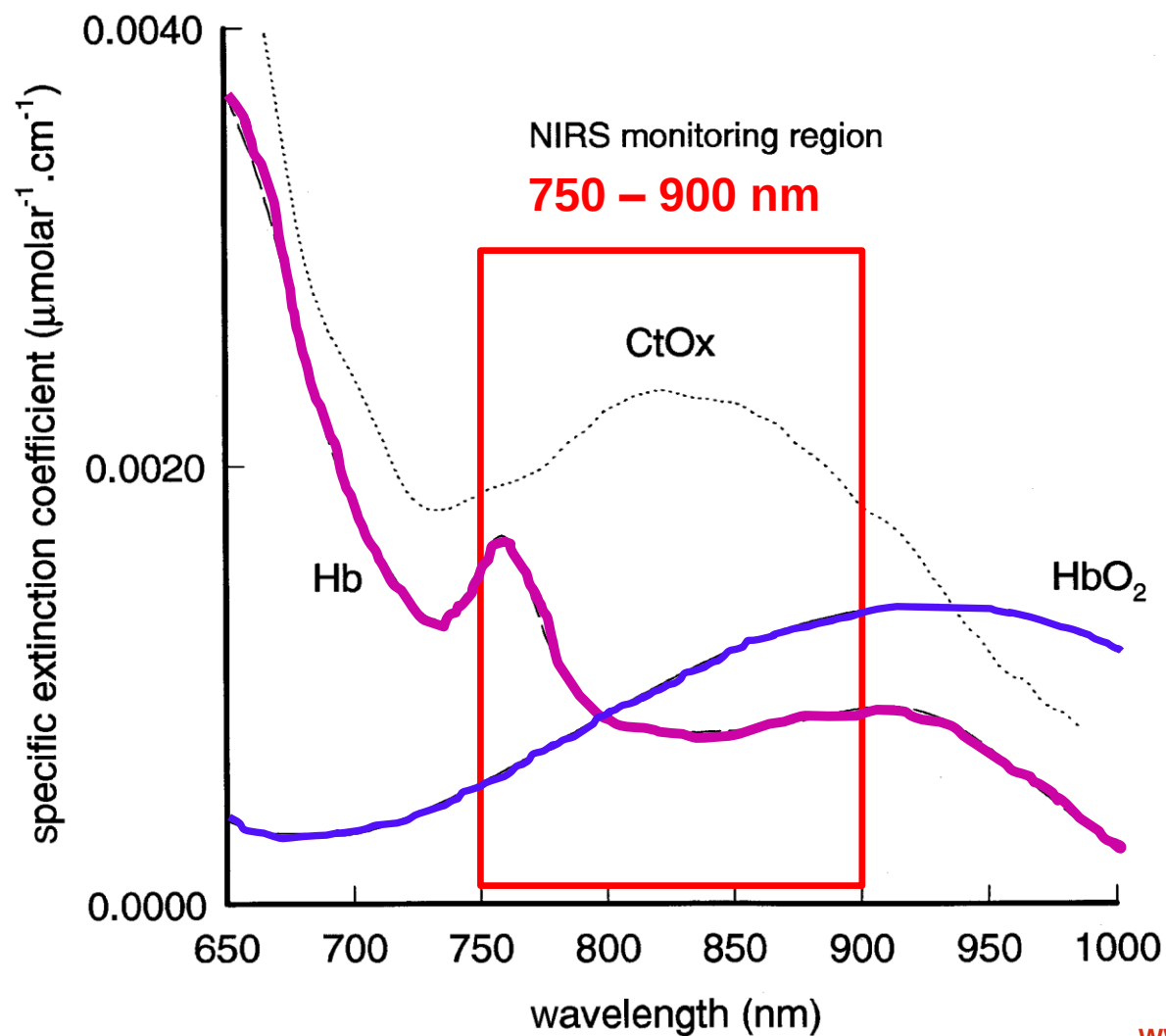
INVOS: 730, 810 (nm)

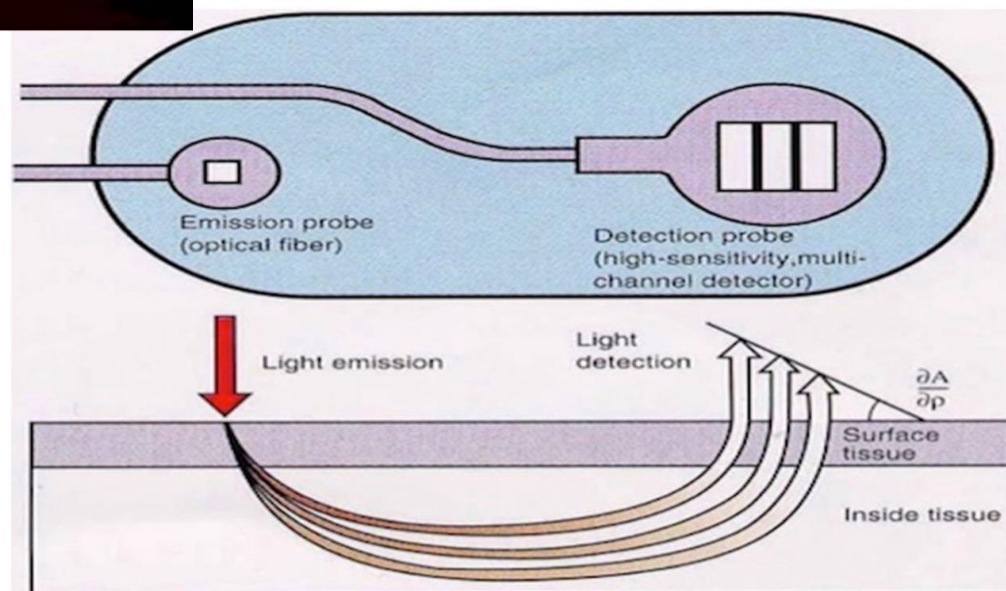
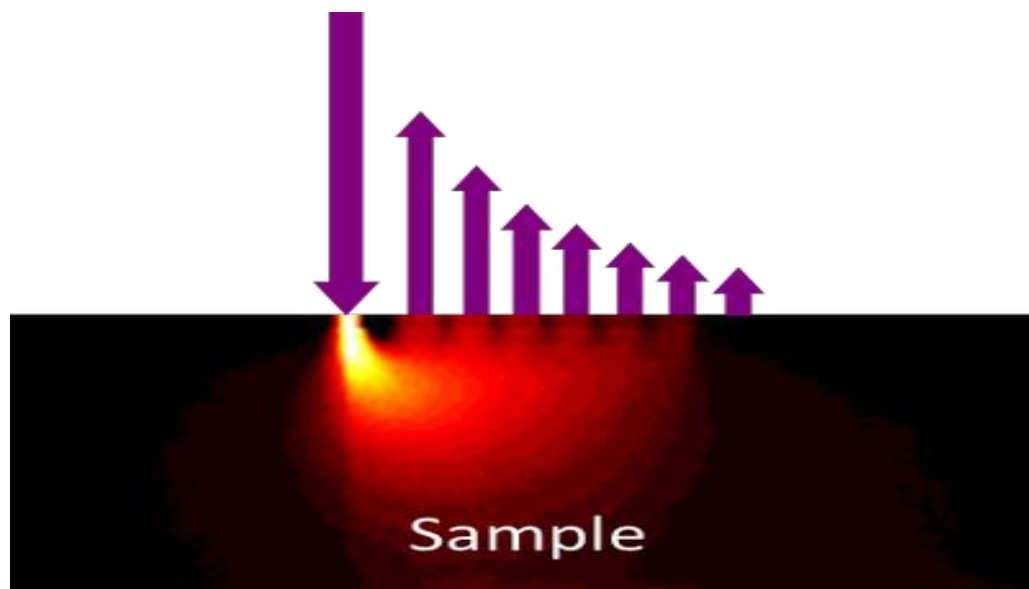
Fore Sight: 690, 780, 805, 850 (nm)

Equanox: 730, 760, 810, 880 (nm)

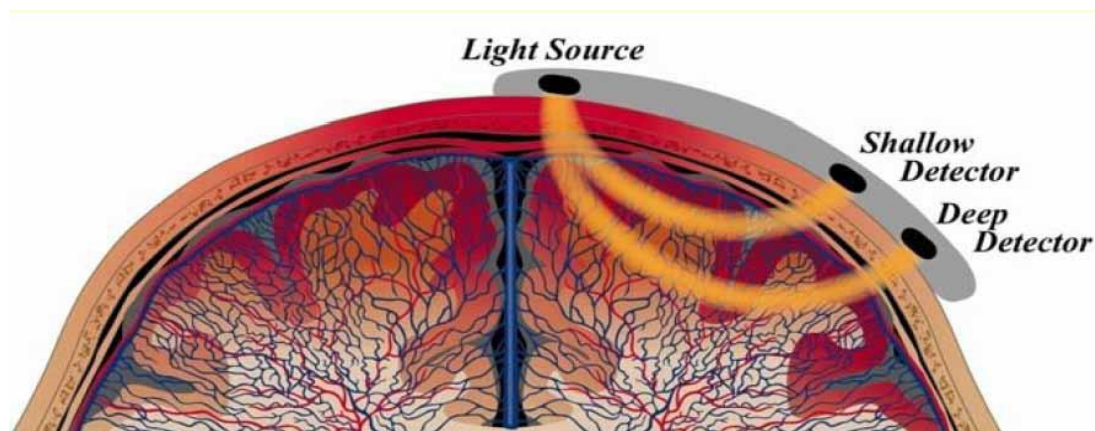
Technologie kontinuálních vln

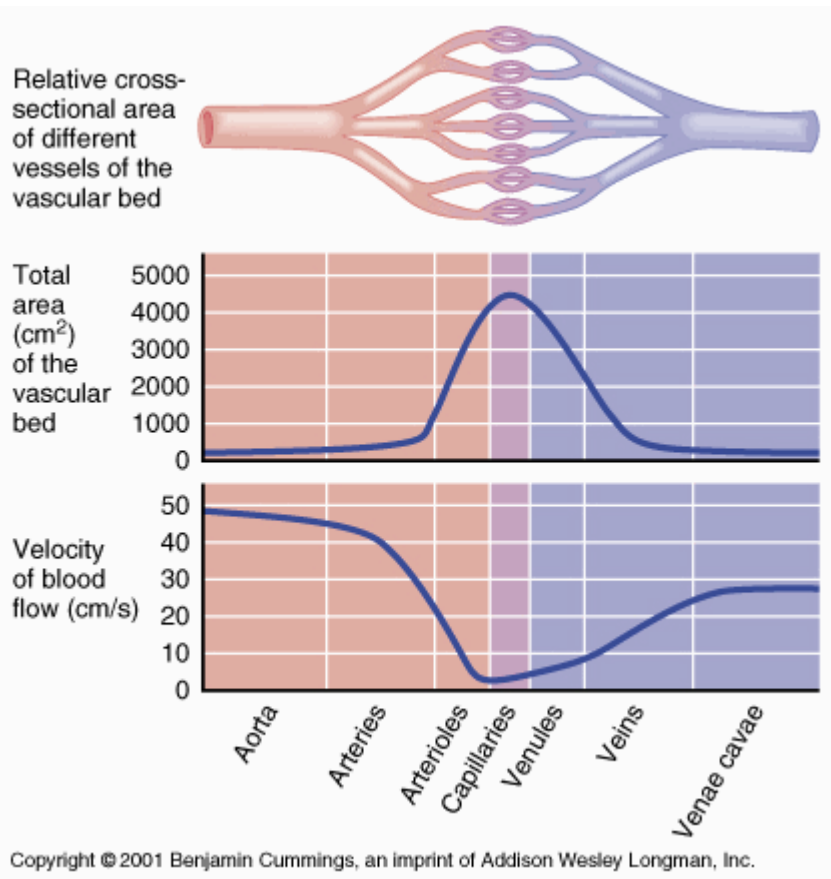






Systém INVOS využívá 2 hloubky průniku světla a data získaná z povrchních struktur (kůže a lebka) odečítá od dat hlouběji cílených struktur.





Kompartmenty cév:

- arterioly 5–0 %
- kapiláry 20 %
- venuly 70–75%

Mancini D et al, J Appl Physiol, 1994; 77: 2470

Firebank M et al, J Appl Physiol, 1998; 85: 1915

Absolutní hodnoty rSO_2 (definování hraničních hodnot ev. pásma)

- Snadná interpretace
- Nelze data individualizovat

Dynamické změny rSO_2

- Složitější interpretace získávaných hodnot
- Individualizace dat je možná

Dynamické změny r_{SO_2} pomáhá interpretovat
frakční tkáňová extrakce kyslíku – FTOE

$$FTOE = (SpO_2 - rSO_2) / SpO_2$$

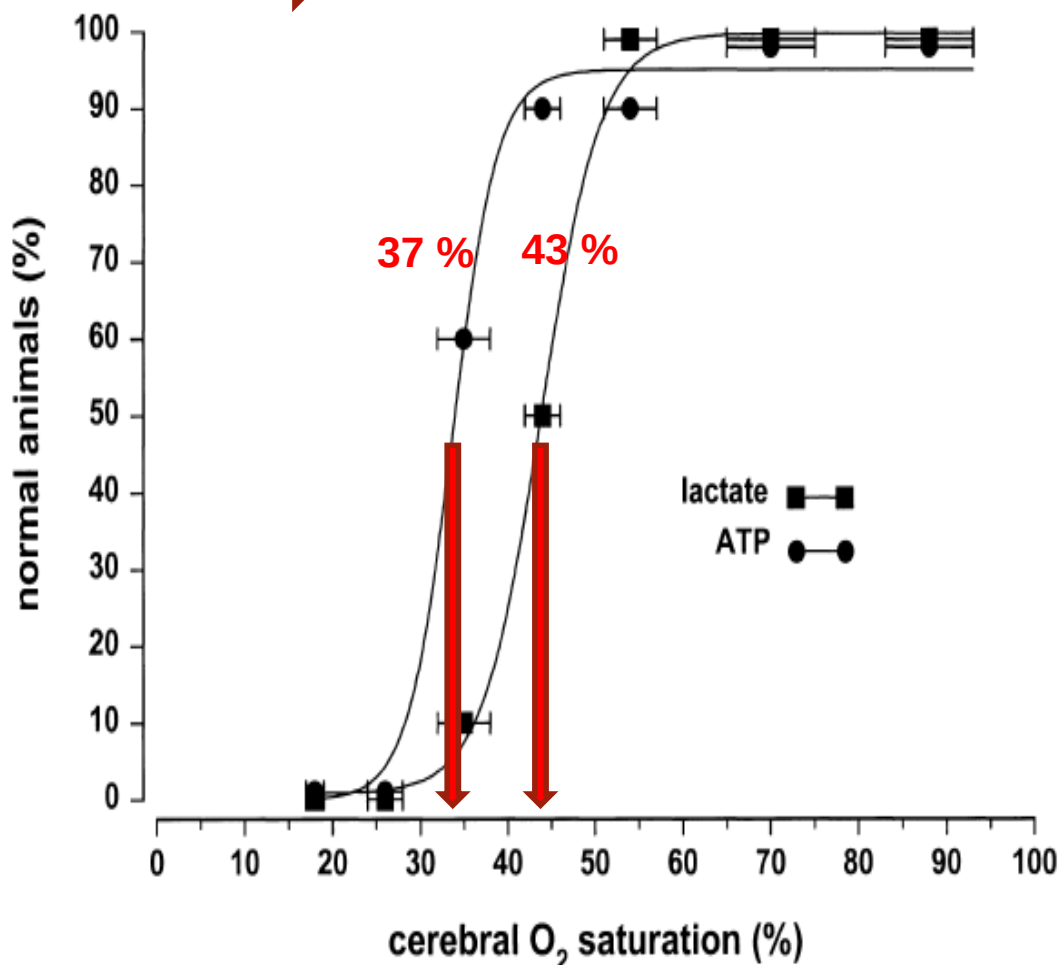
Normální FTOE je 20 – 30 % (0,2–0,3)

FTOE < 20 %: zvážit $\Downarrow$ FiO_2 a vyšetřit pCO_2 (hyperkapnie?)

FTOE > 30 %: zvážit $\Uparrow$ FiO_2 (hypokapnie?, MABP?, CO?)

Aproximace pro INVOS 50–55 %

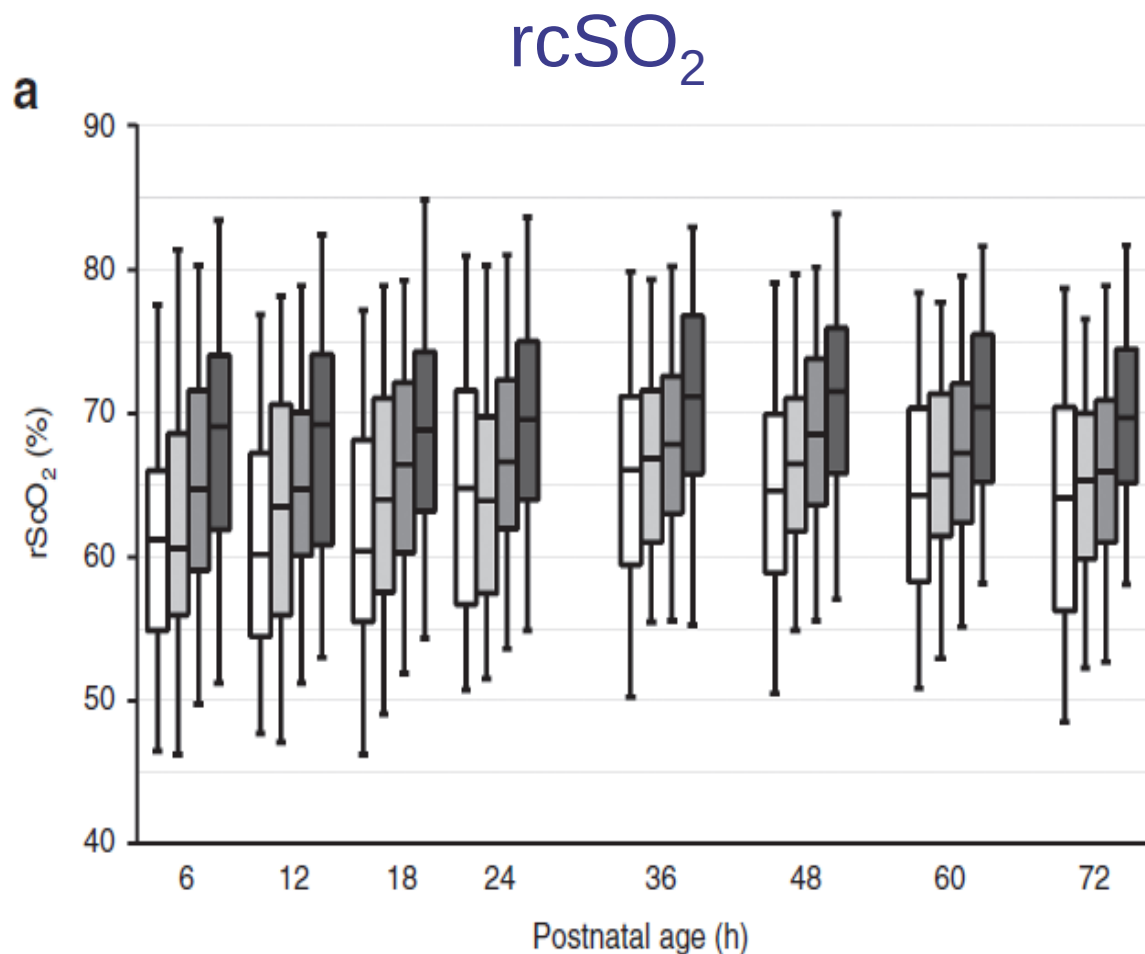
SafeBoosC Trial



Reference values of regional cerebral oxygen saturation during the first 3 days of life in preterm neonates

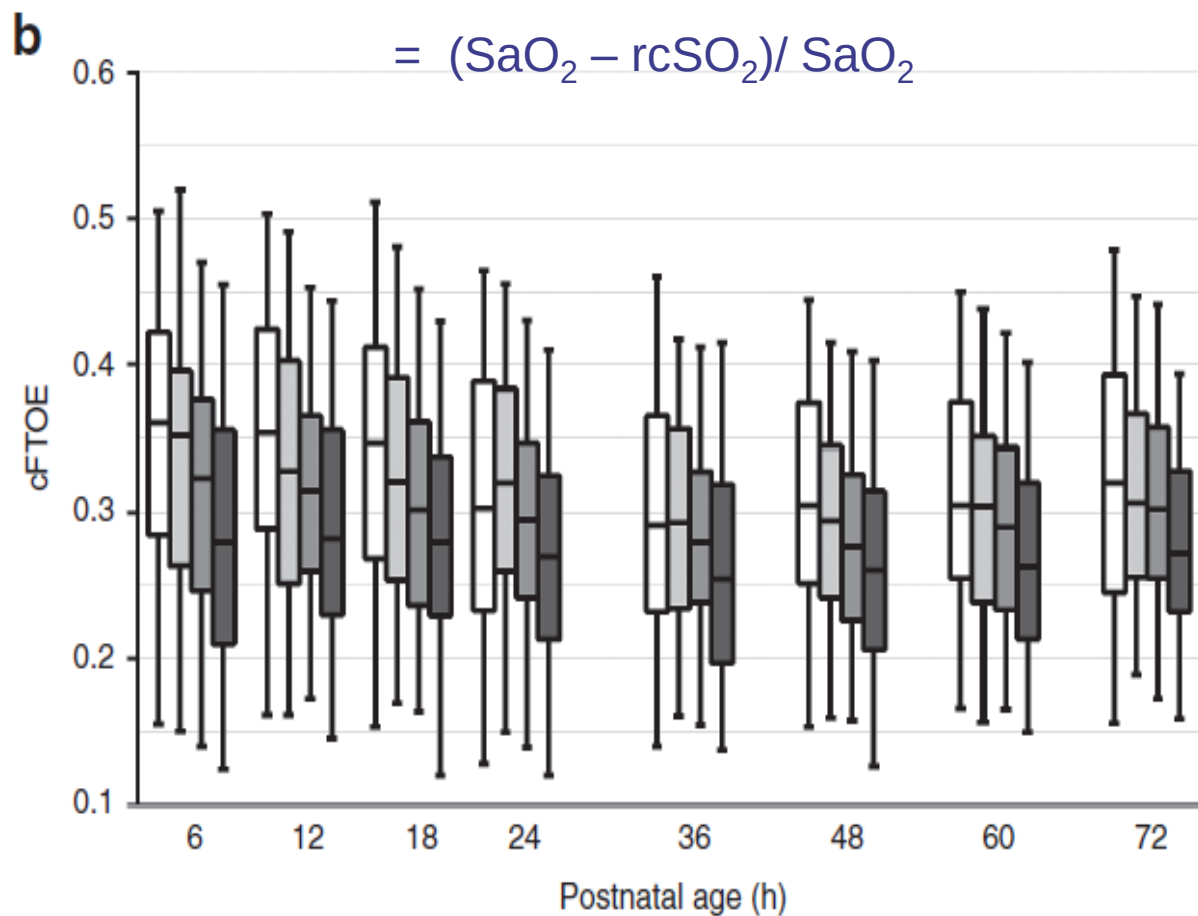
Thomas Alderliesten¹, Laura Dix¹, Wim Baerts¹, Alexander Caicedo^{2,3}, Sabine van Huffel^{2,3}, Gunnar Naulaers⁴, Floris Groenendaal¹, Frank van Bel¹ and Petra Lemmers¹

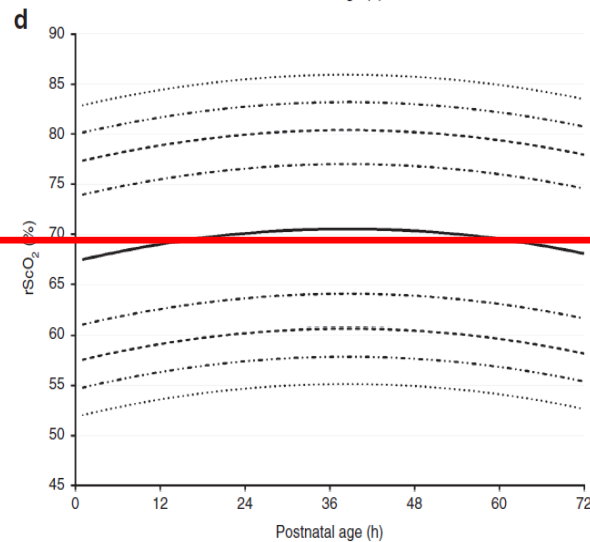
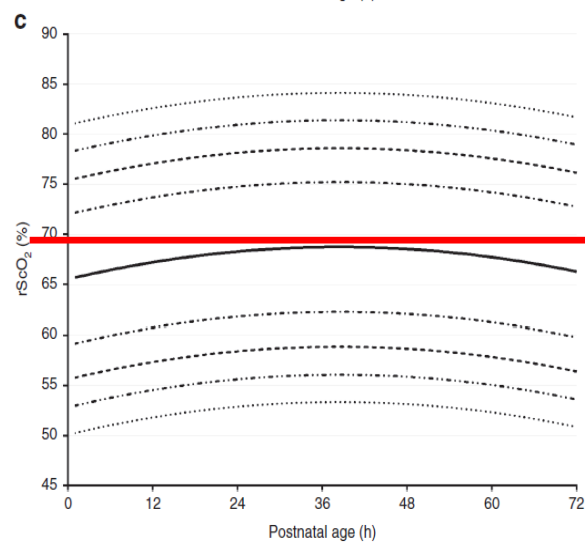
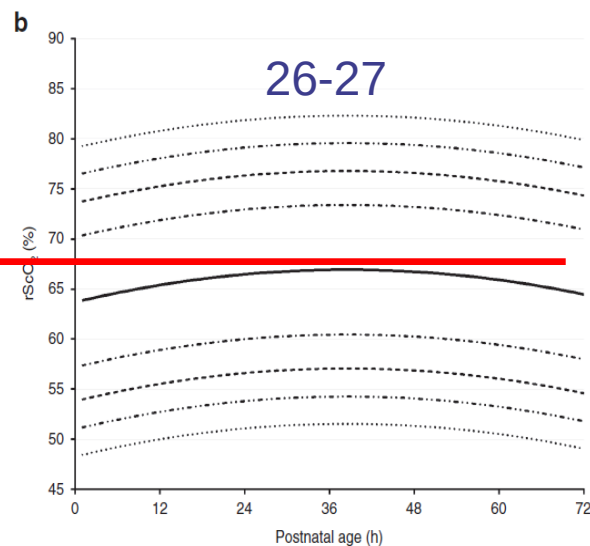
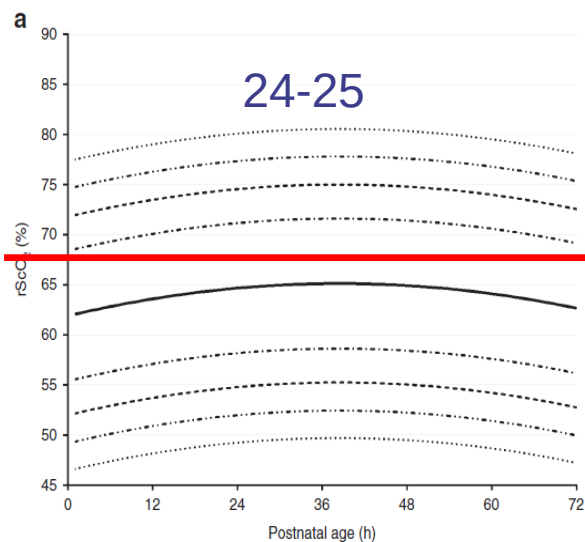
999 infants born preterm (GA <32 wk), NIRS during the first 72 h of life,
stratification: 24–25 wks, 26–27 wks, 28–29 wks, 30–31 wks



cFTOE

$$= (SaO_2 - rcSO_2) / SaO_2$$

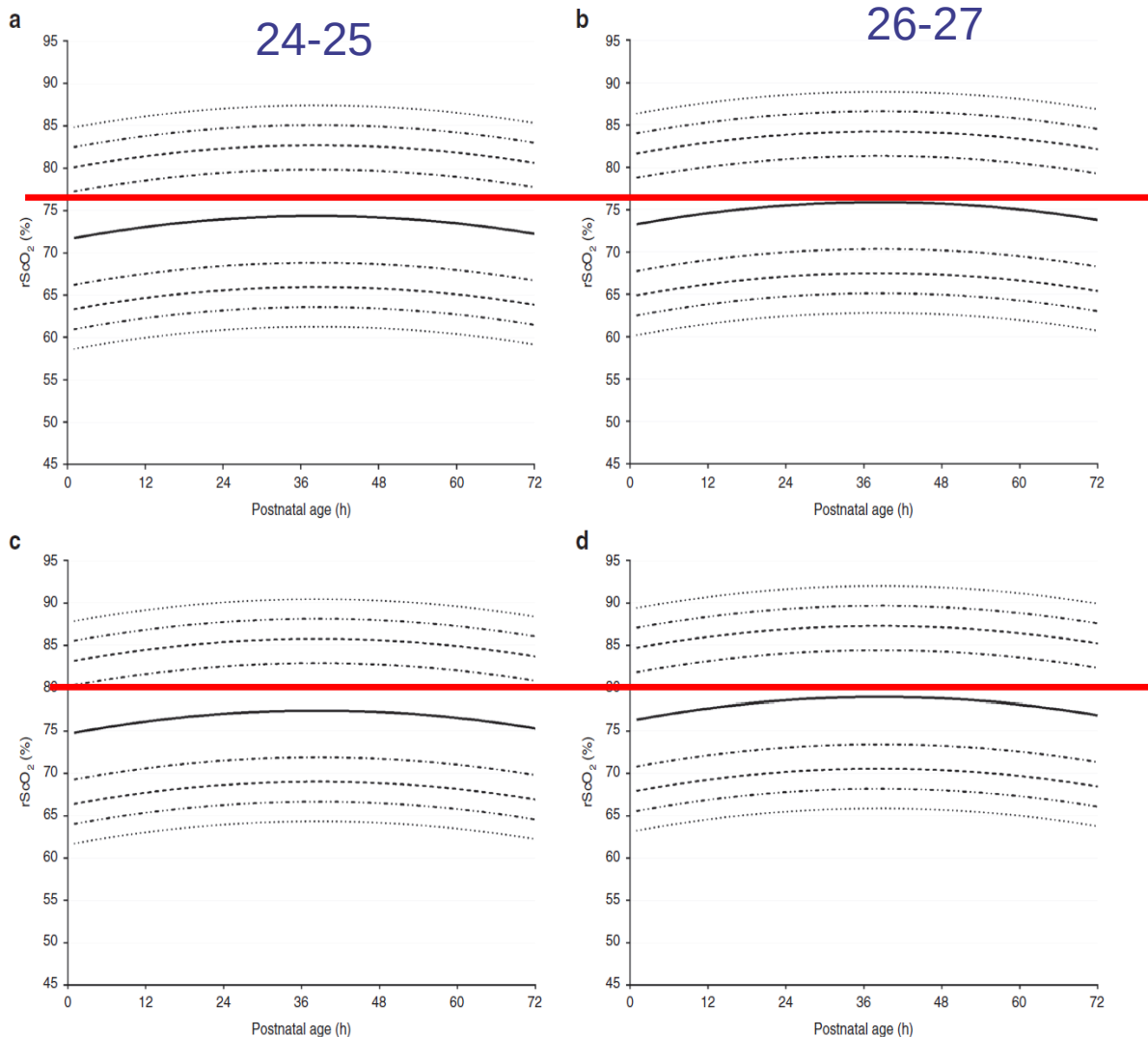




ADULT PROBE

$$rScO_{2_{neo}} = 0,8481 ScO_{2_{adult}} + 19,11$$

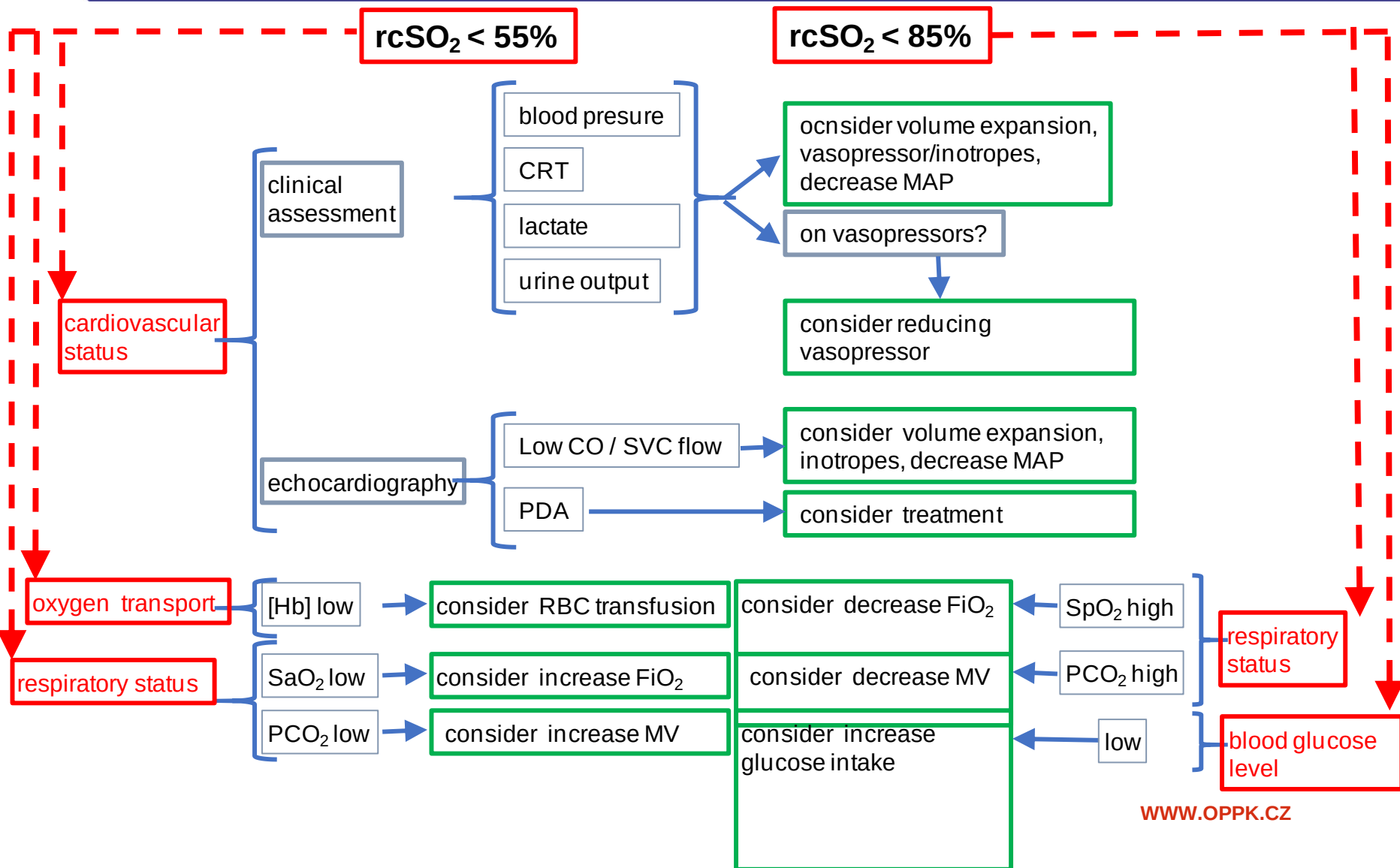
Alderstein et al Ped Res 2016



NEONATAL PROBE

$$rScO_{2_{neo}} = 0,8481 ScO_{2_{adult}} + 19,11$$

Alderstein et al Ped Res 2016



Reference Ranges for Regional Cerebral Tissue Oxygen Saturation and Fractional Oxygen Extraction in Neonates during Immediate Transition after Birth

Gerhard Pichler, MD¹, Corinna Binder, MD¹, Alexander Avian, PhD², Elisabeth Beckenbach, MD¹, Georg M. Schmölzer, MD, PhD^{1,3,4}, and Berndt Urlsberger, MD¹

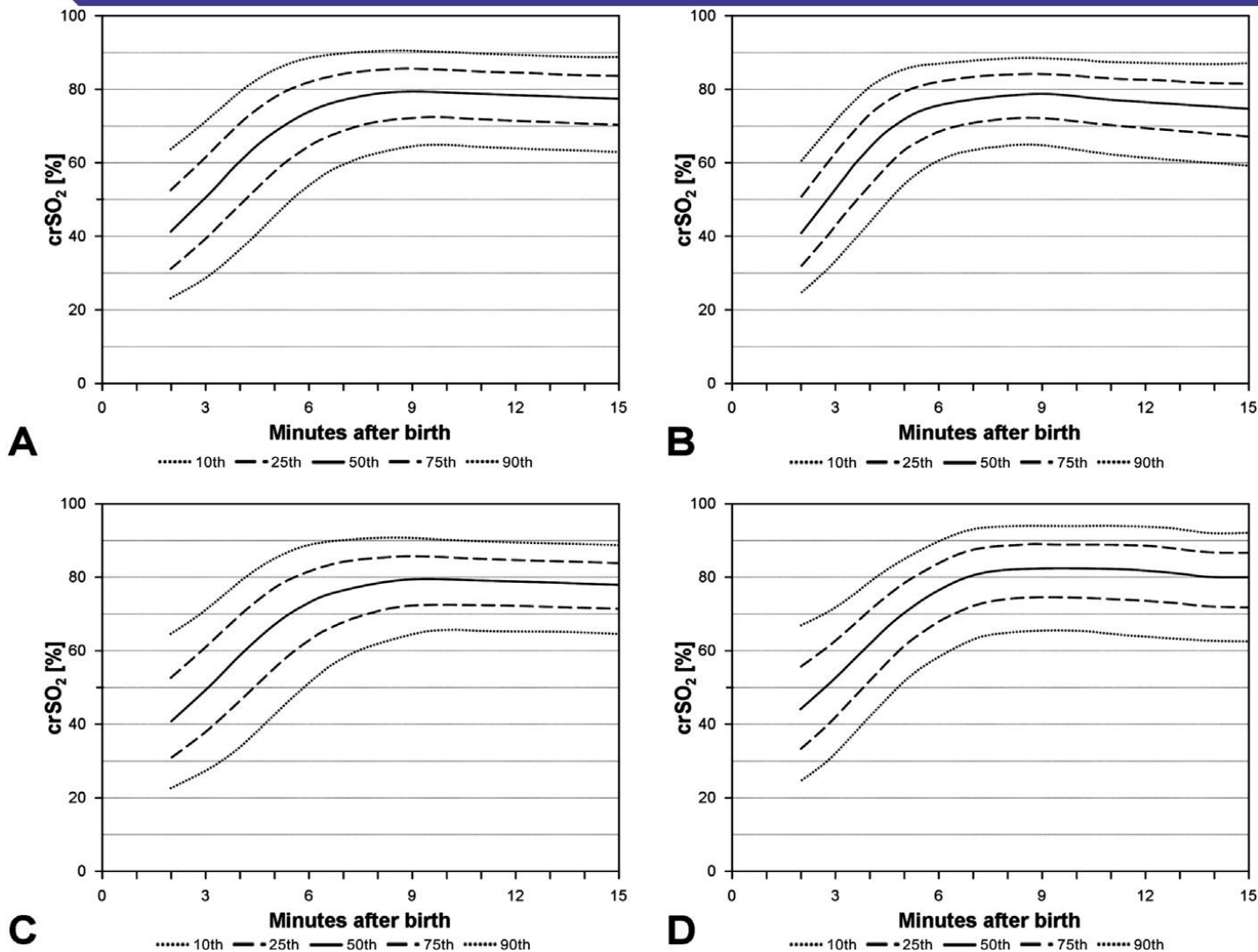


Table 3 Responses of mean arterial blood pressure and regional cerebral oxygen saturation to dopamine

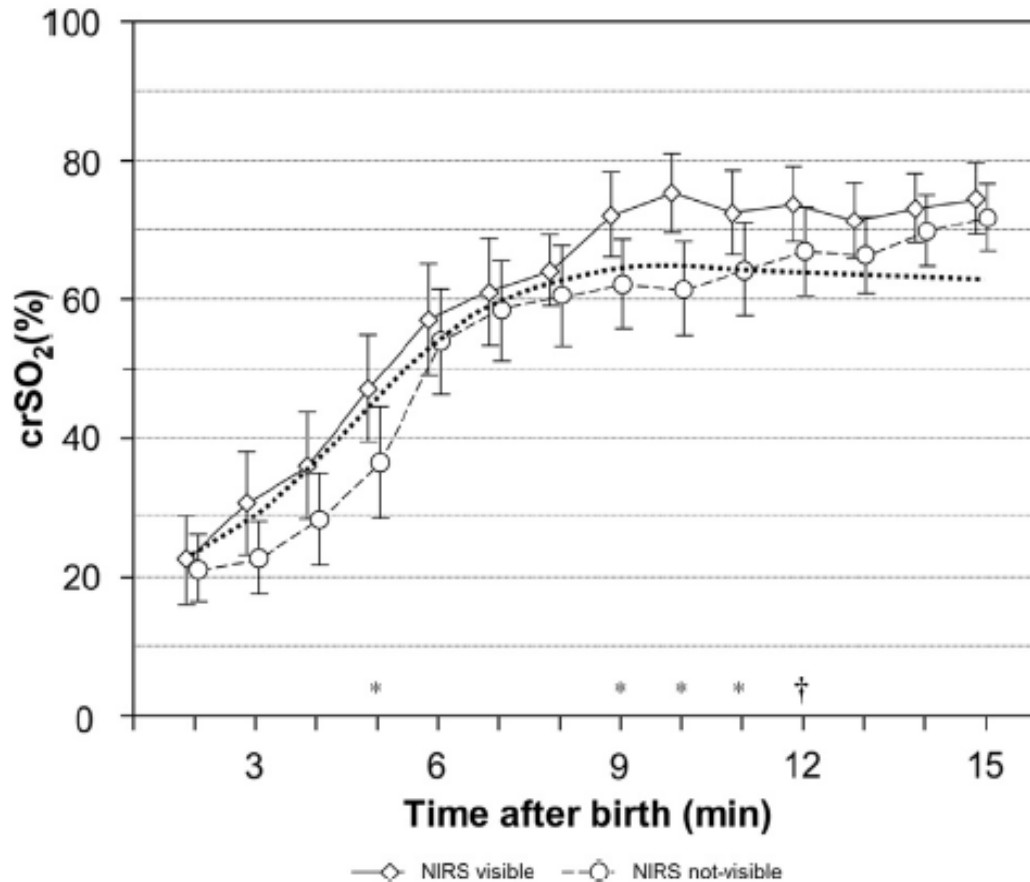
	Pre-dopamine	Post-dopamine	p Value
Mean blood pressure (mm Hg)	27.6 (1.9)	29.5 (3.2)	0.02
rCSO ₂ (%)	69.6 (8.1)	70.7 (7.2)	0.8

rCSO₂, regional cerebral oximetry.

Závěr: Léčba hypotenze u extrémně nezralých novorozenců neovlivnila cerebrální oxygenaci. Využití měření rcSO₂ jako součást indikace pro léčbu hypotenze.

Cerebral Oxygen Saturation to Guide Oxygen Delivery in Preterm Neonates for the Immediate Transition after Birth: A 2-Center Randomized Controlled Pilot Feasibility Trial

Gerhard Pichler, MD^{1,2}, Berndt Urllesberger, MD^{1,2}, Nariae Baik, MD^{1,2}, Bernhard Schwabegger, MD^{1,2}, Corinna Binder-Heschl, MD, PhD^{1,2}, Alexander Avian, PhD³, Jasmin Pansy, MD^{1,2}, Po-Yin Cheung, MBBS, PhD^{4,5}, and Georg Marcus Schmölzer, MD, PhD^{4,5}



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Table III. Burden of cerebral hypoxia (%minutes) in preterm neonates with crSO₂ monitoring visible or not-visible

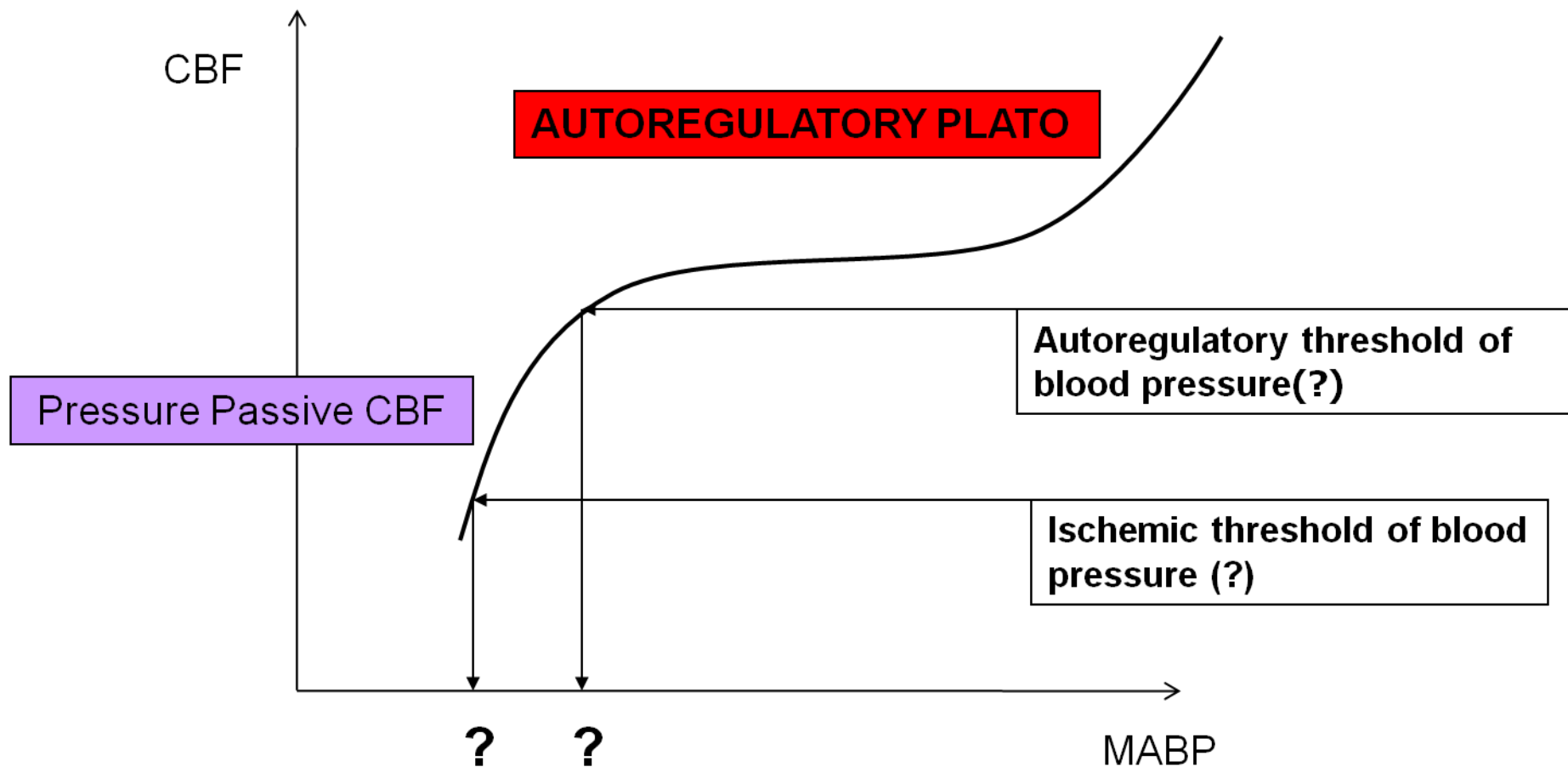
	<u>NIRS-not-visible</u>		<u>NIRS-visible</u>		<i>P</i> value
	n	crSO ₂ , %min	n	crSO ₂ , %min	
Patients with complete data set	13	56.5 ± 56.2	18	126.6 ± 111.7	.028
All patients	30	46.0 ± 54.6	30	89.9 ± 101.6	.107

Řízení rozsahu ventilační podpory a suplementace O₂ podle NIRS snižují rizika vzniku cerebrální hypoxie na PS.

Near infrared spectroscopy (NIRS) Spatially resolved spectroscopy (SRS)

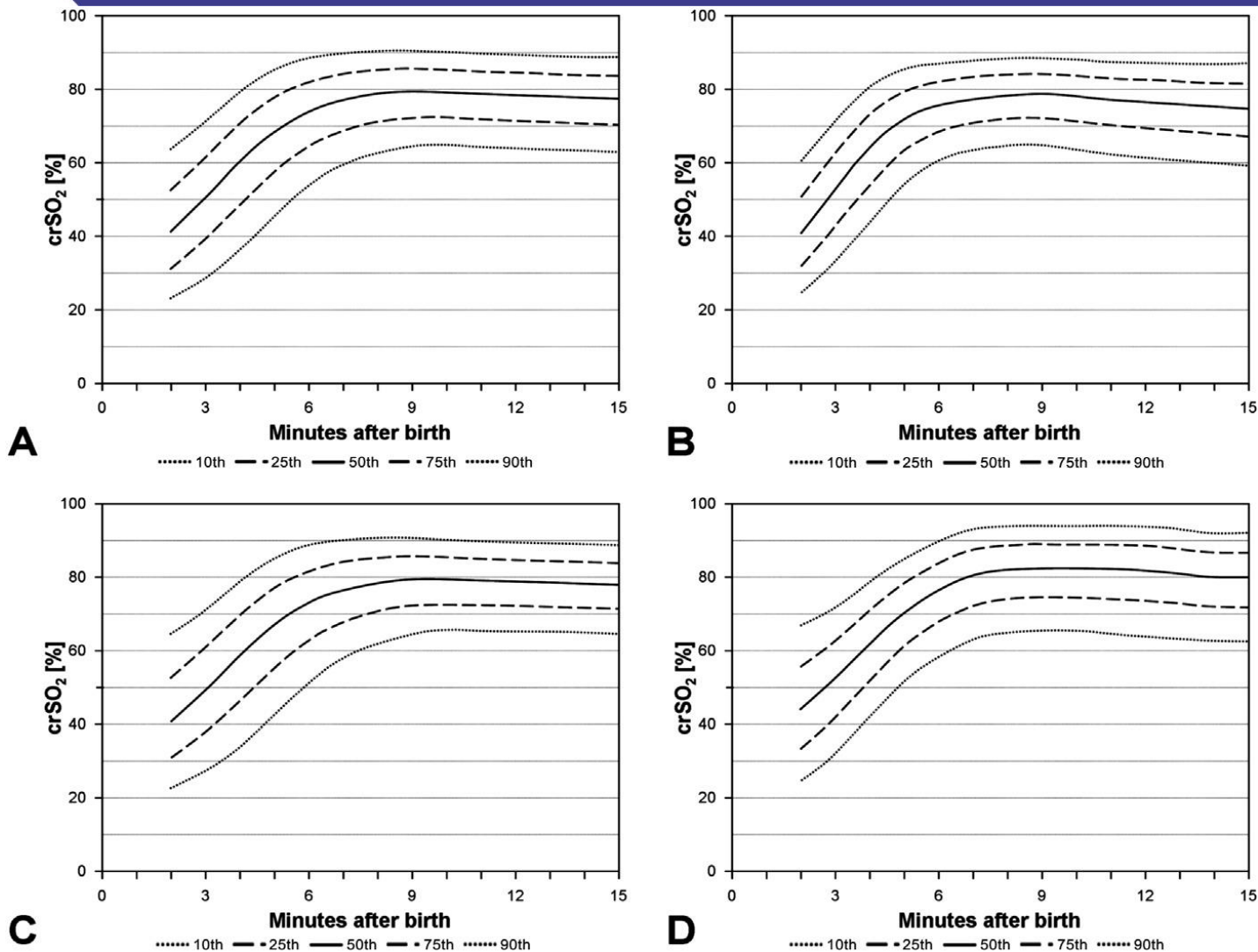
- Noninvasive, continuous quantitative measurement of regional oxygen saturation (rcSO₂, TOI)
- Coherence between MABP a rcSO₂ (> 0,5, **PRESSURE PASSIVE PERFUSION** of brain)





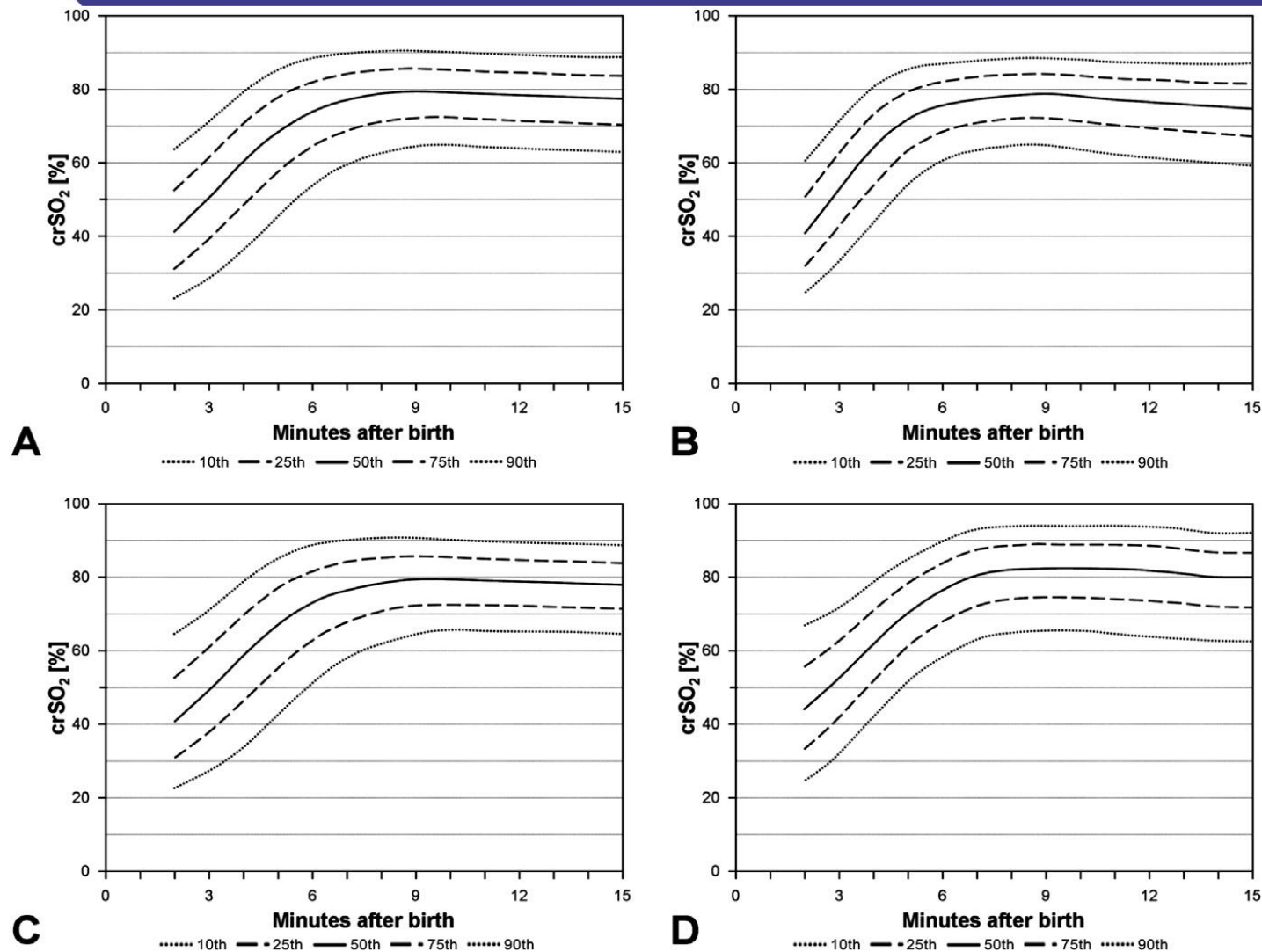
Reference Ranges for Regional Cerebral Tissue Oxygen Saturation and Fractional Oxygen Extraction in Neonates during Immediate Transition after Birth

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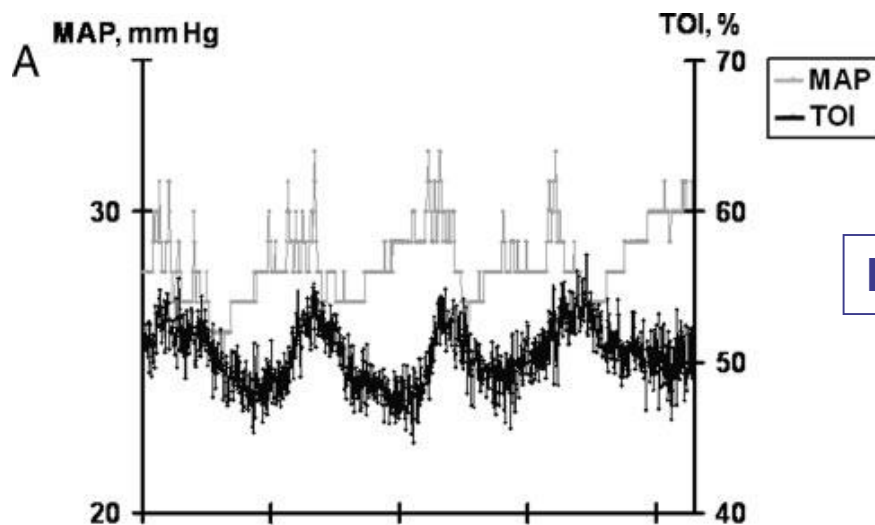


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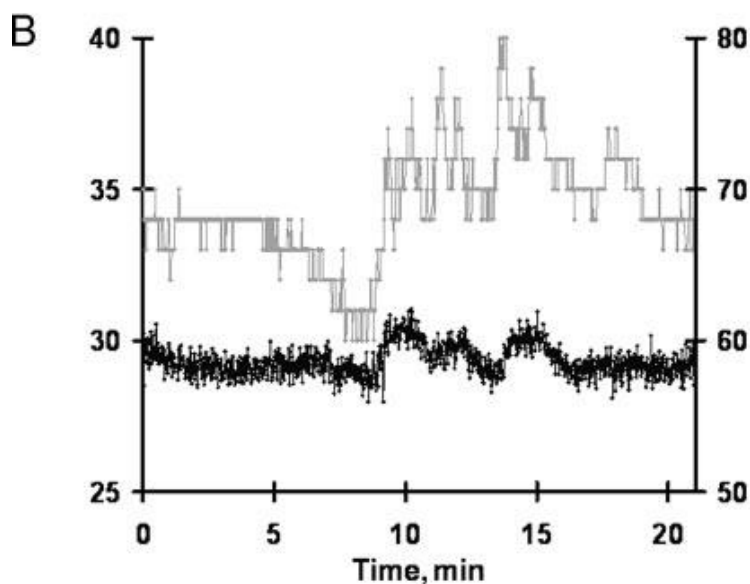


$CS > 0,5$



PRESSURE PASSIVE CBF

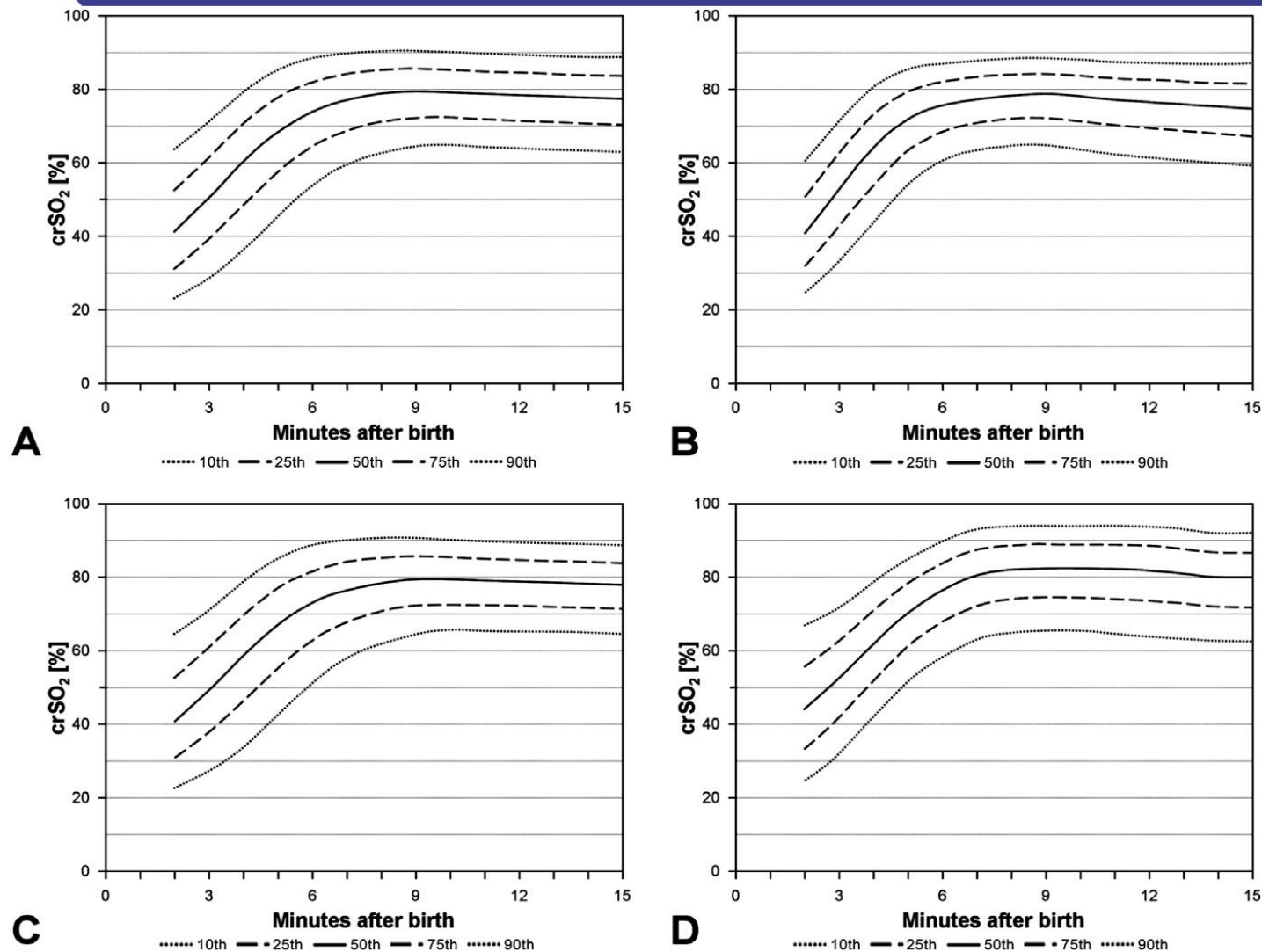
$CS < 0,5$



AUTOREGULATED CBF

Reference Ranges for Regional Cerebral Tissue Oxygen Saturation and Fractional Oxygen Extraction in Neonates during Immediate Transition after Birth

Gerhard Pichler, MD¹, Corinna Binder, MD¹, Alexander Avian, PhD², Elisabeth Beckenbach, MD¹, Georg M. Schmölzer, MD, PhD^{1,3,4}, and Berndt Urlsberger, MD¹



USG CNS within 72 hrs after birth

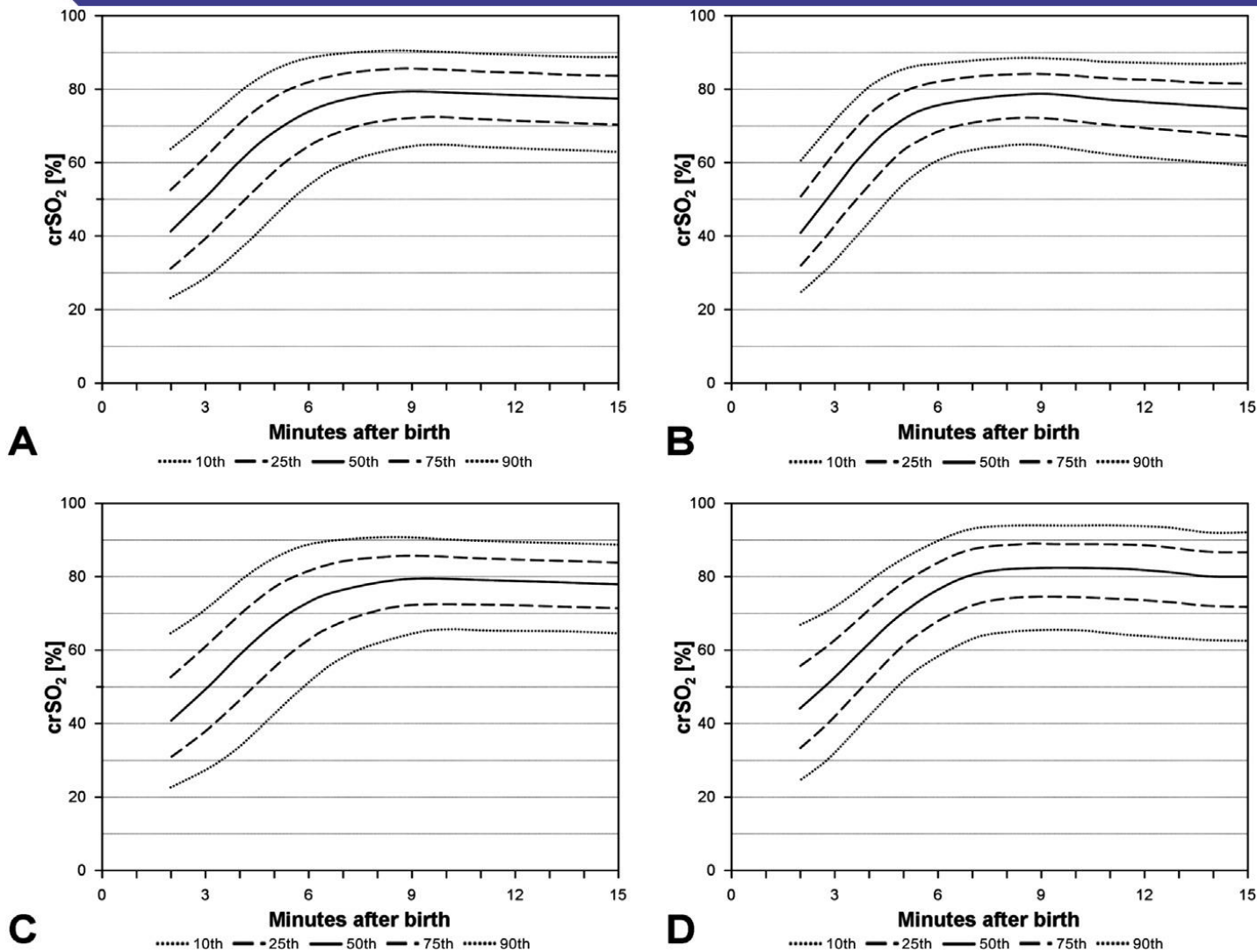
NIRS, 2 hour period:1.,2.,3.,4.,5.,8.,15. DOL

	GMH-IVH N=17	Controls N=17
GA	29.4 (25.4-31.9)	29.9 (26.0-31.6)
BW	1260g (850-1840)	1310g (730-1975)

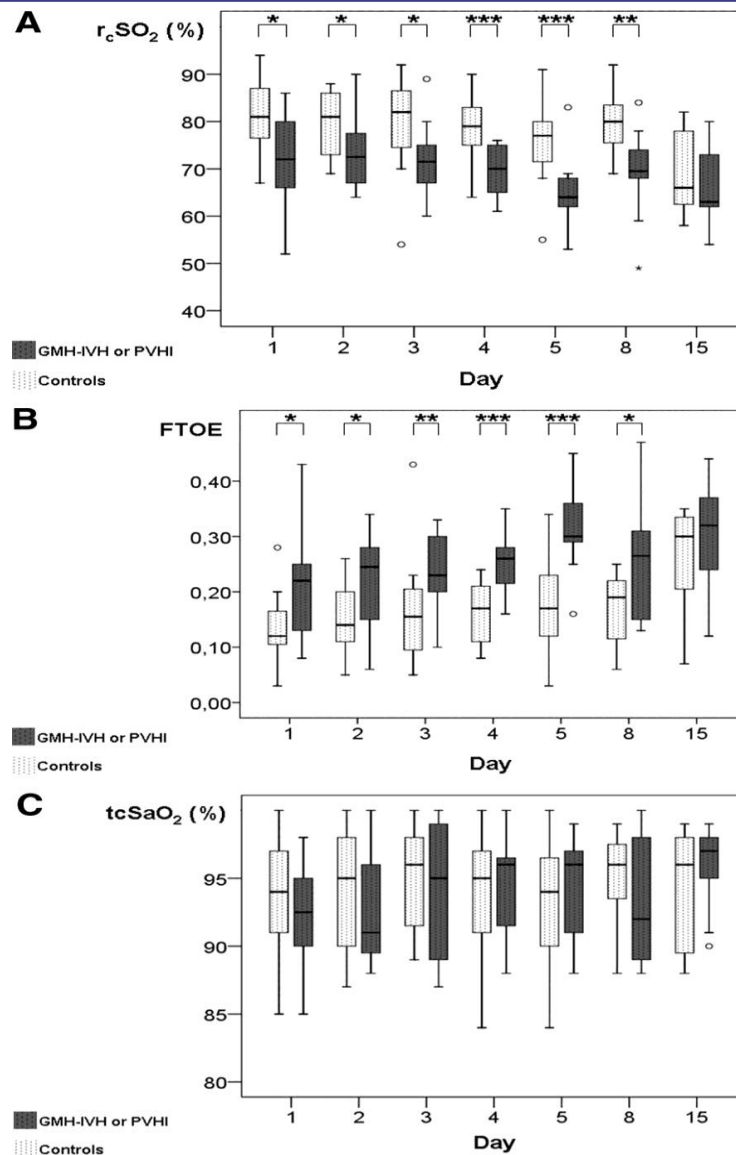
**Preterm Infants with GM-IVH had lower rcSpO₂ .
Decreased cerebral perfusion persists for 2 weeks.**

Reference Ranges for Regional Cerebral Tissue Oxygen Saturation and Fractional Oxygen Extraction in Neonates during Immediate Transition after Birth

Gerhard Pichler, MD¹, Corinna Binder, MD¹, Alexander Avian, PhD², Elisabeth Beckenbach, MD¹, Georg M. Schmölzer, MD, PhD^{1,3,4}, and Berndt Urlsberger, MD¹

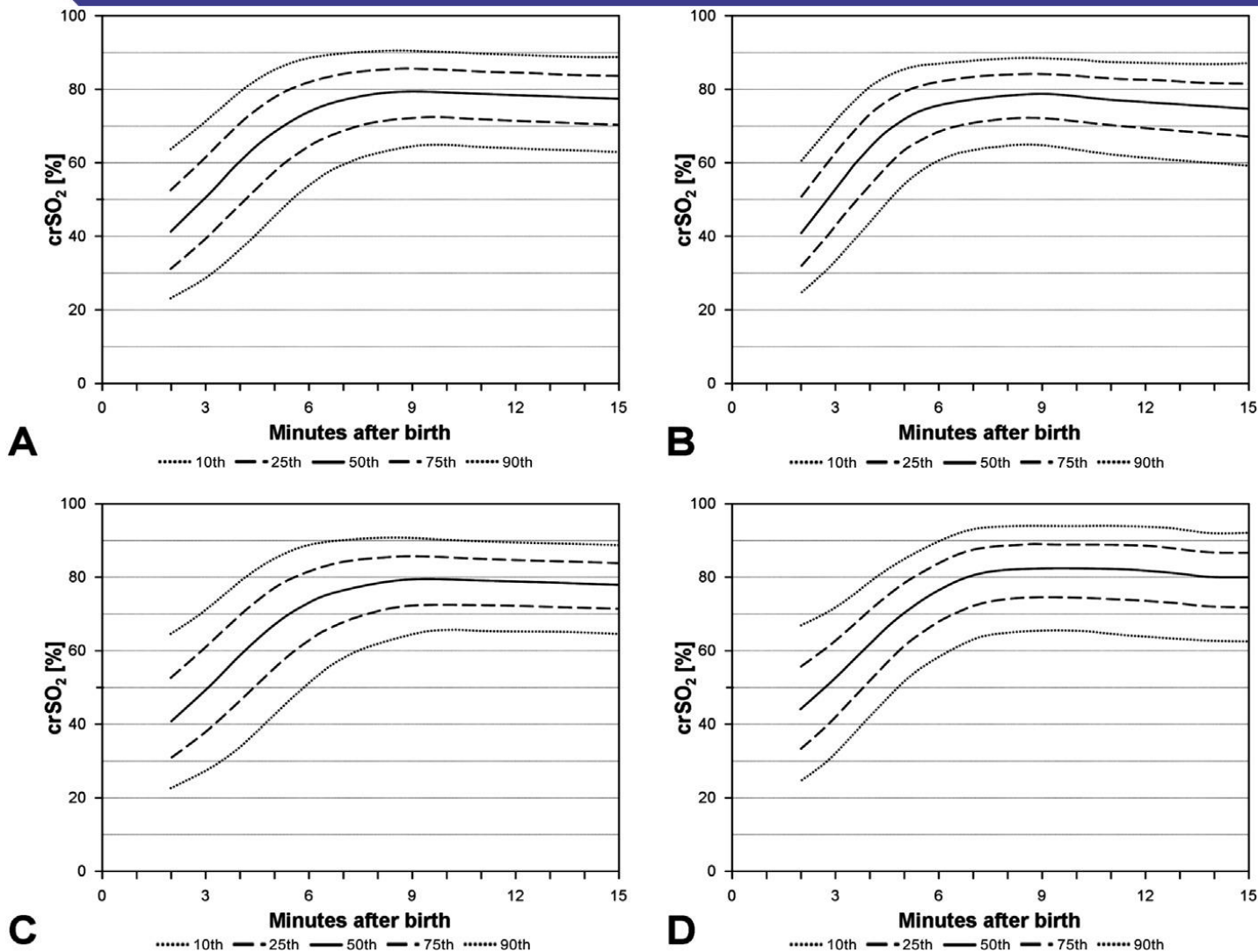


Oxygenace mozku u předčasně narozených dětí krvácení do germinální matrix, krvácení do mozkoých komor



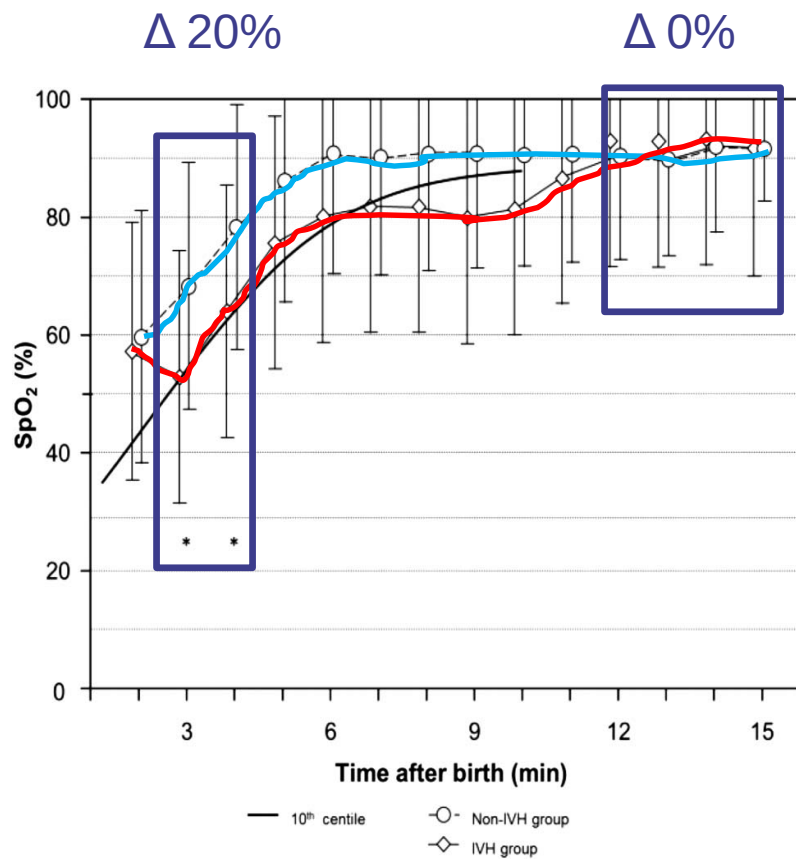
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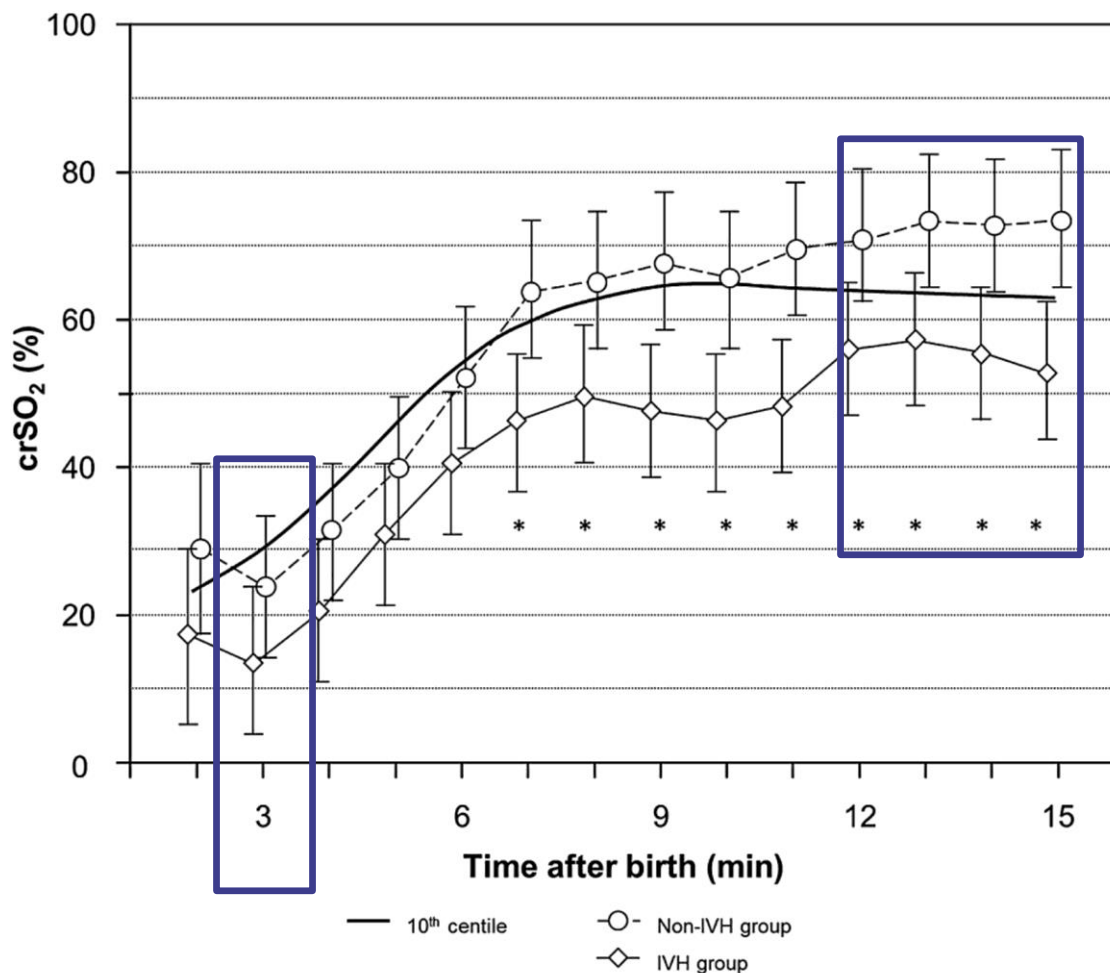
VLBWI < 32 týdnů, NIRS na PS, 12 s IVH vs. 12 kontrol

-



*Significant difference between IVH group and Non-IVH group

VLBWI < 32 týdnů, NIRS na PS, 12 s IVH vs. 12 kontrol

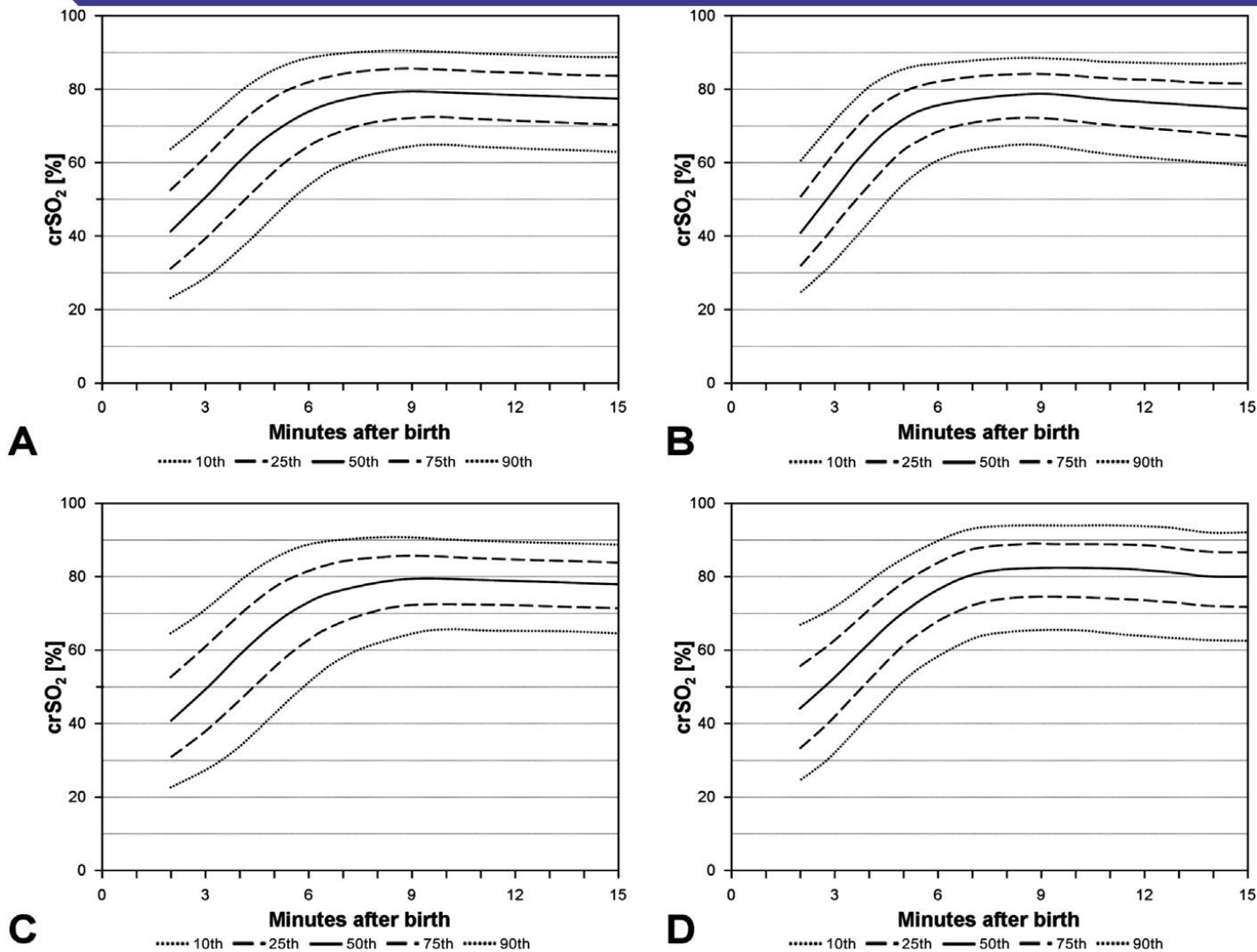


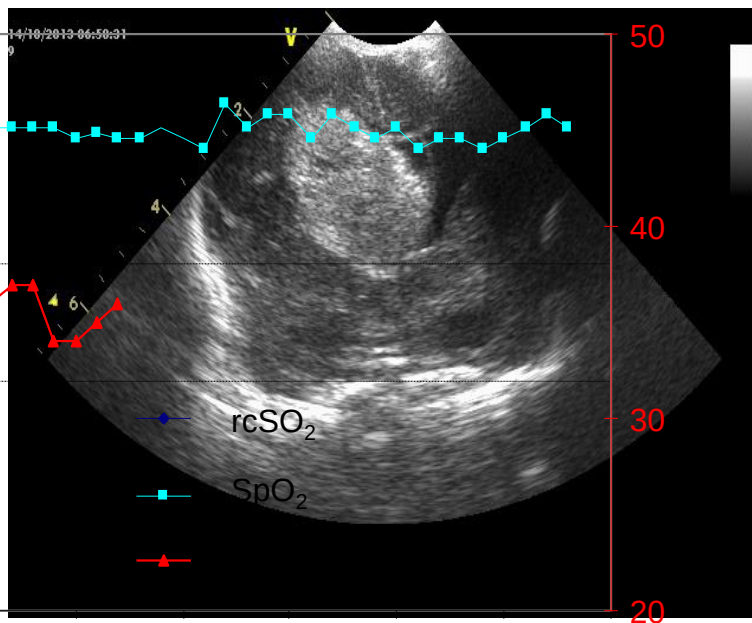
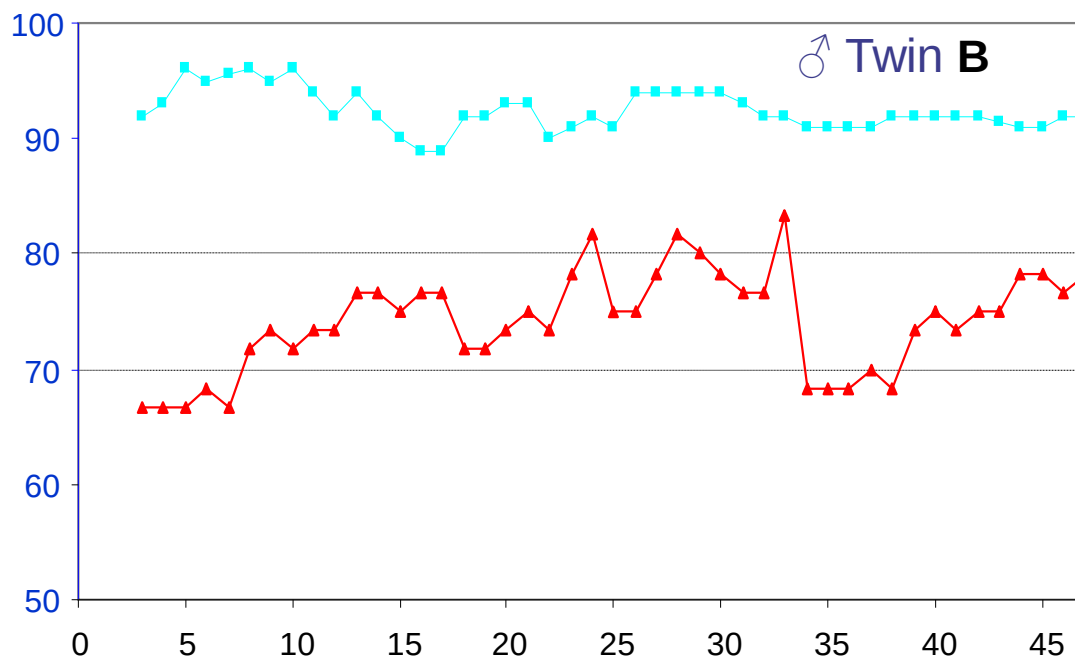
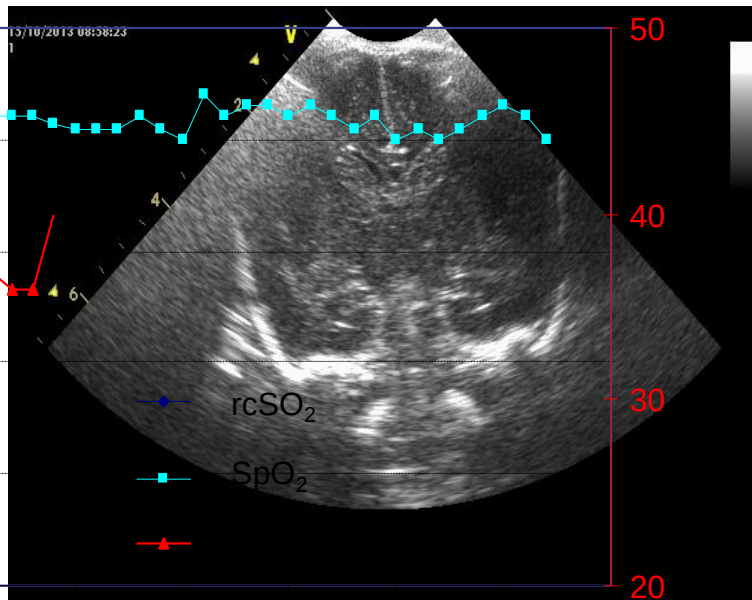
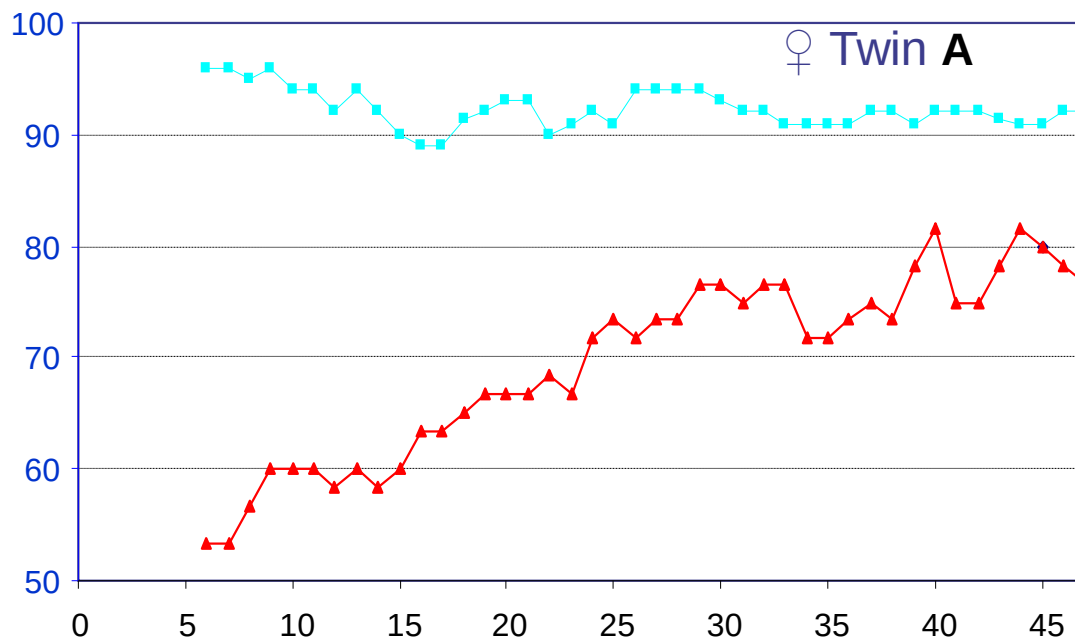
*Significant difference between IVH group and Non-IVH group

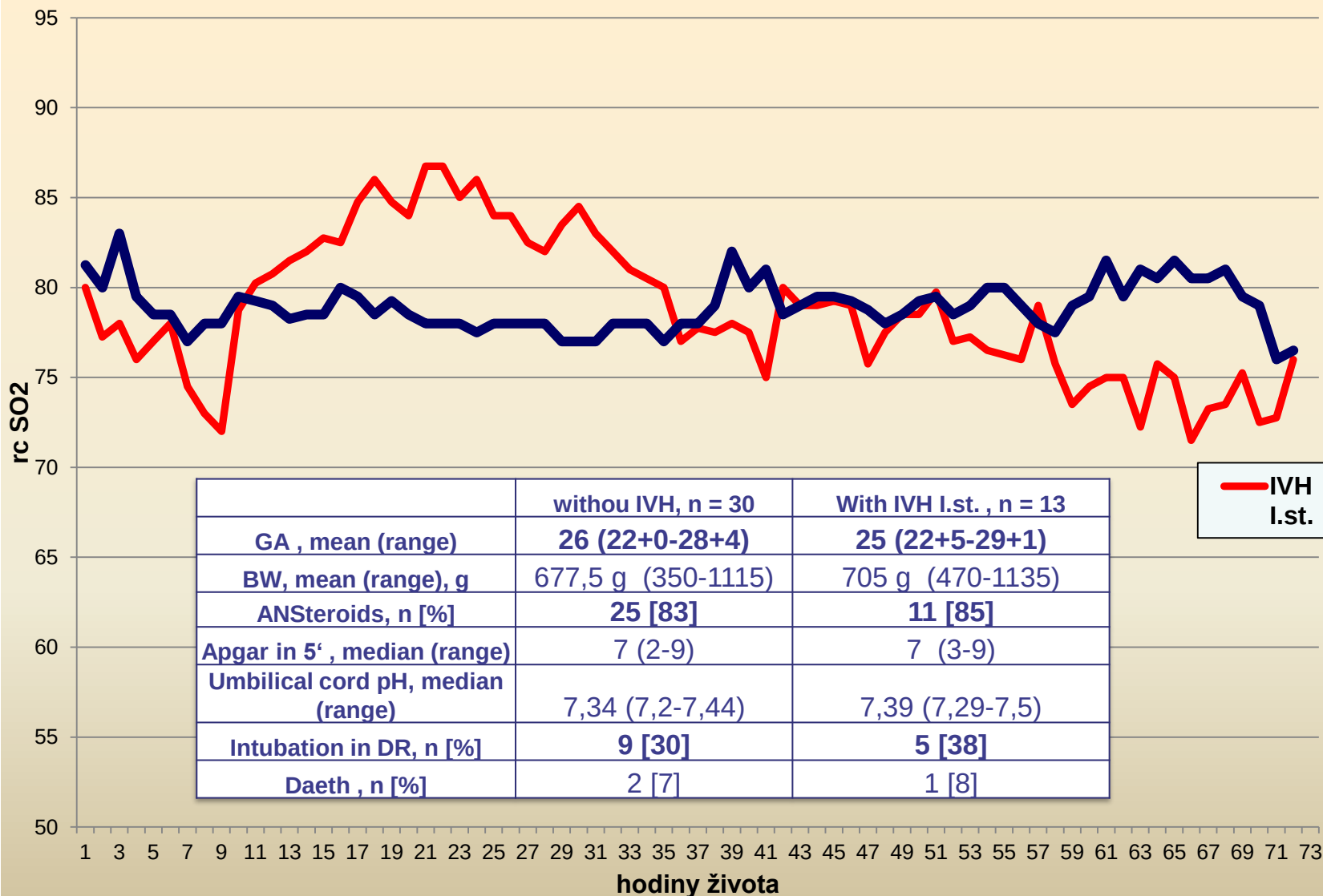
WWW.OPPK,CZ

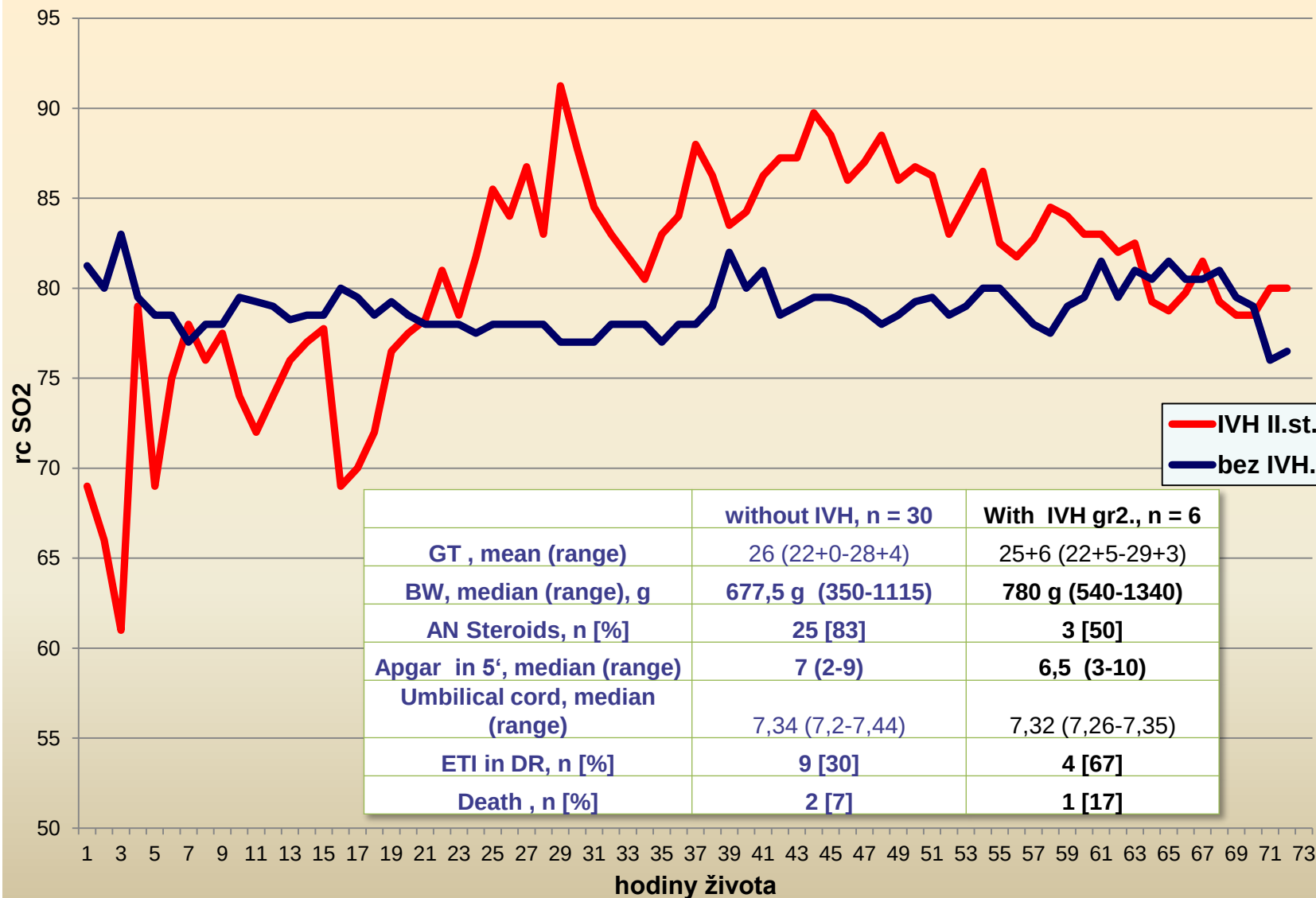
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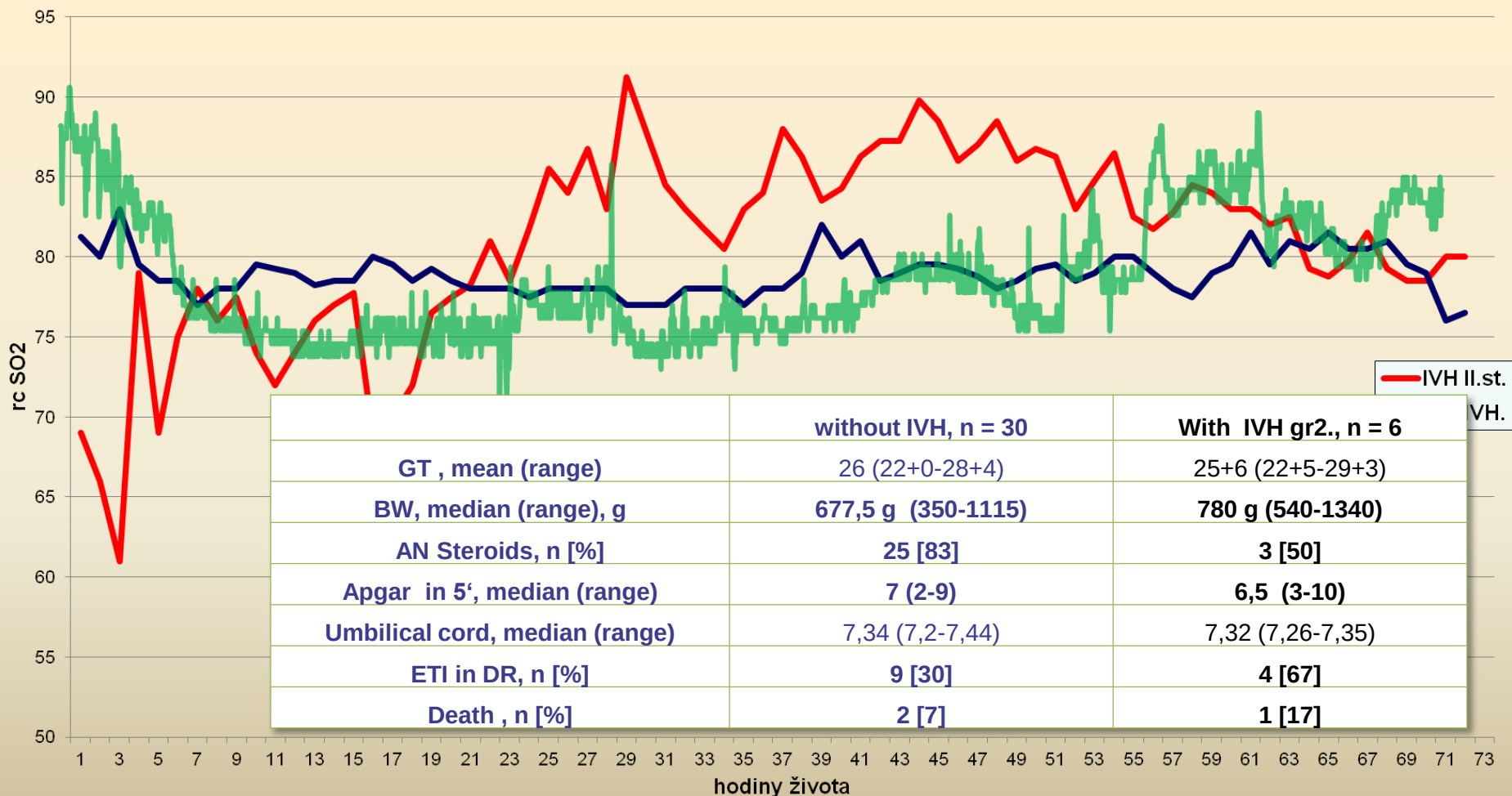
Gerhard Pichler, MD¹, Corinna Binder, MD¹, Alexander Avian, PhD², Elisabeth Beckenbach, MD¹, Georg M. Schmölzer, MD, PhD^{1,3,4}, and Berndt Urlsberger, MD¹

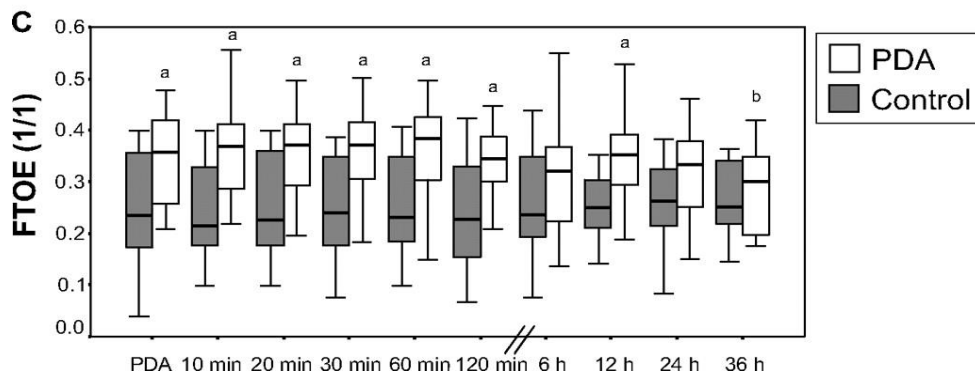
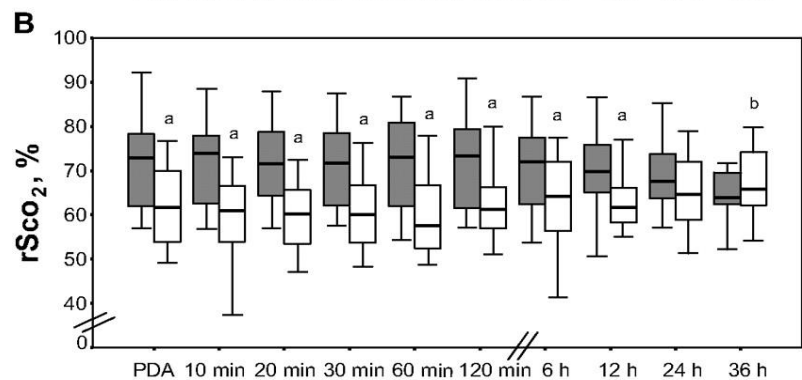
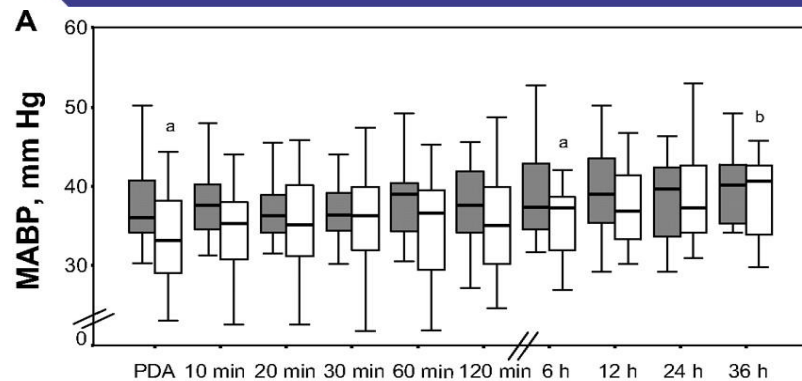




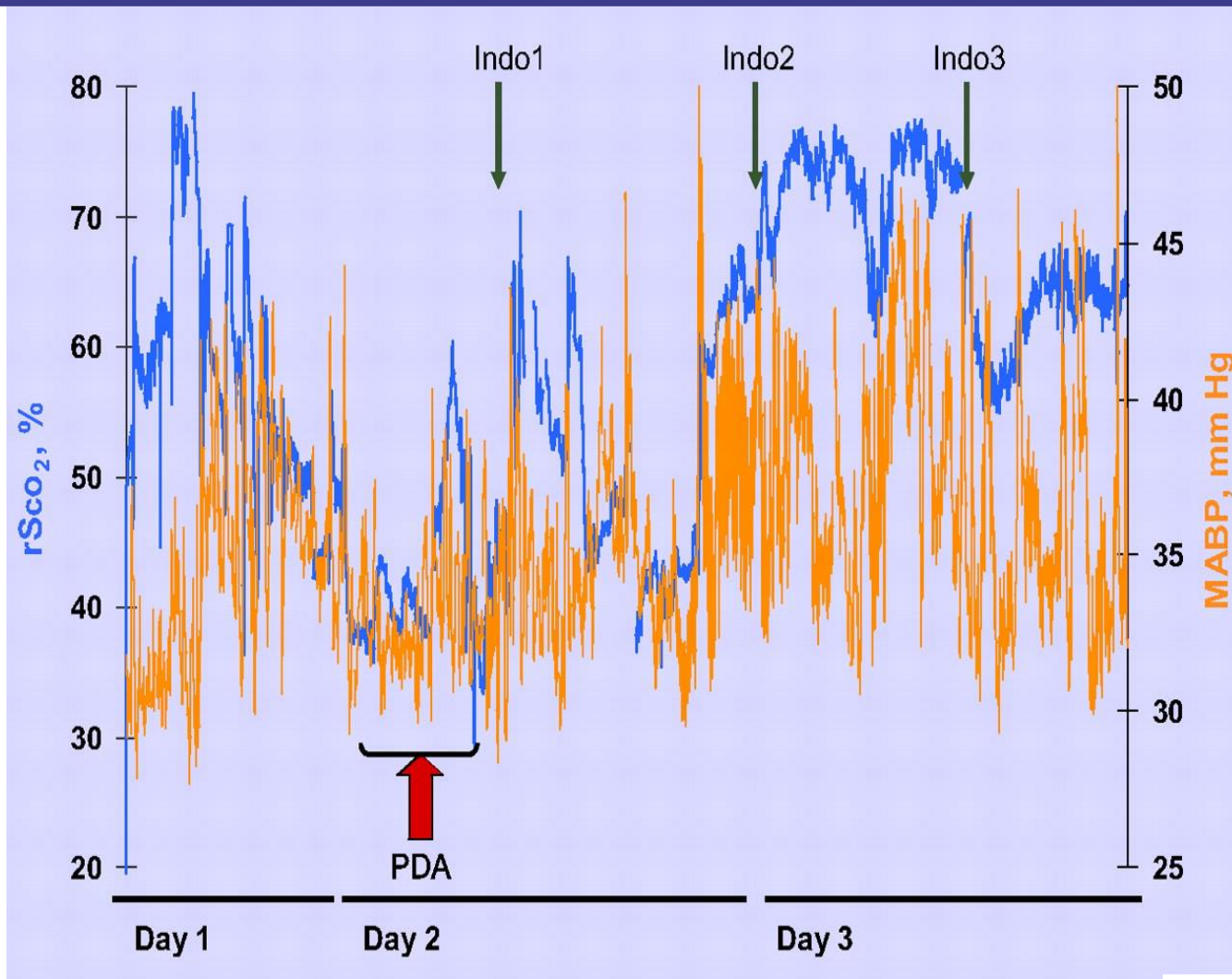




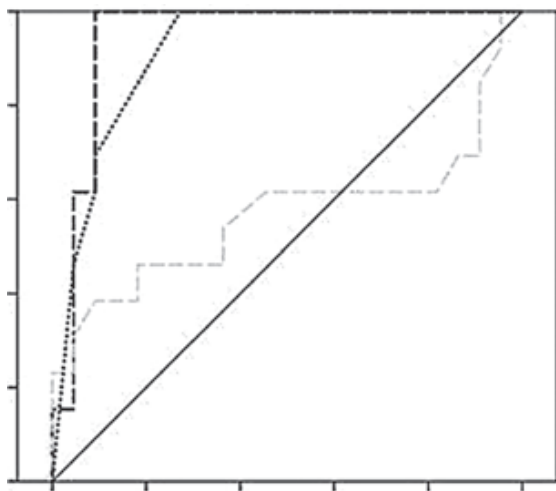




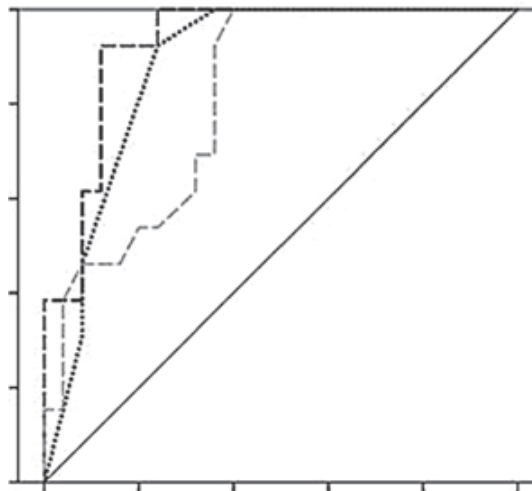
Lemmers PMA et al, Pediatrics, 2008; 121(1): 142–147.



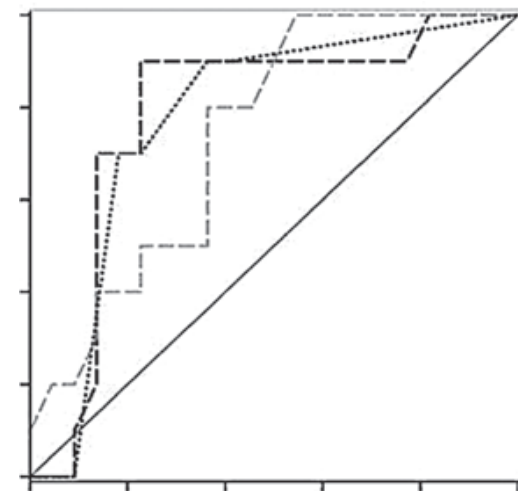
- **rcSO₂** se po 24h **zvyšuje > 80%** (adultní sensor!!!) a **FTOE klesá < 0,2**
Toet MC et al. Pediatrics 2006, 117; 333
- Asfyktičtí novorozenci mají **lepší prognózu**, když rcSO₂ nestoupá nad **cca 80 %** a **FTOE neklesá hlouběji pod 0.2** po 24 hodinách léčebné CT hypotermie!
Lemmers P et al Ped Res 2013
- **Kombinace aEEG skóre a rcSO₂** jsou nejlepším **prognostickým ukazatelem** v průběhu léčebné CT hypotermie
Lemmers P et al Ped Res 2013, Goeral et al 2017



1 – Specificity



1 – Specificity



1 – Specificity

Lemmers PMA, et al, Pediatrics Research, 2013;74(2): 180–5.

Prognostic value of cerebral tissue oxygen saturation during neonatal extracorporeal membrane oxygenation

Marie-Philippine Clair¹, Jérôme Rambaud¹, Adrien Flahault^{2,3}, Romain Guedj⁴, Julia Guilbert¹, Isabelle Guellec¹, Amélie Durandy¹, Maryne Demoulin¹, Sandrine Jean¹, Delphine Mitanchez⁵, François Chalard⁶, Chiara Sileo⁶, Ricardo Carbajal^{1,4,7}, Sylvain Renolleau⁸, Pierre-Louis Léger^{1*}

Table 3. Cerebral tissue oxygen saturation between survivors and non survivors.

	Survivors [n = 17]	Non survivors [n = 17]	<i>p</i>
Right temporo-parietal			
StcO ₂ (mean %)	69 ± 8	54 ± 14	0,0008
StcO ₂ <50% (min)	3 ± 7	31 ± 27	0,0001
ΔStcO ₂ >20% (min)	3 ± 7	28 ± 25	0,0002
Left temporo-parietal			
StcO ₂ (mean %)	67 ± 7	56 ± 16	0,03
StcO ₂ <50% (min)	5 ± 7	22 ± 28	0,01
ΔStcO ₂ >20% (min)	6 ± 7	20 ± 27	0,02

StcO₂: mean tissue oxygen saturation on the total recording time during ECMO duration. StcO₂ <50%: mean time spent below 50%. Δ StcO₂ > 20%: mean time spent below 20% of the mean StcO₂. Data are given as mean ± standard deviation.

Ledviny

- Pouze observační studie
- Složitá interpretace výsledků

Břicho- střevo a játra

- Technické problémy (mekonium pohyb střevních kliček, plyn)
- Inkonzistentní výsledky
- Složitá interpretace výsledků

Svaly

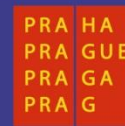
- Validní a dobře reprodukovatelná data o změnách mikrocirkulace

- Jednoduchá metoda a avšak obtížná interpretace získaných dat.
- Absolutní cut-off hodnoty (55 %, 85 %) je třeba dále prověřit v RCT.
- Dynamické hodnoty mohou napomáhat k objasnění patofyziologických mechanismů změn oxygenačně/perfuzního stavu mozku.
- Napomáhá identifikovat pacienty pro léčebné intervence.
- Vždy hodnoty interpretovat v souvislosti s celkovým stavem pacienta.
- U těžké asfyxie a u novorozenců/kojenců na ECMO může predikovat prognózu.

- Kalibrační standardy u jednotlivých přístrojů – konsenzus firem
- Součást monitorovacích jednotek pro dynamické hodnocení – tzv „diagnostické věže“ v jednom monitoru
- Softwarové propojení umožňující korelační analýzu dat.
- Další randomizované kontrolované studie



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Prof. MUDr. Richard Plavka, CSc.

2018

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