



# I. OS. - alternativa PIV v urgentní situaci

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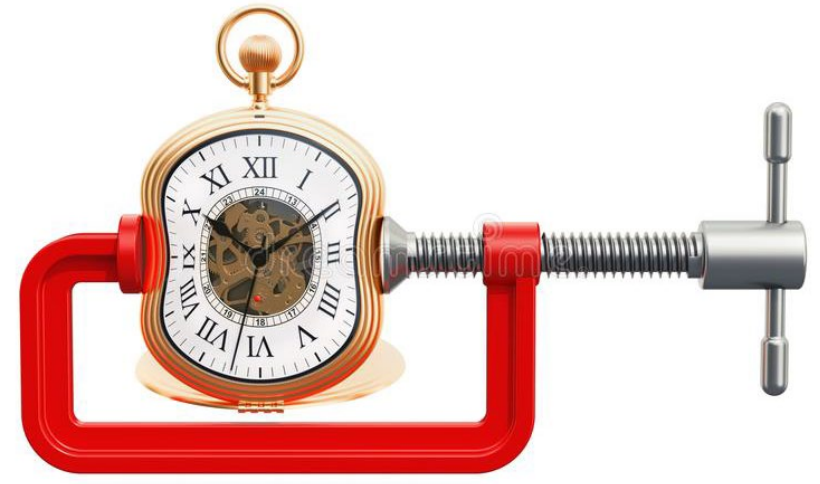
XV. Konference Akutně.cz

25. 11. 2023





**(X)ABCDE**



# I. OS. VSTUP= 1. ALTERNATIVA K NEZDAŘENÉMU PIV



**EUROPEAN  
RESUSCITATION  
COUNCIL**

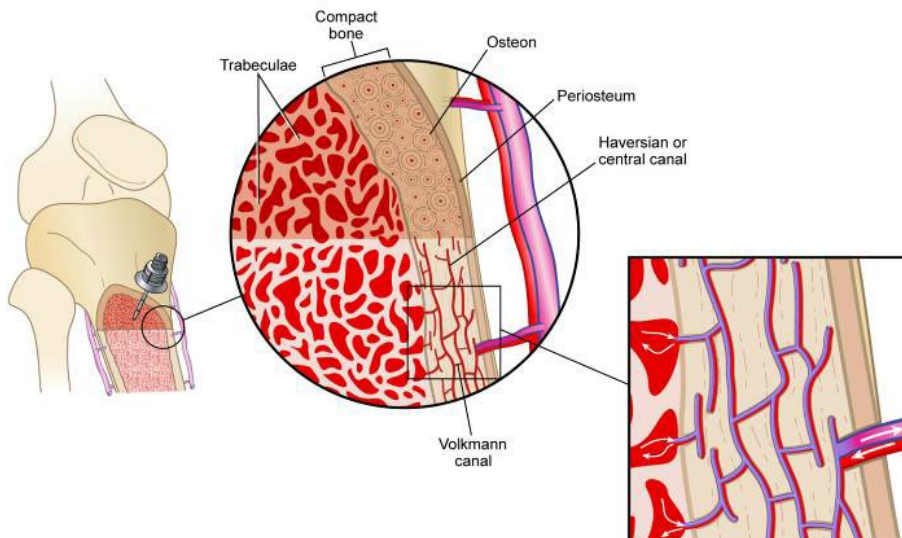


- Děti zástava oběhu nebo dekompenzovaný šok (adrenalin, tekutiny):  
i. os = 1. volba (manuál EPALS, CPR GL 2021)
- EPALS, ALS, ATLS, PHTLS, TCCC.....



# Proč to funguje?

- Ve dřeni hustá síť cév
- Krevní proud rychlý
- Dřeň nezkolabuje
- Léky a tekutiny rychle dosáhnou centrálního cévního řečiště **IO = PIV = efektivní varianta PIV**



Miller, LJ, Kuhn JG, Von Hoff, DD. Does IO equal IV? Prehosp Emerg Care 2005; 9:102

1922 – Drinker et al. – léky a infúze aplikované do kostní dřeni (sternum) se rychle vstřebají do centrálního řečiště

1942 - Papper – doba vstřebání léků do centrálního řečiště je u IV podání a IO identická



# Application Times, Placement Accuracy, and User Ratings of Commercially Available Manual and Battery-Powered Intraosseous Catheters in a High Bone Density Cadaveric Swine Model

Victoria C. Kay, MD<sup>1</sup>,†; Joseph A. Gehrz, MD\*,†; Derek W. Grady, MD†,‡; Alec D. Emerling, MD\*,†; Andrew McGowan, MD\*,†,§; Erin R. Reilly, MPH\*,†; Vikhyat S. Bebart, MD||,¶; Joshua Nassiri, MD†,‡,§; Jorge Vinals, PhD\*\*, Andrew Schrader, DVM††; Gregory J. Zarow, PhD†,‡‡; Jonathan D. Auten, DO†,§

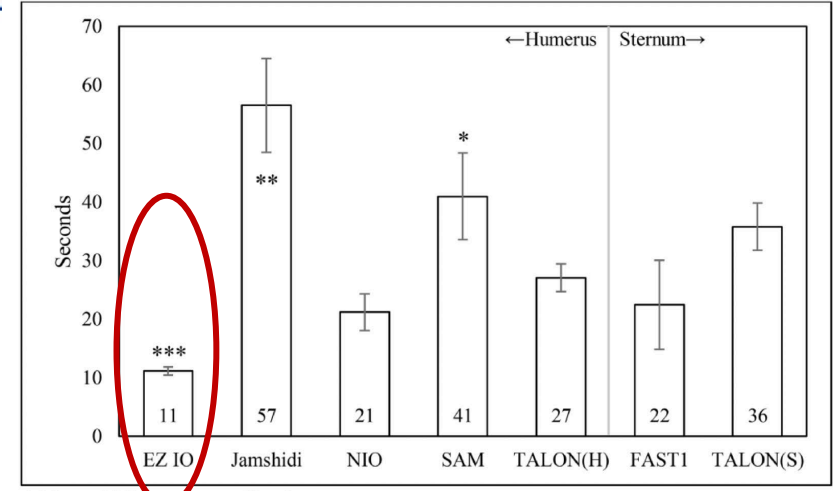
Arrow EZ-IO

Jamshidi IO

PerSys NIO 2

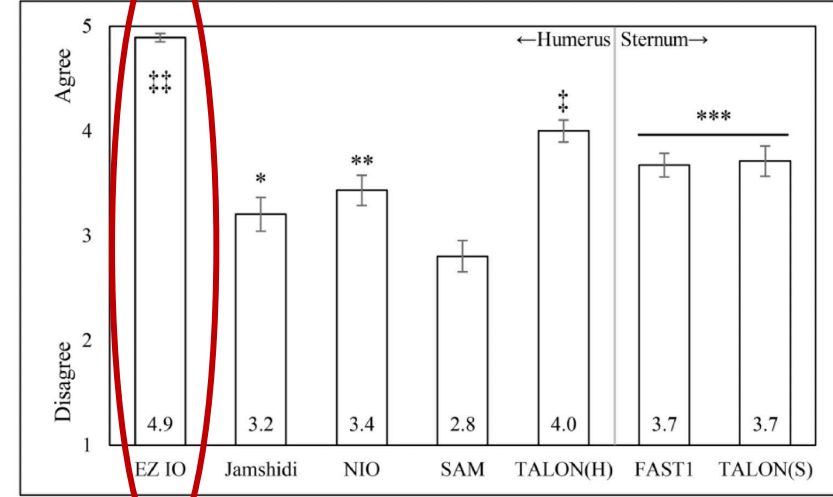


Arrow EZ-IO™ - EZ (Easy) IO (IntraOsseal) access



\*\*\*p<.0001 versus all others  
 \*\*p<.0001 versus NIO, FAST1; p<.001 versus TALONH; p<.01 versus TALONH; p<.05 versus SAM  
 \*p<.05 versus NIO, FAST1

IO End-User Ratings



‡‡‡p<.0001 versus all others  
 ‡‡p<.0001 versus Jamshidi and SAM, p<.01 versus NIO  
 \*\*\*p<.0001 versus SAM, p<.01 versus Jamshidi  
 \*\*p<.01 versus SAM  
 \*p<.05 versus SAM

**ORIGINAL RESEARCH**

**Open Access**

# Efficacy of the EZ-IO<sup>®</sup> needle driver for out-of-hospital intraosseous access - a preliminary, observational, multicenter study

Richard Schalk<sup>1</sup>, Uwe Schweigkofler<sup>2</sup>, Gösta Lotz<sup>1</sup>, Kai Zacharowski<sup>1</sup>, Leo Latasch<sup>3</sup> and Christian Byhahn<sup>1\*</sup>

**Table 1 Indications for EZ-IO<sup>®</sup> use in 74 patients**

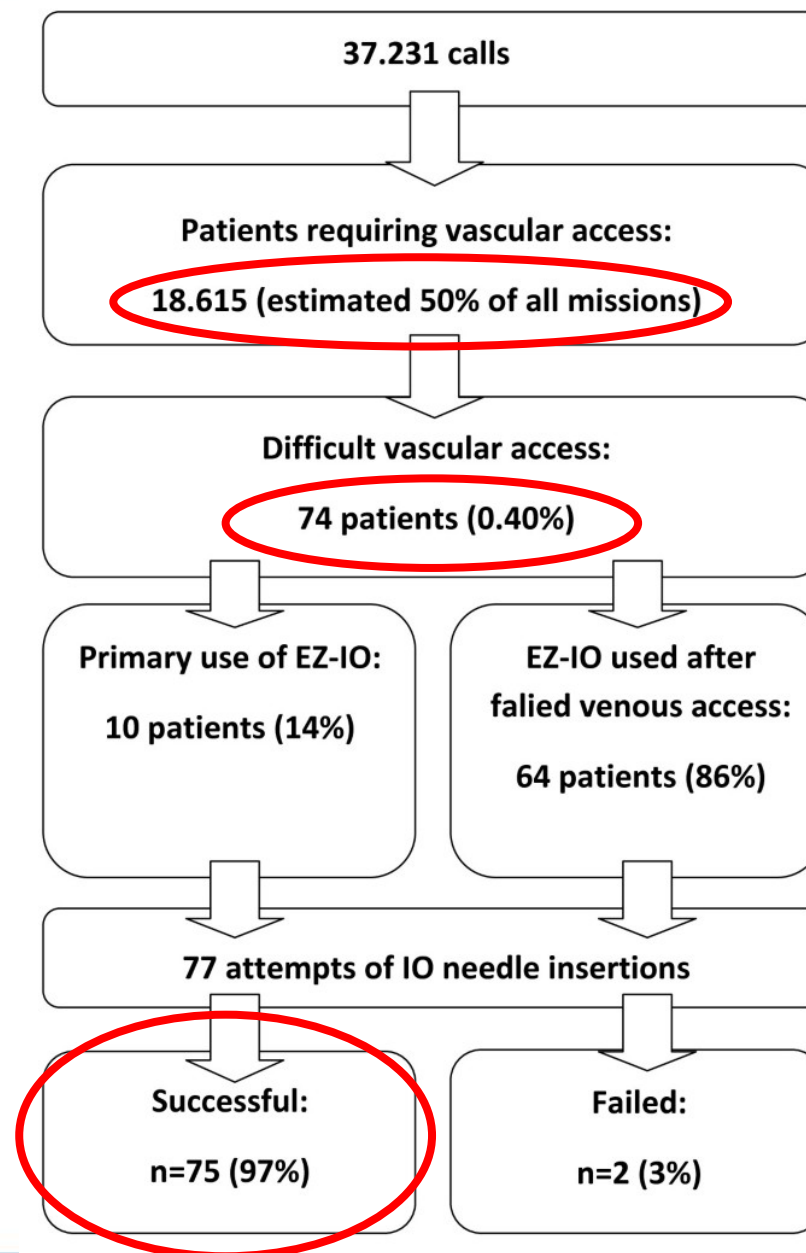
Diagnosis	n and (%)
Cardiac arrest	41 (56%)
Multiple trauma	15 (20%)
Myocardial ischemia	5 (7%)
Pulmonary edema	4 (5%)
Drug poisoning	4 (5%)
Stroke/Intracerebral hemorrhage	3 (4%)
Gastrointestinal hemorrhage	2 (3%)

**Table 2 Previous personal experience with IO needle placement**

Previously placed intraosseous needles (n = 63 EP/PM)*				
None	1-5	6-10	> 10	
25 (40%)	32 (50%)	3 (5%)	3 (5%)	

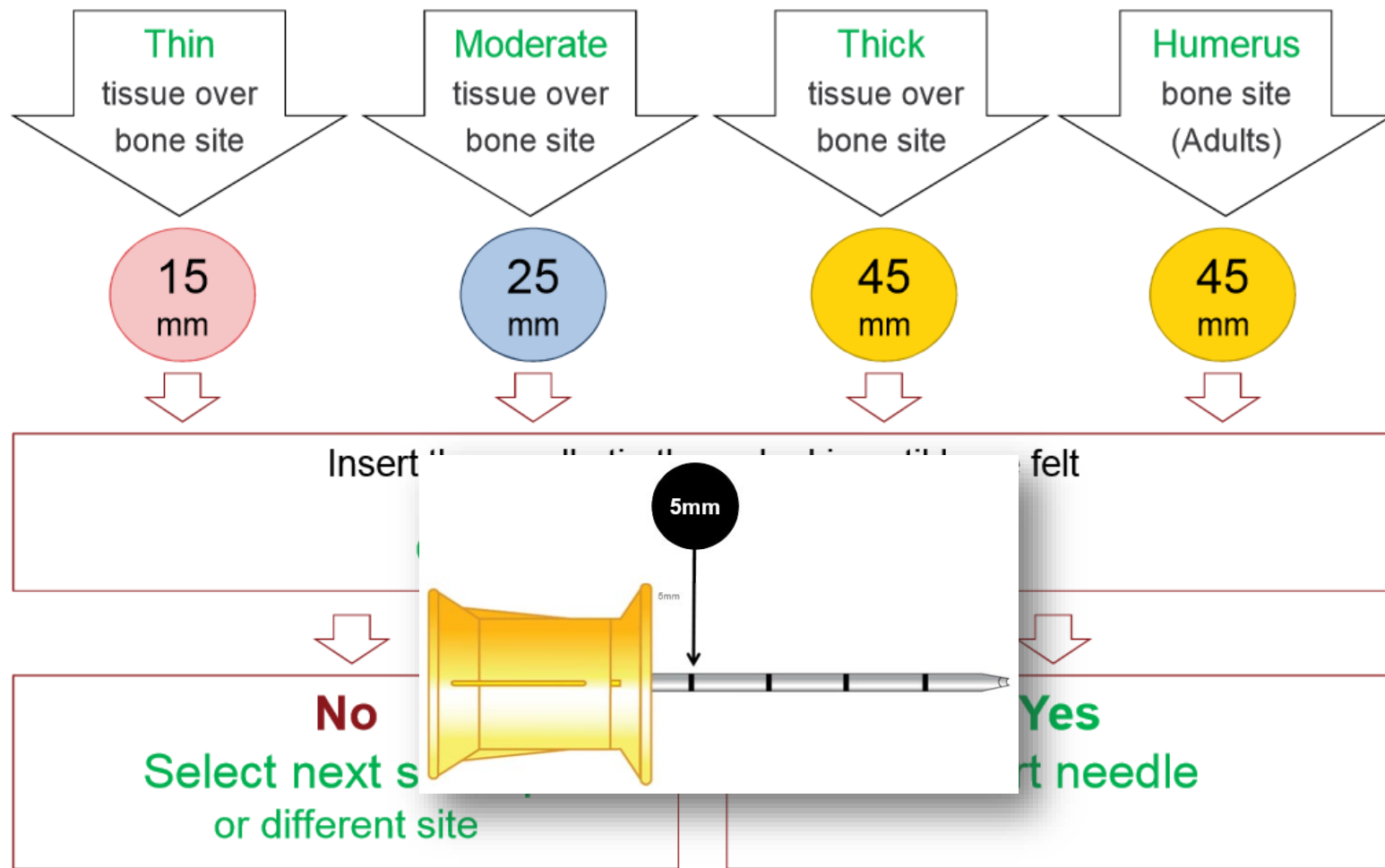
Data are number and (%)

EM: emergency physician PM: paramedic

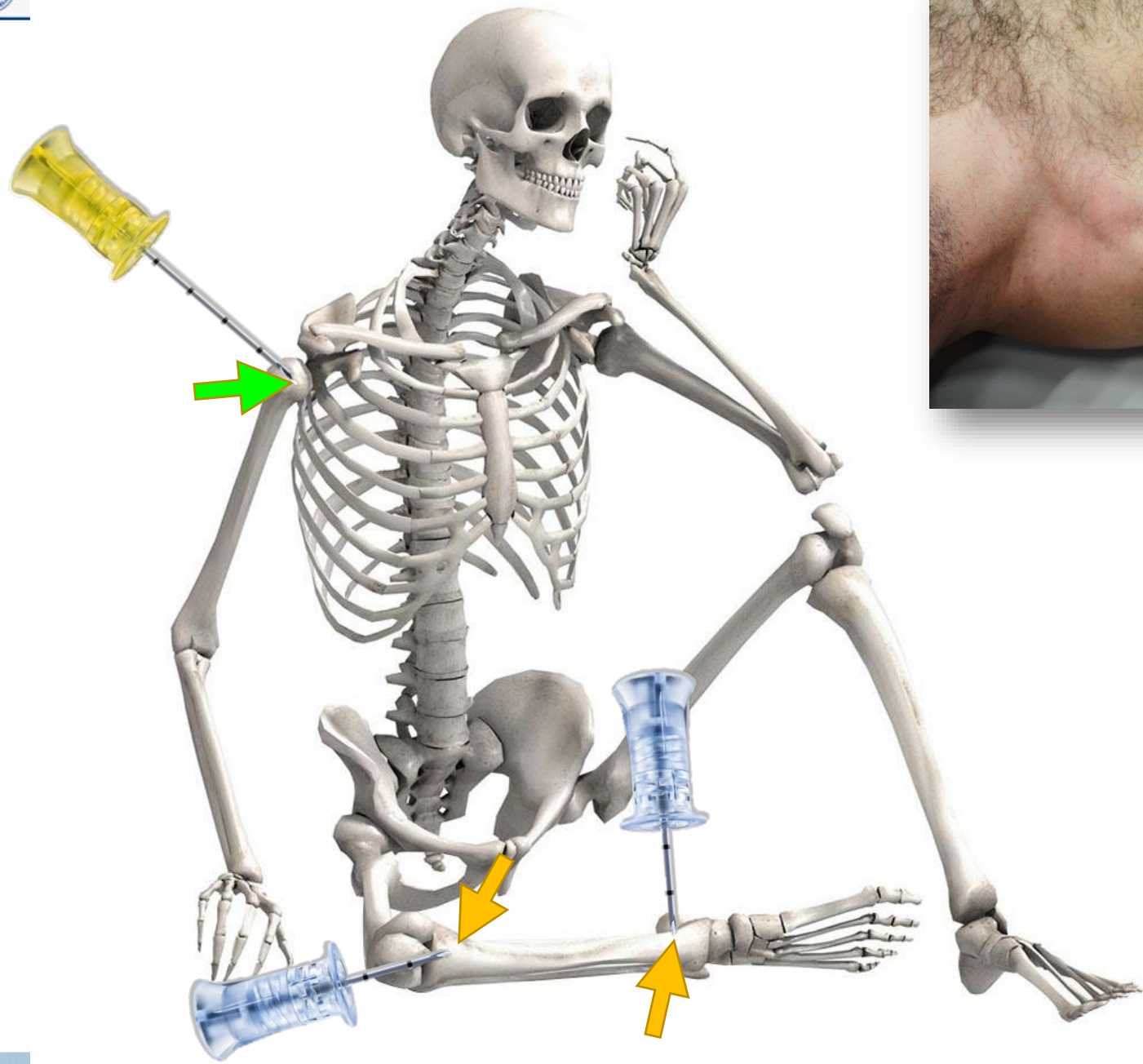






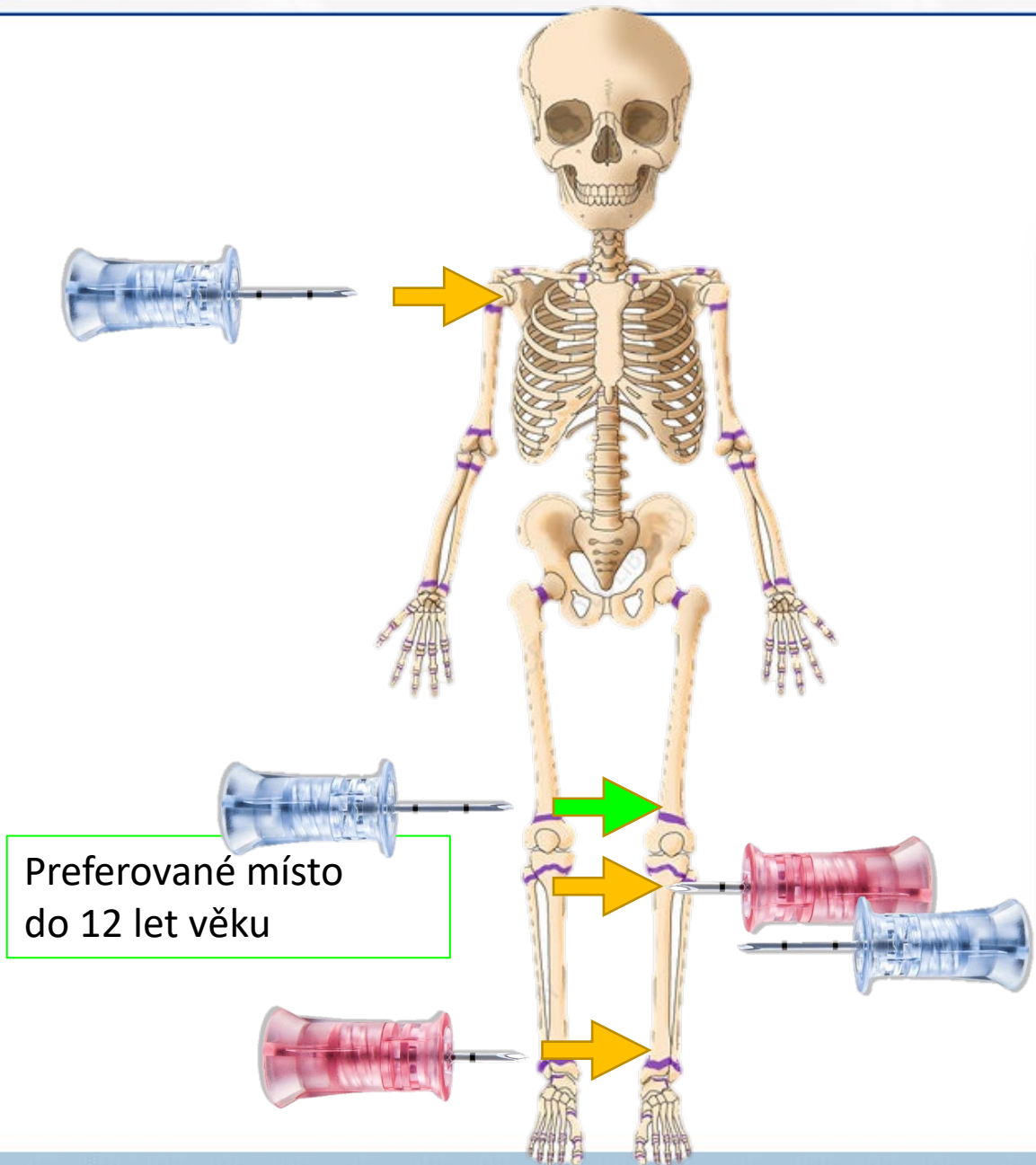






## Proximální humerus – vyhledání místa vpichu

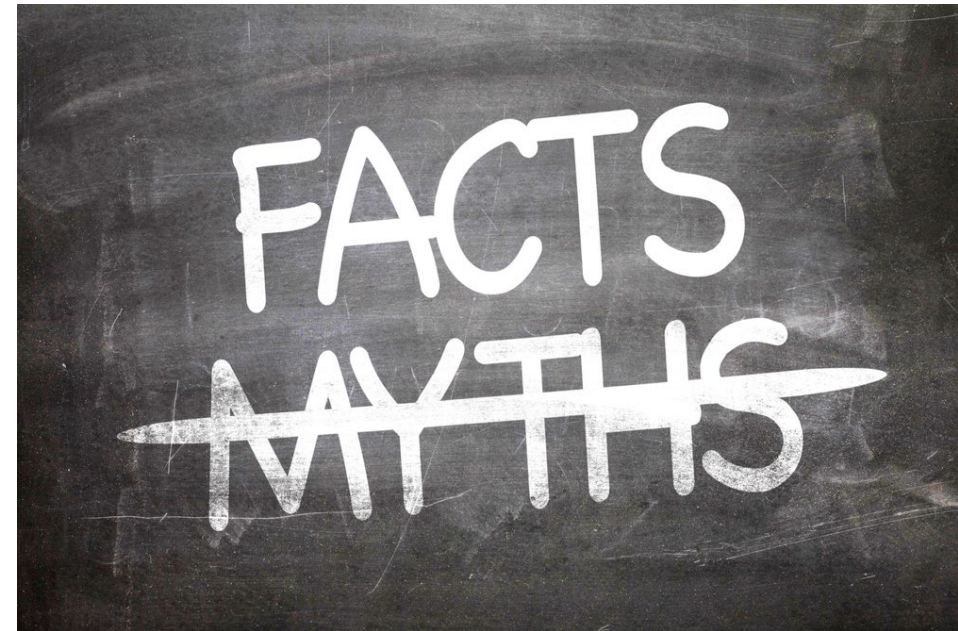






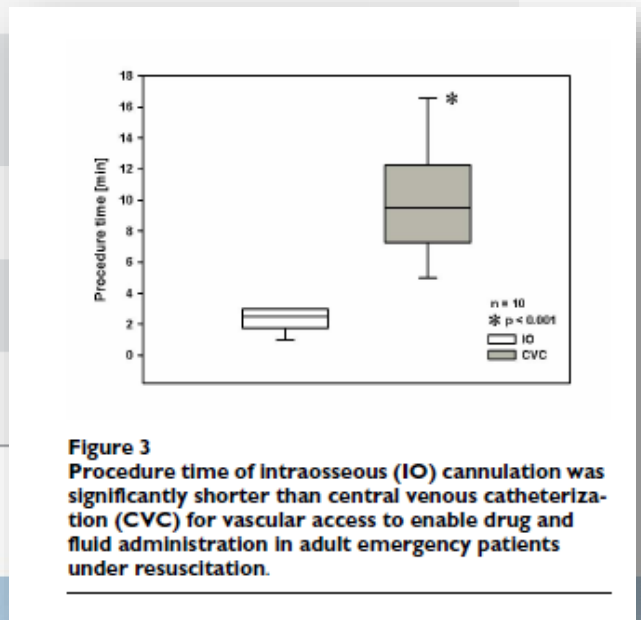
# Mýty? Fakta? Otázky?

- CVK je zavedený stejně rychle?
- Průtok je pomalý?
- Laboratorní odběr?
- Může sestra zajistit humerus?
- Riziko vážných komplikací?
- MR?



Participants	Grading						Insertion time [sec]			Attempt [number]				
	[1 = excellent to 6 = failure]													
	Participant			Observer			EZ-IO tibia	EZ-IO humerus	FASTR	EZ-IO tibia	EZ-IO humerus	FASTR	EZ-IO tibia	EZ-IO humerus
EZ-IO tibia	EZ-IO humerus	FASTR	EZ-IO Tibia	EZ-IO humerus	FASTR									
Mean value	1.3	2.0	1.6	1.0	1.4	1.1	17.0	29.1	32.6	1.1	1.2	1.1		
Standard deviation	0.5	0.8	0.8	0.2	0.6	0.2	7.2	42.3	20.6	0.3	0.4	0.2		
Median	1	2	1	1	1	1	15	19	30	1	1	1		
Minimum	1	1	1	1	1	1	8	5	14	1	1	1		
Maximum	2	3	3	2	3	2	33	210	110	2	2	2		
<i>p</i> value (ANOVA)	0.008		0.012		0.165			0.209						
<i>post hoc analysis (if applicable)</i>	<b>Rychlost zavedení</b>													
EZ-IO tibia vs. EZ-IO humerus	0.006		0.025											
EZ-IO humerus vs. FASTR	0.390		0.039											
EZ-IO tibia vs. EZ-IO humerus	0.349		1.0											

doi:10.1371/journal.pone.0143726.t001



# Flow rate

**Table 2** Comparison of flow rates with/without pressure bag

Flow rate	Tibia (mL/min)	Humerus (mL/min)
No pressure bag	73.0 (35.4)	84.4 (37.5)
With pressure bag	165.3 (112.5)	153.2 (65.0)
Difference	-92.3	-68.8
95% CI	-132.2 to -52.3	-99.0 to -38.7

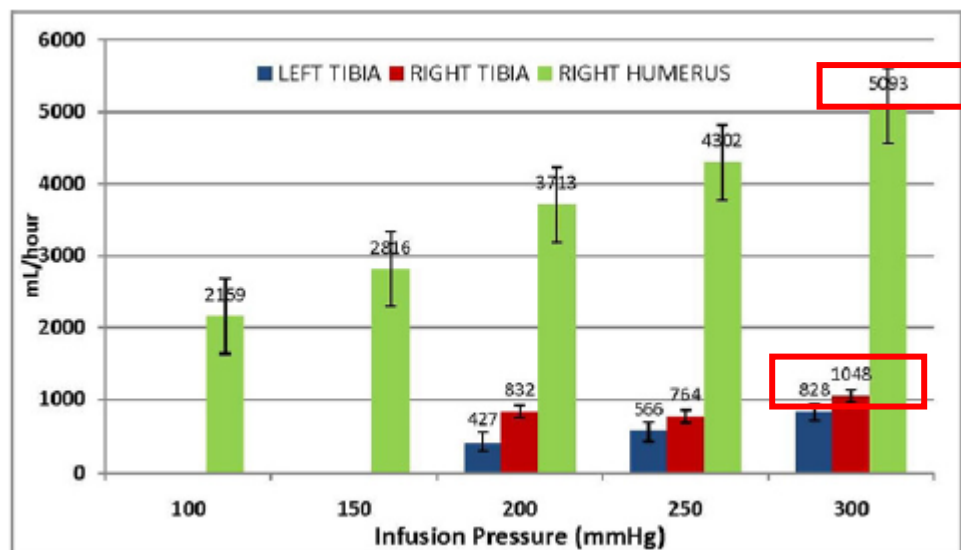
Published in The American journal of emergency medicine 2009

[An observational, prospective study comparing tibial and humeral intraosseous access using the EZ-IO.](#) M. Ong, Y. Chan, J.

Oh, A. Ngo

## 467 A Two-Phase Study of Fluid Administration Measurement During Intraosseous Infusion

Miller L, Philbeck T, Montez D, Puga T/Vidacare Corporation, San Antonio, TX



**Table 2** Flow rates of devices

Intravenous catheter	Rate of flow with gravity (ml/min)	Rate of flow with pressure (ml/min)	Rate of flow with Bionector (ml/min)	Percentage increase with pressure	Percentage decrease with Bionector
14G 50 mm cannula	236.1	384.2	138.3	62.7%	-41.4%
14G 14 cm Abbocath	197	366	131.3	85.8%	-33.4%
16G 50 mm cannula	154.7	334.4	109.6	116.2%	-29.2%
14G 15 cm Leadercath	117.3	211.1	101.1	80%	-13.8%
18G 45 mm cannula	98.1	153.1	80.3	56%	-18.1%
16G distal port triple lumen central line	69.4	116.1	67.4	67.3%	-2.88%
20G 33 mm cannula	64.4	105.1	58.5	63.2%	-9.17%
22G 25 mm cannula	35.7	71.4	34.7	100%	-2.80%
18G proximal port triple lumen central line	29.7	79.3	28.7	167%	-3.37%

## 79 Intraosseous Pressure Infusion Comparison Using a Rapid Infusion Device and a Pressure Bag In a Swine Model

Lairet JR, Bebartha V, Lairet K, Kacprowicz R, Johnson R, Pitotti R, Bolleter S, Cowart J, Bush A/Wilford Hall Medical Center, San Antonio, TX; US Army Institute of Surgical Research, Ft Sam Houston, TX; Wright Patterson AFB, WPAFB, OH; San Antonio AirLife, San Antonio, TX; 59th Clinical Research Division, San Antonio, TX

Site	Rate of infusion (mL/min)	Mean pressure (mmHg)
Proximal Humerus PB	115	394 (380 - 422)
Proximal Humerus RID	79	239 (180 - 278)
Proximal Tibia PB	81	471 (458 - 491)
Proximal Tibia RID	47	270 (260 - 288)
Femoral Vein Introducer PB	170	147 (133 - 155)

PB = pressure bag system; RID = rapid infusion device; Rate = mL/min; Pressure = mmHg



# Průtok kanylou

- Hagen-Poiseuilleův zákon:  $Q = \pi r^4 \cdot \Delta P / 8 \mu l$

- $Q$  = průtok
- $r$  = poloměr kanyly
- $\Delta P$  = tlakový gradient mezi začátkem a koncem
- $M$  = viskozita podávaného roztoku
- $l$  = délka kanyly

⇒ průtok závisí přímo úměrně na čtvrté mocnině poloměru

⇒ průtok krátkou kanylou zavedenou do PŽ ( $l=4,5\text{cm}$ ) bude min.  $3x \uparrow$  než průtok katétrem téhož kalibru zavedeném do CŽ ( $l=15 - 20\text{cm}$ )



# Průtok kanylou



# POC laboratorní diagnostika

- *Analysis of intraosseous blood samples using an EPOC point of care analyzer during resuscitation, Tallman 2017*
  - Závěr: výsledky srovnatelné pro pH, bikarbonát, sodík, BE, laktát
- *Intraosseous blood samples for point-of-care analysis: agreement between intraosseous and arterial analyses, Jousi et al., 2017*
  - Výsledky: IO vs art. krev - srovnatelné pH, glukóza, laktát. K<sup>+</sup> lehce vyšší u IO, BE a bikarbonát lehce vyšší, Na a Ca lehce nižší u IO, hodnoty krevních plynů jsou mezi v IO a art. odběrem. Hb, HCT variabilní





# Máme se bát komplikací?



- Výchozí podmínky – kritický pacient, PIV nelze, stresová situace
- Četnost zavedení spíše nízká, četnost zavedení na 1 osobu spíše raritní
- Úspěšnost metody 71 – 100%





## Complication with Intraosseous Access: Scandinavian Users' Experience

Peter Hallas, MD,\* Mikkel Brabrand, MD,<sup>†</sup> and Lars Folkestad, MD<sup>‡</sup>

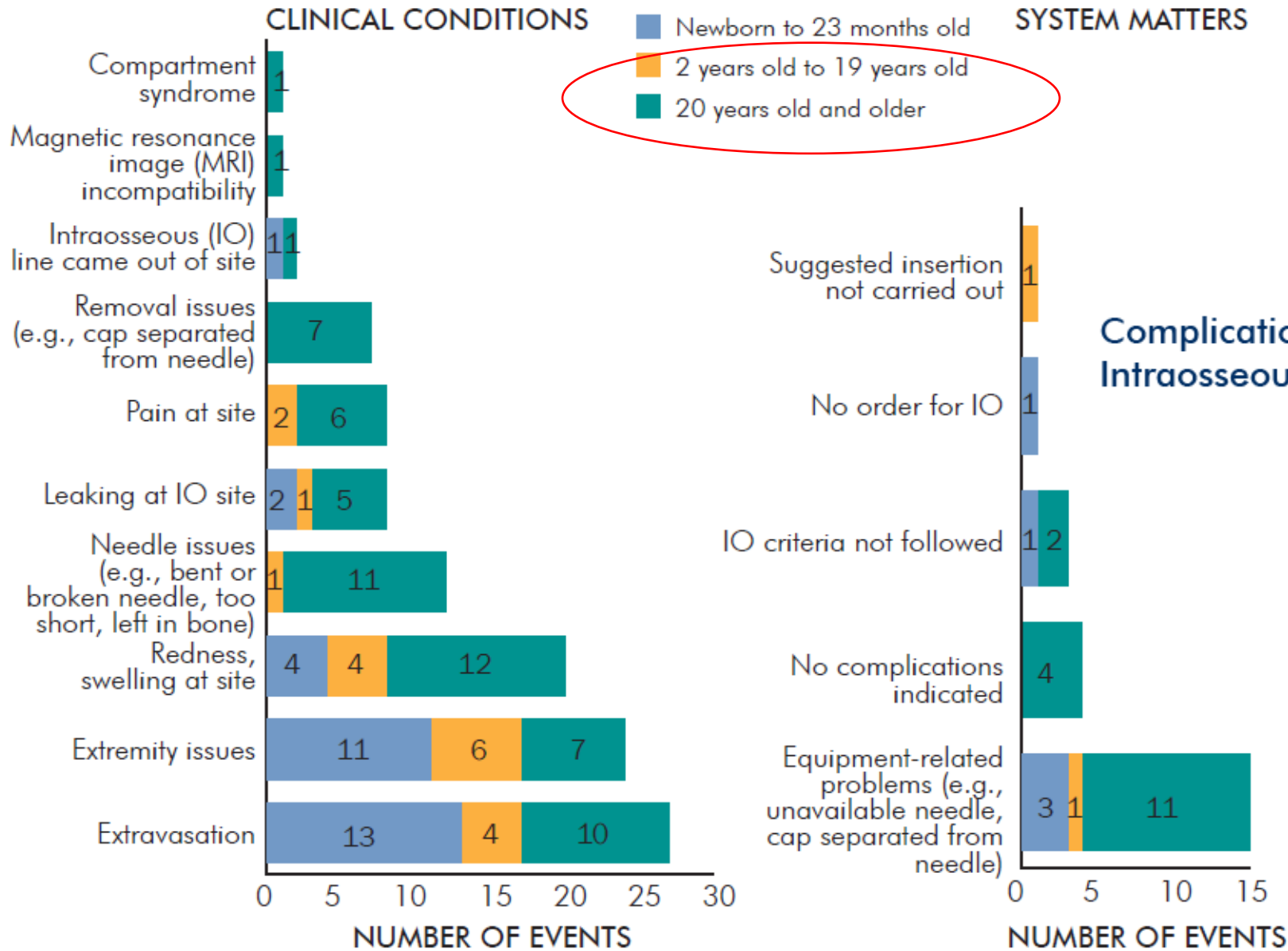
Complication with Intraosseous Access

Hallas et al

**Table.** Complication rate with intraosseous access (IO) reported by Scandinavian users - listed by device.

IO-equipment used	All	%	EZ-IO	B.I.G	Cook	Others	p-value*
Cases reported	1,802	100.0	861	255	418	268	
Start complications							
Equipment difficult to assemble	36	2.0	4	21	5	6	< 0.0001
Difficult to identify correct anatomical site	57	3.2	28	17	5	7	0.0013
Bended or broken needle	72	4.0	11	17	20	24	< 0.0001
Patient discomfort / pain	128	7.1	73	13	20	22	0.0663
Difficult to penetrate the periosteum	186	10.3	18	56	51	61	< 0.0001
Difficult to aspirate bone marrow	221	12.3	92	51	38	40	< 0.0001
Complications in use							
Difficult to inject fluid and drugs	133	7.4	59	33	27	14	0.0026
Slow infusion despite use of pressure bag	159	8.8	77	32	34	16	0.0610
Displacement after insertion	153	8.5	47	50	38	18	< 0.0001
Extravasation	66	3.7	25	12	17	12	0.4089
Late complications							
Compartment syndrome	10	0.6	6	1	1	2	0.796
Osteomyelitis	7	0.4	4	1	1	1	1.000
Skin infection	6	0.3	4	1	1	0	0.829

Figure 3. PA-PSRS Intraosseous Line Clinical Conditions and System Matters, January 1, 2006, through December 31, 2015 (N = 90)\*



Lea Anne Gardner, PhD, RN  
 Senior Patient Safety Analyst  
 Pennsylvania Patient Safety Authority

### Complications and Circumstances Pertaining to Intraosseous Lines

MS16579

\* 41.1% (37 of 90) of the event reports had two or more circumstances identified in the event narrative.





Case Report e59

## Serious Complications of Intraosseous Access during Infant Resuscitation

Jiri Molacek<sup>1</sup> Karel Houdek<sup>1</sup> Václav Opatrný<sup>1</sup> Jiri Fremuth<sup>2</sup> Lumir Sasek<sup>2</sup> Inka Treskova<sup>3</sup>  
Vladislav Treska<sup>1</sup>

<sup>1</sup>Department of Vascular Surgery, University Hospital in Pilsen, Pilsen, Czech Republic

<sup>2</sup>Department of Pediatric Intensive Care Unit, University Hospital in Pilsen, Pilsen, Czech Republic

<sup>3</sup>Department of Plastic Surgery, University Hospital in Pilsen, Pilsen, Czech Republic

[Address for correspondence](#) Jiri Molacek, MD, PhD, Department of Vascular Surgery, University Hospital in Pilsen, alej Svobody, Pilsen 30460, Czech Republic (e-mail: molacek@fnplzen.cz).

Eur J Pediatr Surg Rep 2018;6:e59–e62.



We report on a 2.5-month-old infant with ischemia of the left leg and compartment following intraosseous needle application during resuscitation. Unfortunately, this event led to major limb amputation. The cause, mechanism, and prevention of this severe complication are discussed in this article.



# Lze snížit % komplikací?

- Dostupné pomůcky – EZ-IO
- Dostatečné vzdělání a trénink – anatomie, protokoly, simulace = vyhledání místa, technika zavedení, správná fixace
- Dostatečné zkušenosti s metodou – nebát se a používat, je-li indikace
- **Častá kontrola vstupu**





## Arrow™ EZ-IO™ Needle – the first and only IO with MR Conditional safety status labeling

### Same EZ-IO™ Needle, Added Versatility

The Arrow™ EZ-IO™ Needle is now FDA cleared for use in an MRI environment. After gaining access with the EZ-IO™ System, the inserted EZ-IO™ Needle can stay in place when MRI scans are needed\*, removing a barrier to expedient patient care.

\*See IFU or back of this card for MR Conditional parameters

### MR Conditional

Non-clinical testing has demonstrated Arrow™ EZ-IO™ Needles are MR Conditional. A patient with this device inserted for intraosseous (IO) vascular access can be safely scanned in an MR system that meets the following conditions:

- Static magnetic field of 1.5-Tesla (1.5 T) or 3-Tesla (3 T)
- Maximum spatial field gradient of 4,000 G/cm (40 T/m)
- Maximum MR system reported, whole body averaged specific absorption rate (SAR) of 2.0 W/kg (Normal Operating Mode)

### RF Heating

Under the scan conditions defined above, EZ-IO™ Needles are expected to produce a maximum temperature rise less than or equal to 5.1 °C after 15 minutes of continuous scanning.



Scan to access updated IFU

Teleflex™



# 1. VYHLEDAT MÍSTO VPICHU

- Dle situace
- Dle věku
- EZ-IO zvolit správnou délku jehly

## 2. PŘÍPRAVA MÍSTA VPICHU



- Dezinfekce
- Asepse





### 3. PROPÍCHNOUT KŮŽI





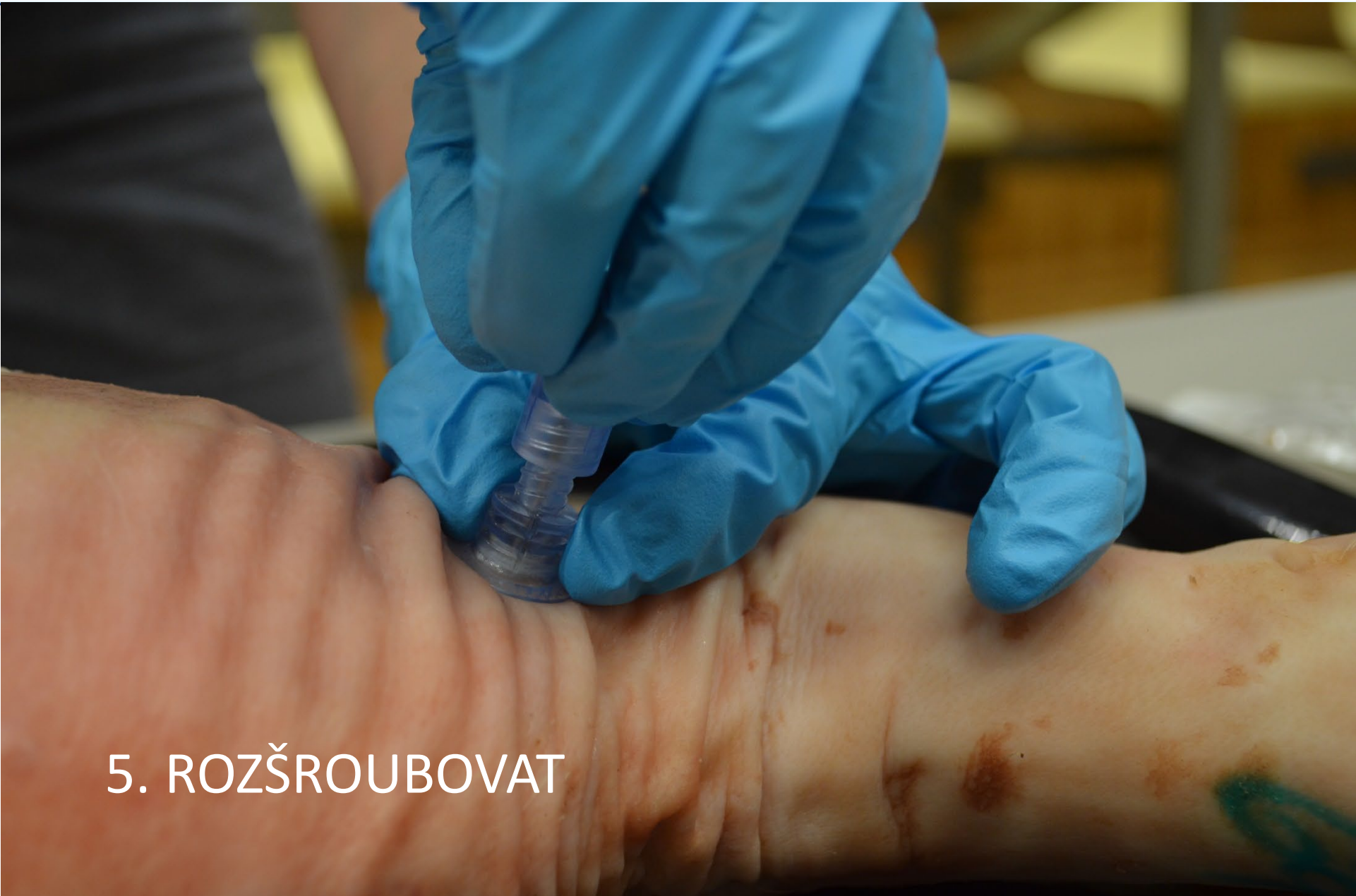


4. VRTAT (frézovat)...



..... DO ZTRÁTY ODPORU





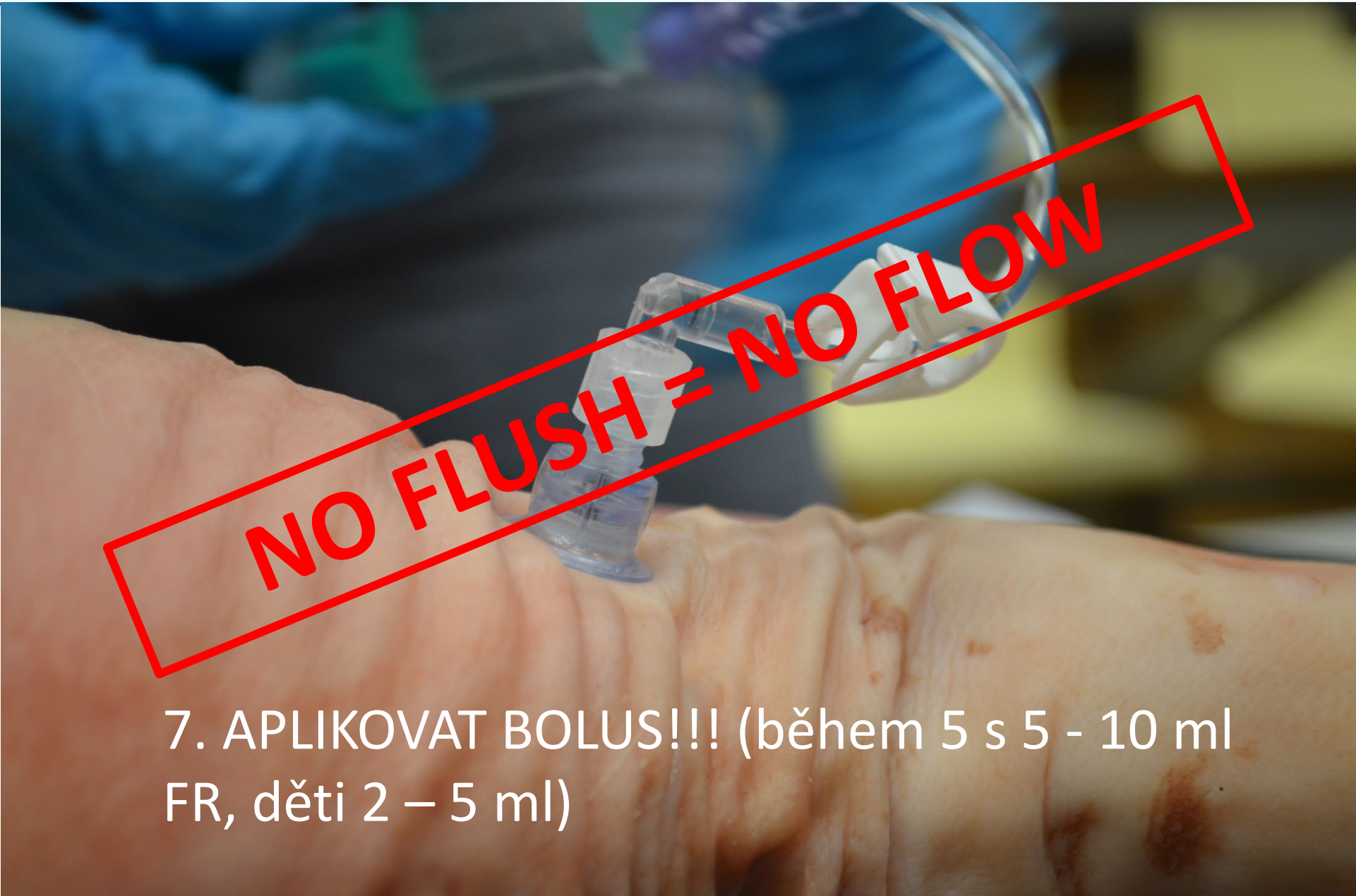
5. ROZŠROUBOVAT



6. ASPIROVAT







7. APLIKOVAT BOLUS!!! (během 5 s 5 - 10 ml  
FR, děti 2 – 5 ml)



8. FIXOVAT (fixátor, dlahá), APLIKOVAT INFÚZI  
PŘETLAKEM (300 mmHg)



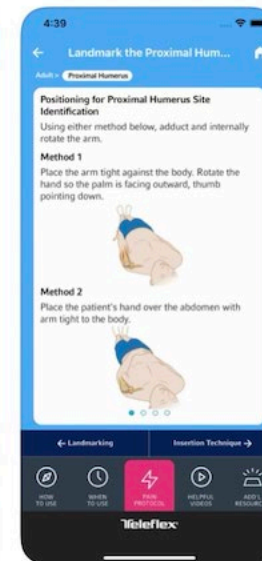


9. ČASTÁ KONTROLA !!!!

**THANK YOU  
FOR YOUR ATTENTION**



Teleflex Arrow® EZ-IO® App  
Vzdělávání



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Zdravotnická záchranná služba Zlínského kraje, p.o.  
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