

UNIVERSITY HOSPITAL BRNO
FACULTY OF MEDICINE
MASARYK UNIVERSITY



DEPARTMENT OF **PAEDIATRIC**
ANAESTHESIOLOGY
AND INTENSIVE CARE MEDICINE

Waste-Free Blood Sampling na PICU - jaké jsou možnosti v ČR?

Eva Klabusayová

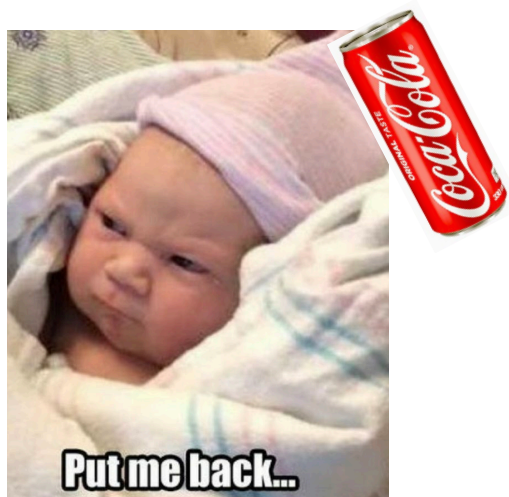
F FAKULTNÍ
NEMOCNICE
BRNO

M U N I
M E D

Objem krve

Věk	Objem krve (ml/kg)
Novorozenec	80-90
Kojenec	70-80
Děti	70-75
Dospělí	65-70

Novorozenec \approx 300ml



3-leté dítě \approx 1l



Dospělý \approx 4,5l



250-500 μ l



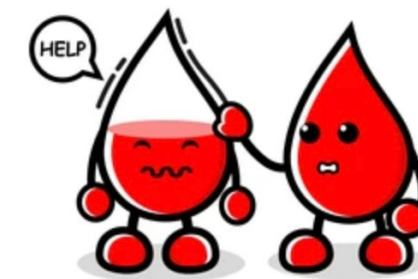
10 ml



10 ml



Anémie



Snížení počtu RBC – snížení transportní kapacity pro O₂

Population	Non -Anaemia*	Anaemia*		
		Mild ^a	Moderate	Severe
Children 6 - 59 months of age	110 or higher	100-109	70-99	lower than 70
Children 5 - 11 years of age	115 or higher	110-114	80-109	lower than 80
Children 12 - 14 years of age	120 or higher	110-119	80-109	lower than 80
Non-pregnant women (15 years of age and above)	120 or higher	110-119	80-109	lower than 80
Pregnant women	110 or higher	100-109	70-99	lower than 70
Men (15 years of age and above)	130 or higher	110-129	80-109	lower than 80

WHO. Haemoglobin Concentrations for the Diagnosis of Anaemia and Assessment of Severity. Geneva: World Health organization; 2011



Hospital-acquired anemia

Nová anemie u pacienta, který před hospitalizací anemický nebyl

Multifaktoriální etiologie

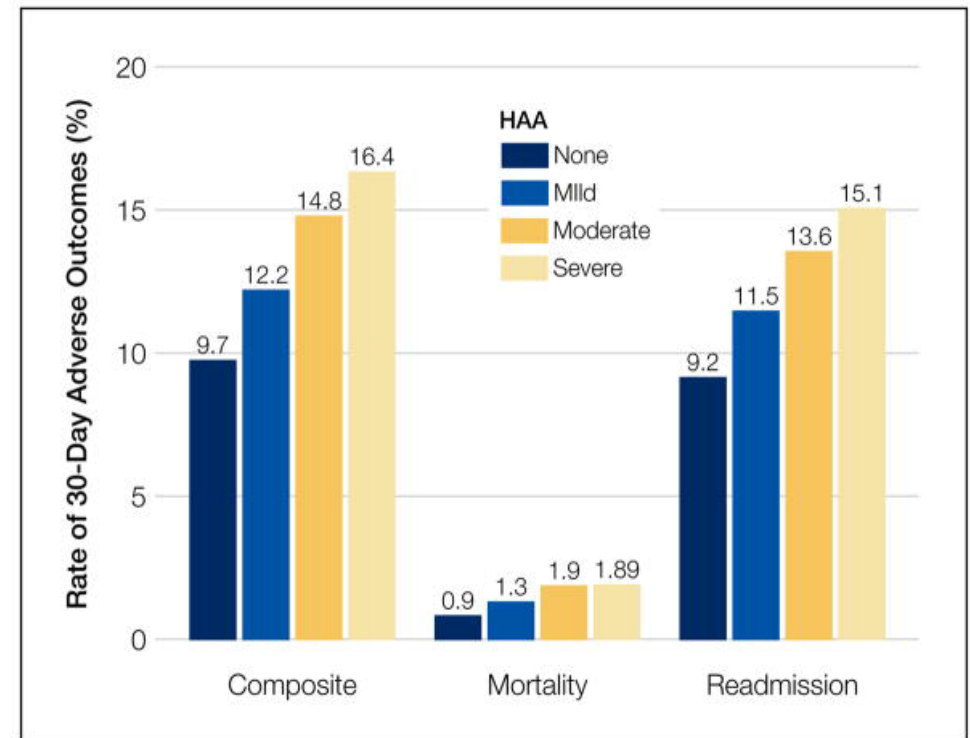
- Tíže kritického onemocnění
- Množství krevních odběrů
- Technika provedení odběrů

→ Tkáňová hypoxie

→ Delší hospitalizace, dny na UPV

→ Častější podání RBC

→ Vyšší morbidita i mortalita



Makam et al. Predictors, and Outcomes of Hospital-Acquired Anemia. J Hosp Med. 2017 May;12(5):317-322.



Jak je to na PICU?

Impact of Blood Sampling on Anemia in the PICU: A Prospective Cohort Study

François, Tine MD¹; Sauthier, Michaël MD, MBI¹; Charlier, Julien MD¹; Dessureault, Jessica BSN, RN¹; Tucci, Marisa MD, FRCPC, FAAP¹; Harrington, Karen MD, MSc¹; Ducharme-Crevier, Laurence MD, FRCPC, MSc¹; Al Omar, Sally PhD²; Lacroix, Jacques MD, FRCPC, FAAP¹; Du Pont-Thibodeau, Geneviève MD, FRCPC, MSc¹

[Author Information](#) 

Pediatric Critical Care Medicine: June 2022 - Volume 23 - Issue 6 - p 435-443

doi: 10.1097/PCC.0000000000002947

423 pediatrických pacientů, LOS 2,1 dní

Při propuštění z PICU **incidence anémie 56%**, z toho u 16% Hb<90 g/l

Průměrně odebráno 3,9 ± 19 ml krve/kg = 5% TCV

Průměrně 26% ze vzorků krve bylo vyhozeno

Statisticky signifikantní asociace mezi množstvím odebrané krve a anémií

Anemia status during PICU	N	Mean Hb (g/L)	95%CI	p
New anemia at discharge	57	-19.2	[-22.3, -16.2]	<i>p<.001</i>
No change in anemia during PICU stay	239	-5.7	[-7.5, -3.8]	
Anemia at admission only	19	18.5	[13.3, 23.8]	

Jak je to na PICU?

'True Blood' The Critical Care Story: an audit of blood sampling practice across adult, paediatric and neonatal intensive care settings

Ullman, Amanda, Keogh, Samantha, Coyer, Fiona, Long, Deborah A., New, Karen, and Richard, Claire M. (2016). 'True Blood' The Critical Care Story: an audit of blood sampling practice across adult, paediatric and neonatal intensive care settings. *Australian Critical Care* 29 (2) 90-95. <https://doi.org/10.1016/j.aucc.2015.06.002>

Table 2

Blood sampling across the included intensive care units (n = 940).

	Neonatal ICU (n = 140)	Paediatric ICU (n = 140)	Adult ICU (n = 655)	p values
Blood test: n (%)				
Arterial blood gas	66 (47%)	116 (80%)	543 (82%)	<0.001
Full blood count	21 (15%)	38 (26%)	152 (23%)	0.015
Capillary gas	35 (25%)	0	0	N/A
Urea, electrolytes and liver function test	9 (6%)	36 (25%)	157 (24%)	<0.001
Other	38 (27%)	55 (38%)	128 (20%)	N/A
Reason for blood sampling: n (%)				
Routine	45 (33.1%) ^a	39 (45.4%) ^b	113 (47.5%) ^c	0.024
Medical request	77 (56.6%)	43 (54.4%)	109 (45.8%)	
Previous abnormal result	6 (4.4%)	4 (5.1%)	8 (3.4%)	
Other	8 (5.9%)	0	8 (3.4%)	
Reason for arterial blood gas: n (%)				
Medical staff request	84 (95.4%) ^d	39 (37.5%) ^e	75 (13.4%) ^f	<0.001
Nurse initiated	0	55 (52.9%)	271 (48.5%)	
Routine	3 (3.4%)	1 (1.0%)	192 (35.4%)	
Other	1 (1.1%)	9 (8.6%)	21 (3.7%)	
Number of samples/patient/day: ^g	0.7 (0.4)	2.3 (2.9)	5.0 (2.4)	0.045
Volume of samples/patient/day: ^g	0.16 (0.4)	5.0 (1.0)	22.3 (16.8)	<0.001
Line clearance method: n (%)				
Return	140 (100%)	99 (68%)	0	<0.001
Discard	0	46 (32%)	655 (100%)	
Volume discarded for line clearance/patient/day: ^g	0	3.4 (2.6)	12.6 (8.4)	<0.001
Total blood volume for sampling/patient/day: ^g	0.15 (0.4)	9.30 (8.4)	37.7 (23.1)	<0.001

^a7 missing; ^b66 missing; ^c419 missing; ^d55 missing; ^e41 missing; ^f97 missing; ^gmedian (interquartile range).

Dalo by se to zlepšit?



Indikujeme odběry uvážlivě?

Protokolizace?

Rutina, nebo to opravdu potřebuju?

Nestačil by mi neinvazivní monitoring?

11. Policies and procedures are in place and followed that minimize the frequency and volume of blood sampling for diagnostic laboratory testing, facilitate earliest possible removal of sampling lines and provide for the safe return of discard or void volumes.
12. Non-invasive techniques are used for monitoring of blood gases, hemoglobin and other analytes whenever possible.

Society for the advancement of blood management administrative and clinical standards for patient blood management programs. 4th edition (pediatric version)

Susan M. Goobie ✉, Trudi Gallagher, Irwin Gross, Aryeh Shander





Dalo by se to zlepšit?

Jak probíhá to, co naordinuji
= vlastní odběr?

Rozdíl v množství odebrané krve
pro POCT x odběr do laboratoře

Vracíme odtáhnutou krev
zpátky nebo ji vyhazujeme?

Odtáhnutí z katetru za účelem
„dekontaminace vzorku“ od podané
medikace

Proč ji vlastně vyhazujeme?

Riziko infekce?

Riziko koagul?

Nešlo by to i jinak?



Push-pull metoda

Opakovaný odběr a vrácení krve
Dekontaminace katetru
Uzavřený systém

- ✗ Okluze katetru
- ✗ Katetrové infekce
- ✗ Hemolýza

- ✓ Spolehlivé výsledky
- ✓ Nic se nevyhodí

A Standard Push-Pull Protocol for Waste-Free Sampling in the Pediatric Intensive Care Unit

McBride, Clare BSN, RN, CCRN; Miller-Hoover, Suzan DNP, RN, CCNS, CCRN-K; Proudfoot, James A. MSC



1. Attach a 10-mL syringe with 3 to 5 mL 0.9% sodium chloride to the catheter and flush using push-pause technique.

2. Keep the 10-mL syringe attached and use to withdraw and return 4 mL through the catheter a total of 4 times.

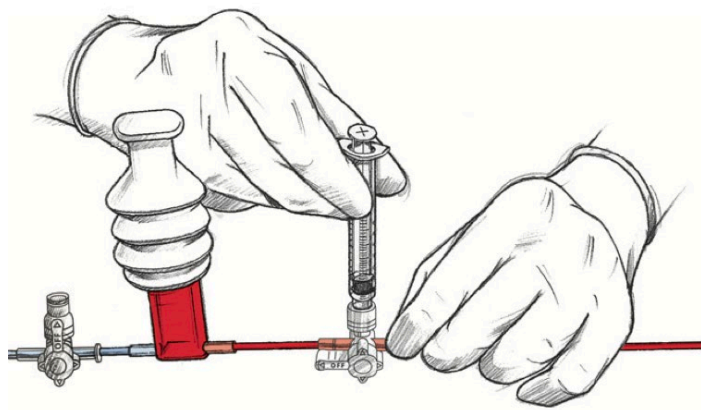
3. Attach a new syringe and withdraw and withdraw sample(s) from the catheter.

4. Attach a 10-mL 0.9% sodium chloride syringe and flush the catheter with 3 to 5 mL using push-pause technique.



Uzavřené odběrové systémy

VAMP Jr system
(Edwards Lifesciences)



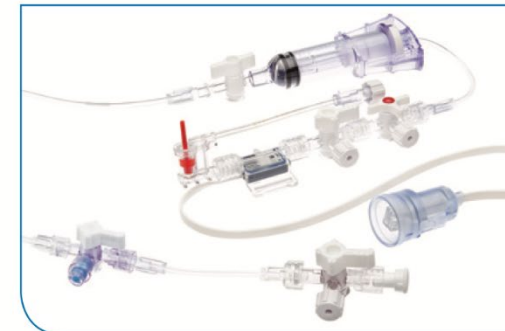
SafeSet® (ICU Medical)

Encapsulated internal sheath
guards against touch
contamination

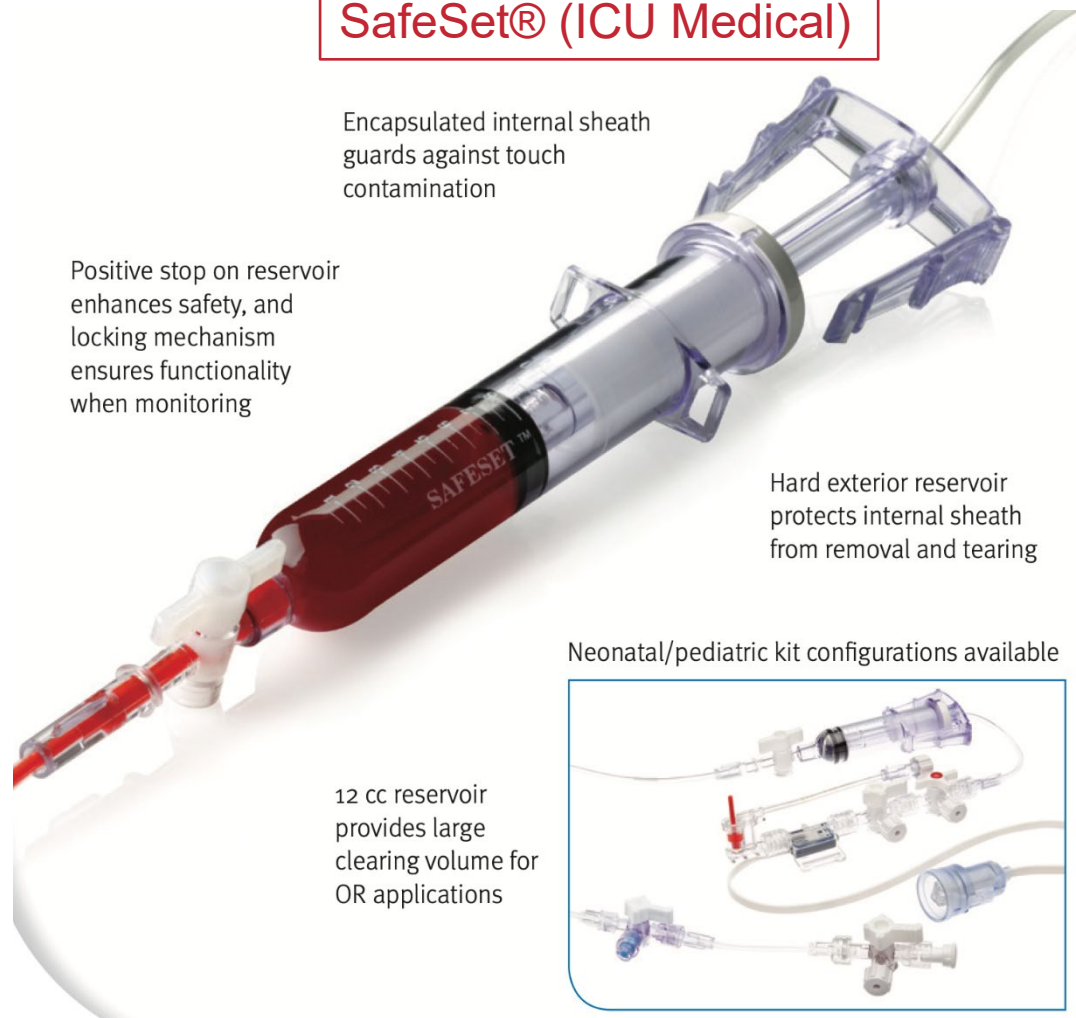
Positive stop on reservoir
enhances safety, and
locking mechanism
ensures functionality
when monitoring

Hard exterior reservoir
protects internal sheath
from removal and tearing

Neonatal/pediatric kit configurations available



12 cc reservoir
provides large
clearing volume for
OR applications



Keep blood where it belongs

- ✓ Adekvátní indikace krevních odběrů
 - ✓ Protokolizace
 - ✓ Minimalizovat četnost
 - ✓ Snaha o minimalizaci odebraného odběru – POCT

- ✓ Neinvazivní měření všude, kde je to možné



Noninvasive and continuous hemoglobin (SpHb) monitoring offers real-time visibility to changes – or lack of changes – in hemoglobin between invasive blood sampling. (Photo courtesy of Masimo Corporation)

Keep blood where it belongs

✓ Zlepšení techniky odběru

- ✓ Uzavřené systémy
- ✓ Push-pull metoda
- ✓ Odběr přes 2 kohouty s následným vrácením krve?
- ✓ Odebraný objem – kolik potřebuje laboratoř



hematologie							
Morfologie rutinní							
Krevní obraz a diferenciální rozpočet leukocytů 03841/01014 03841/01016a 03841/01019a 03848/01004	R, S	nesrážlivá krev	EDTA	3 ml [X] 0,2-3 ml [•]	500 µl		
Koagulace							
Protrombinový test 03842/01201 03848/01019	R,S	nesrážlivá krev / plazma	citrát	1,4 nebo 3 nebo 5ml	200µl		
Fibrinogen 03842/01202 03848/01021	R,S	nesrážlivá krev / plazma	citrát	1,4 nebo 3 nebo 5ml	200µl		

Primární materiál

Vyšetřovaný materiál



Keep blood where it belongs

✓ Zlepšení techniky odběru

- ✓ Uzavřené systémy
- ✓ Push-pull metoda
- ✓ Odběr přes 2 kohouty s následným vrácením krve?
- ✓ Objem zkumavky

✓ Maximalizace využití odebraného materiálu = minimalizace zbytečných ztrát:

Odtah z arterie 2x mrtvý prostor katetru (1-2ml)

Odtaz CVK 3-6x objem katetru (2-5ml pro většinu)



Použití zdroje

François T, Sauthier M, Charlier J, et al. Impact of Blood Sampling on Anemia in the PICU: A Prospective Cohort Study. *Pediatr Crit Care Med*. 2022;23(6):435-443. doi:10.1097/PCC.0000000000002947

Rickard CM, Couchman BA, Schmidt SJ, Dank A, Purdie DM. A discard volume of twice the deadspace ensures clinically accurate arterial blood gases and electrolytes and prevents unnecessary blood loss. *Crit Care Med* 2003;31:1654–8.

Shander A, Corwin HL. A Narrative Review on Hospital-Acquired Anemia: Keeping Blood where It Belongs. *Transfus Med Rev*. 2020;34(3):195-199. doi:10.1016/j.tmr.2020.03.003

Goobie SM, Gallagher T, Gross I, Shander A. Society for the advancement of blood management administrative and clinical standards for patient blood management programs. 4th edition (pediatric version). *Paediatr Anaesth*. 2019;29(3):231-236. doi:10.1111/pan.13574

McBride C, Miller-Hoover S, Proudfoot JA. A Standard Push-Pull Protocol for Waste-Free Sampling in the Pediatric Intensive Care Unit. *J Infus Nurs*. 2018;41(3):189-197. doi:10.1097/NAN.0000000000000279

Ullman AJ, Keogh S, Coyer F, Long DA, New K, Rickard CM. 'True Blood' The Critical Care Story: An audit of blood sampling practice across three adult, paediatric and neonatal intensive care settings. *Aust Crit Care*. 2016;29(2):90-95. doi:10.1016/j.aucc.2015.06.002

Recommendations on RBC Transfusion in General Critically Ill Children Based on Hemoglobin and/or Physiologic Thresholds From the Pediatric Critical Care Transfusion and Anemia Expertise Initiative. *Pediatr Crit Care Med*. 2018;19(9S Suppl 1):S98-S113. doi:10.1097/PCC.0000000000001590

Valentine SL, Bembea MM, Muszynski JA, et al. Consensus Recommendations for RBC Transfusion Practice in Critically Ill Children From the Pediatric Critical Care Transfusion and Anemia Expertise Initiative. *Pediatr Crit Care Med*. 2018;19(9):884-898. doi:10.1097/PCC.0000000000001613



Děkuji za pozornost

UNIVERSITY HOSPITAL BRNO
FACULTY OF MEDICINE
MASARYK UNIVERSITY



**DEPARTMENT OF PAEDIATRIC
ANAESTHESIOLOGY
AND INTENSIVE CARE MEDICINE**