ULTRASONOGRAFICKY ŘÍZENÁ KARDIOPULMONÁLNÍ RESUSCITACE

ROMAN ŠKULEC

- Klinika anesteziologie, perioperační a intenzivní medicíny, Masarykova nemocnice v Ústí nad Labem, Univerzita J. E. Purkyně v Ústí nad Labem
- Zdravotnická záchranná služba Středočeského kraje, Kladno
- Klinika anesteziologie, resuscitace a intenzivní medicíny, UK v Praze, LFHK, FN Hradec Králové

ERC GUIDELINES 2020

Use of ultrasound imaging during advanced life support

- Only skilled operators should use intra-arrest point-of-care ultrasound (POCUS).
- POCUS must not cause additional or prolonged interruptions in chest compressions.
- POCUS may be useful to diagnose treatable causes of cardiac arrest such as cardiac tamponade and pneumothorax.
- Right ventricular dilation in isolation during cardiac arrest should not be used to diagnose massive pulmonary embolism.
- Do not use POCUS for assessing contractility of the myocardium as a sole indicator for terminating CPR.

NEGATIVNÍ EFEKT

RESUSCITATION

EUROPEAN RESUSCITATION COUNCIL

CLINICAL PAPER | VOLUME 119, P95-98, OCTOBER 01, 2017

Ultrasound use during cardiopulmonary resuscitation is associated with delays in chest compressions

Maite A. Huis in 't Veld • Michael G. Allison • David S. Bostick • ... Olga G. Goloubeva • Michael D. Witting • Michael E. Winters • Show all authors

Published: July 25, 2017 • DOI: https://doi.org/10.1016/j.resuscitation.2017.07.021 • Check for updates

Table 2
Mean duration of pulse checks, calculated by treating each pulse check as an independent observation.

Type of pulse check	Mean duration in seconds	95% CI
Without POCUS	13	12–15
With POCUS	21	18–24

MOŽNOSTI VYUŽITÍ POCUS-CA

MOŽNOSTI VYUŽITÍ POCUS-CA

4H/4T A DALŠÍ

- hypoxie
- hypovolémie
- hypo/hyperK a metab. příčiny
- hypotermie

- trombóza
- tamponáda
- toxické látky
- tenzní pneumotorax

- srdce zcela vyplněné tromby
- porucha integrity volné stěny
- tenzní fluidothorax
- hypovolemie u VF

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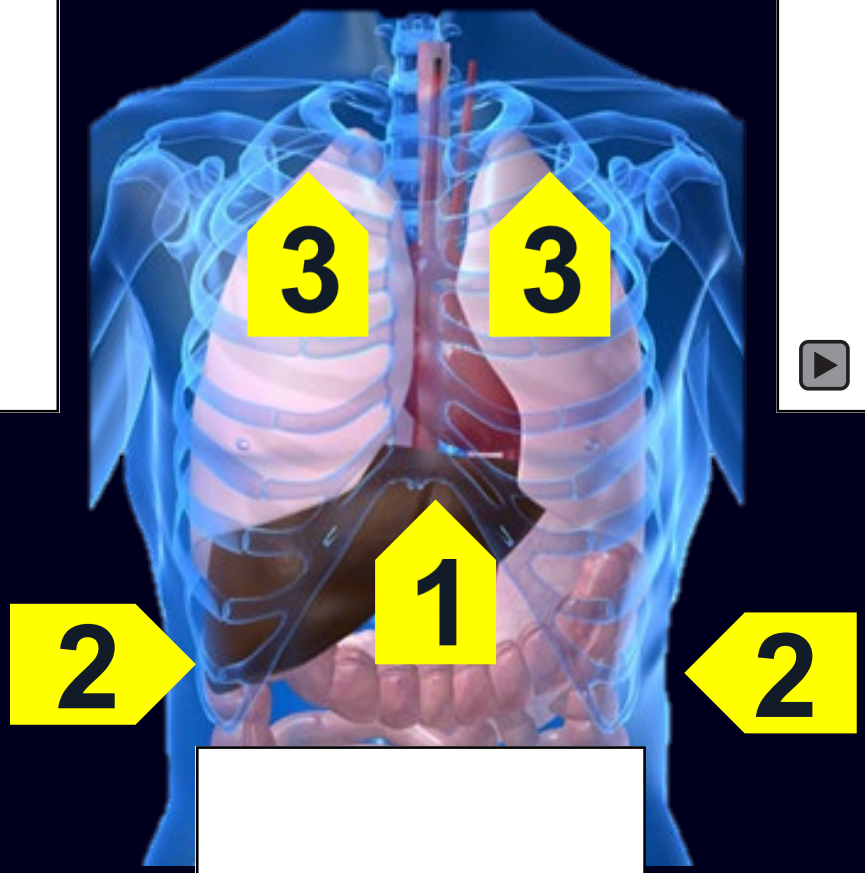
TRACE (Thoracic and Abdominal Sonography in Cardiac Arrest)



4H/4T A DALŠÍ

AP014 | VOLUME 96, SUPPLEMENT 1, 48, NOVEMBER 01, 2015

TRACE: A new protocol for ultrasound examination during out-of-hospital cardiac arrest

Roman Skulec • Anatolij Truhlar • Jiri Knor • Vladimir Cerny

Concordance of WD and FD diagnosis of reversible cause of OHCA.

Reversible cause	WD (*n*)	FD (*n*)	Reversible cause	WD (*n*)	FD (*n*)
Coronary thrombosis	21	22	Hypoxia	9	7
Pulmonary thrombosis	6	7	Hypovolaemia	4	4
Cardiac tamponade	1	1	Metabolic	1	1
Toxins	0	0	Hypothermia	0	0
Tension pneumothorax	1	1			

- konkordance 93,7 %
- ROSC 41,7 %
- CPC 1 / 2 při propuštění 20,8 %

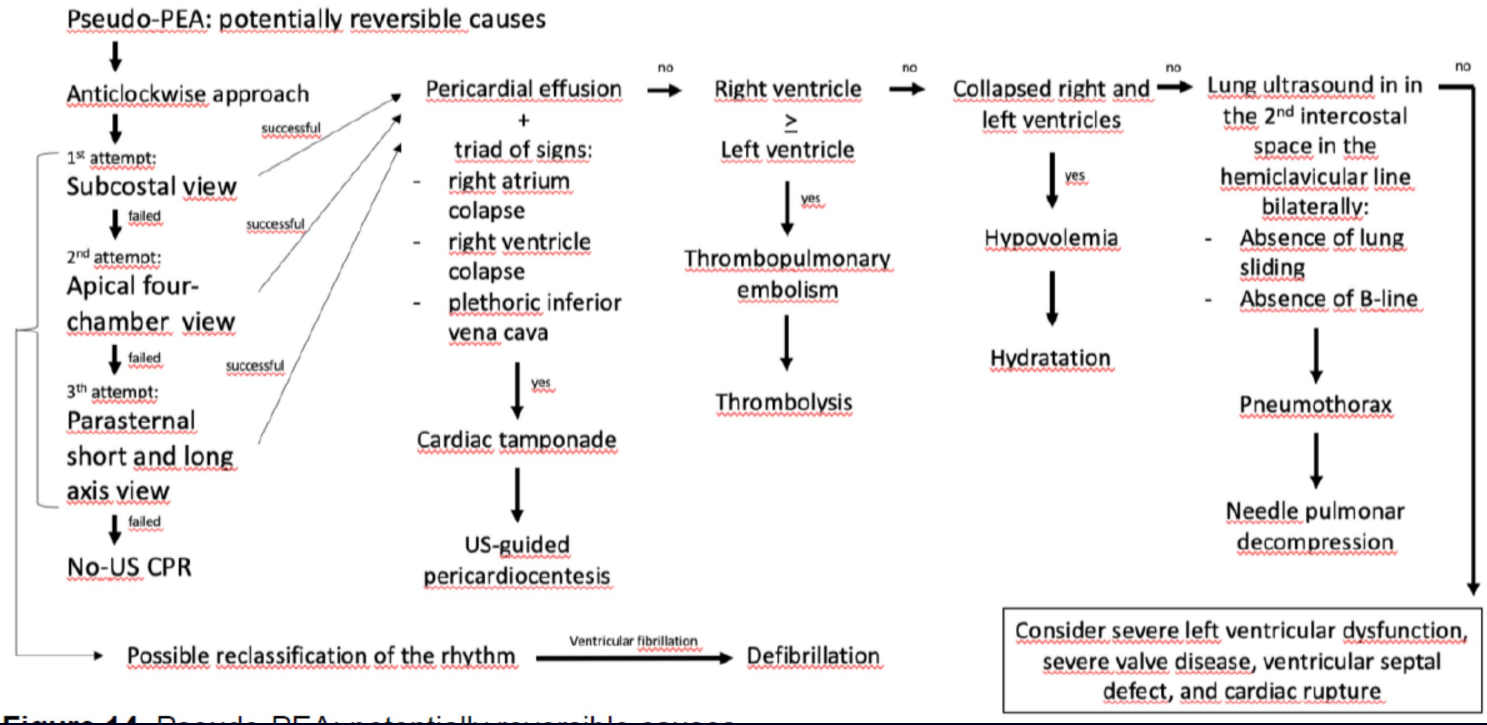
RŮZNÉ PŘÍSTUPY

JBMEDE 2021;1(2):e21015

Review Article

JBMEDE
JORNAL BRASILEIRO de MEDICINA DE EMERGÊNCIA

Ultrasound in Cardiopulmonary Arrest: State of Art

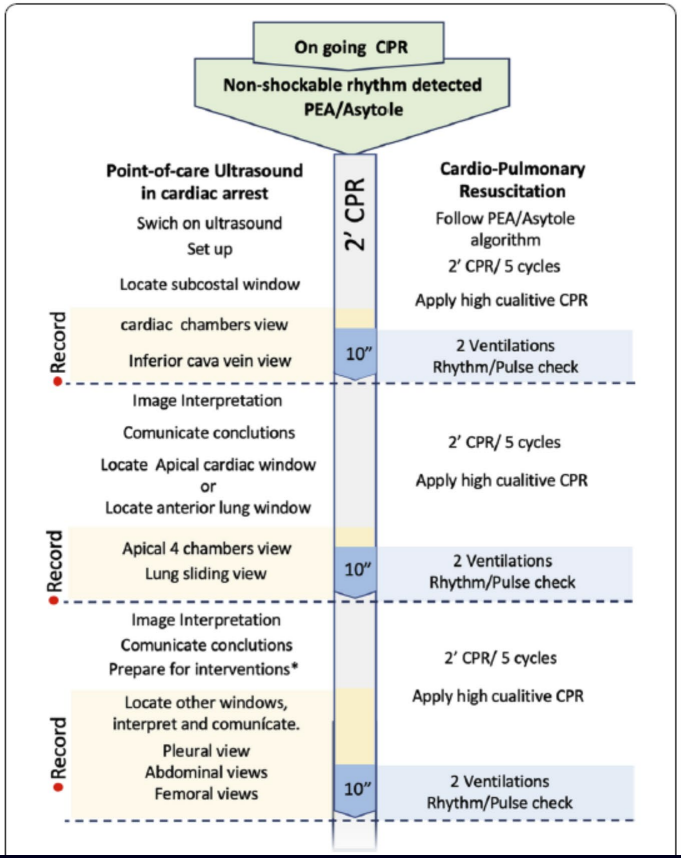


RŮZNÉ PŘÍSTUPY

REVIEW Open Access

Point-of-care ultrasound in cardiorespiratory arrest (POCUS-CA): narrative review article

Diana Ávila-Reyes[1*], Andrés O. Acevedo-Cardona[2,3], José F. Gómez-González[4,5], David R. Echeverry-Piedrahita[6], Mateo Aguirre-Flórez[7] and Adrian Giraldo-Diaconeasa[7]



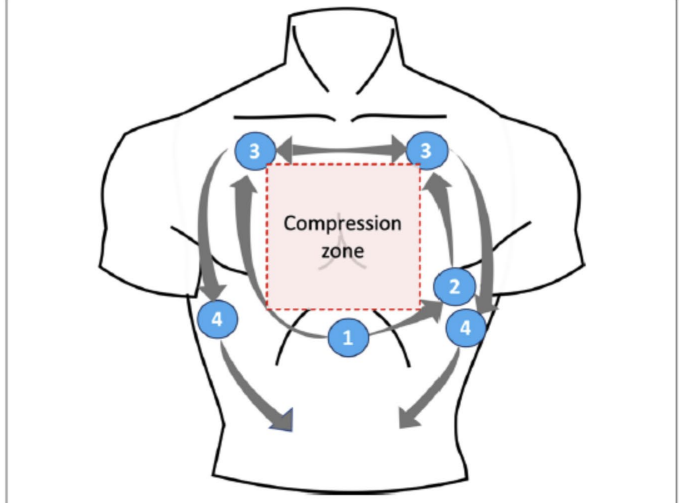


Fig. 2 POCUS-CA Windows

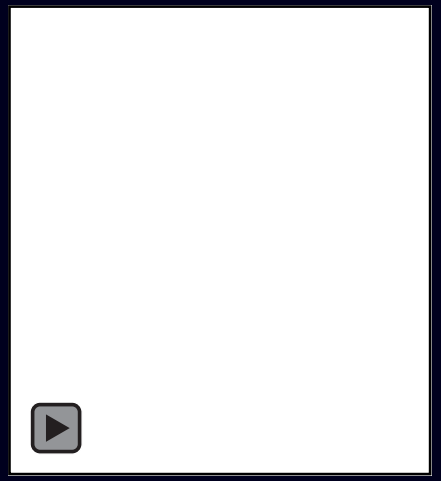
4H/4T A DALŠÍ

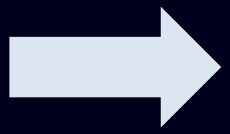
- korekce hypovolemie
- perikardiocentéza
- systémová trombolýza (rTPA 50mg/0,5 mg.kg^{-1})
- dekomprese hrudníku
- korekce hypoxie

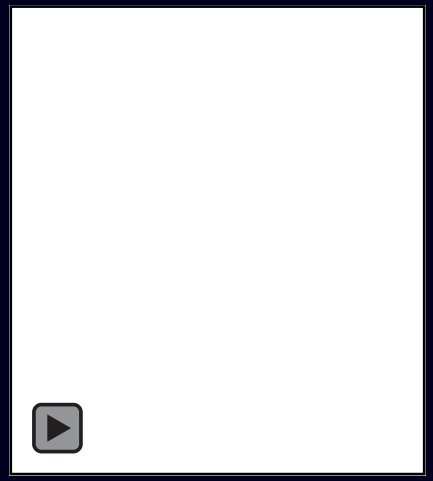
KOREKCE HYPOVOLEMIE

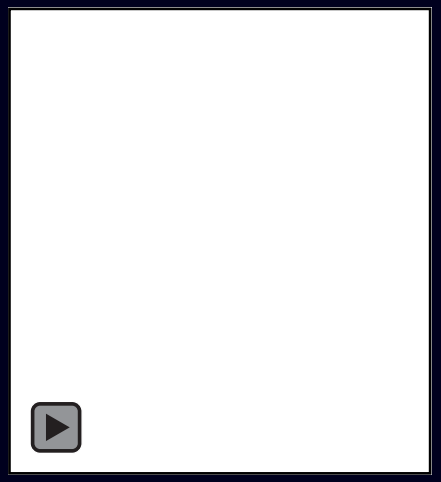
úvodní nález

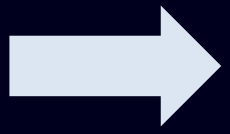
po korekci

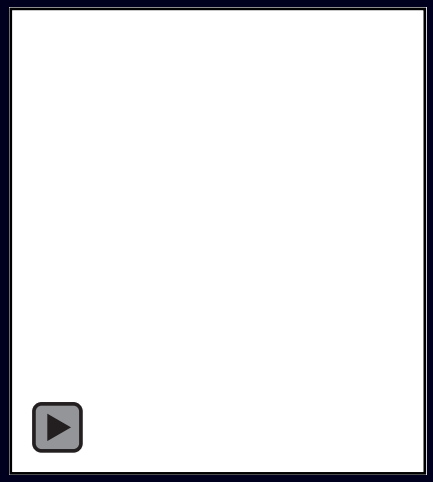






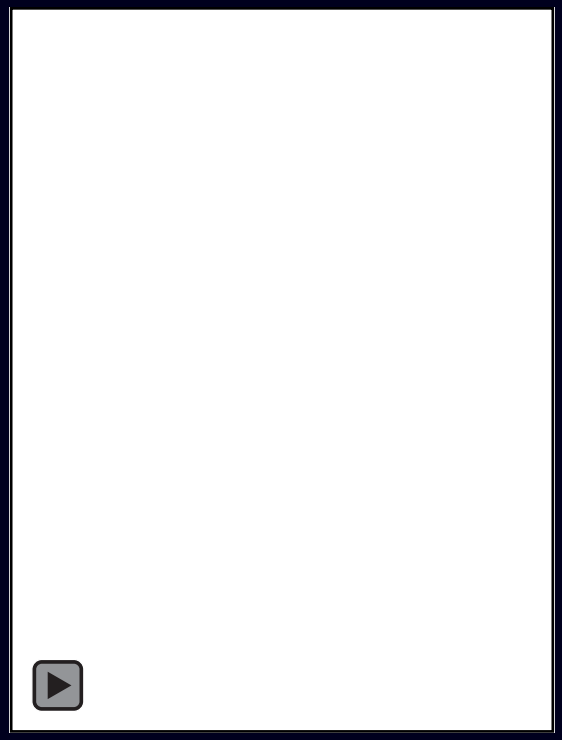


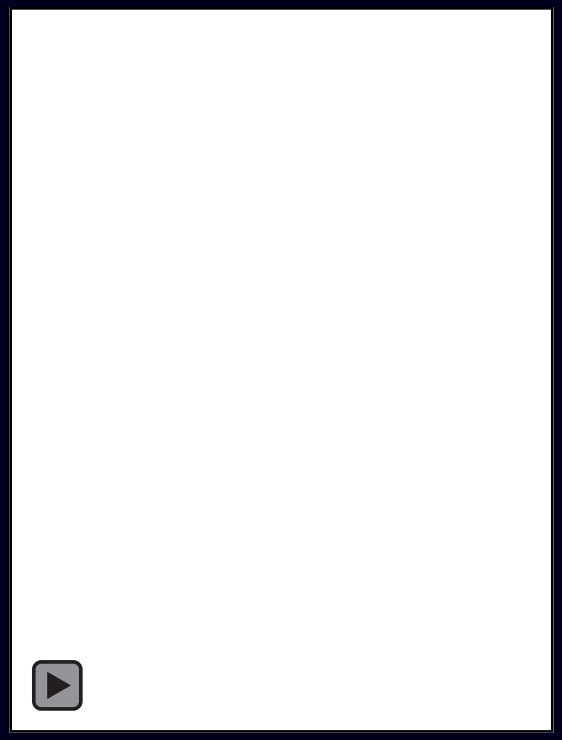




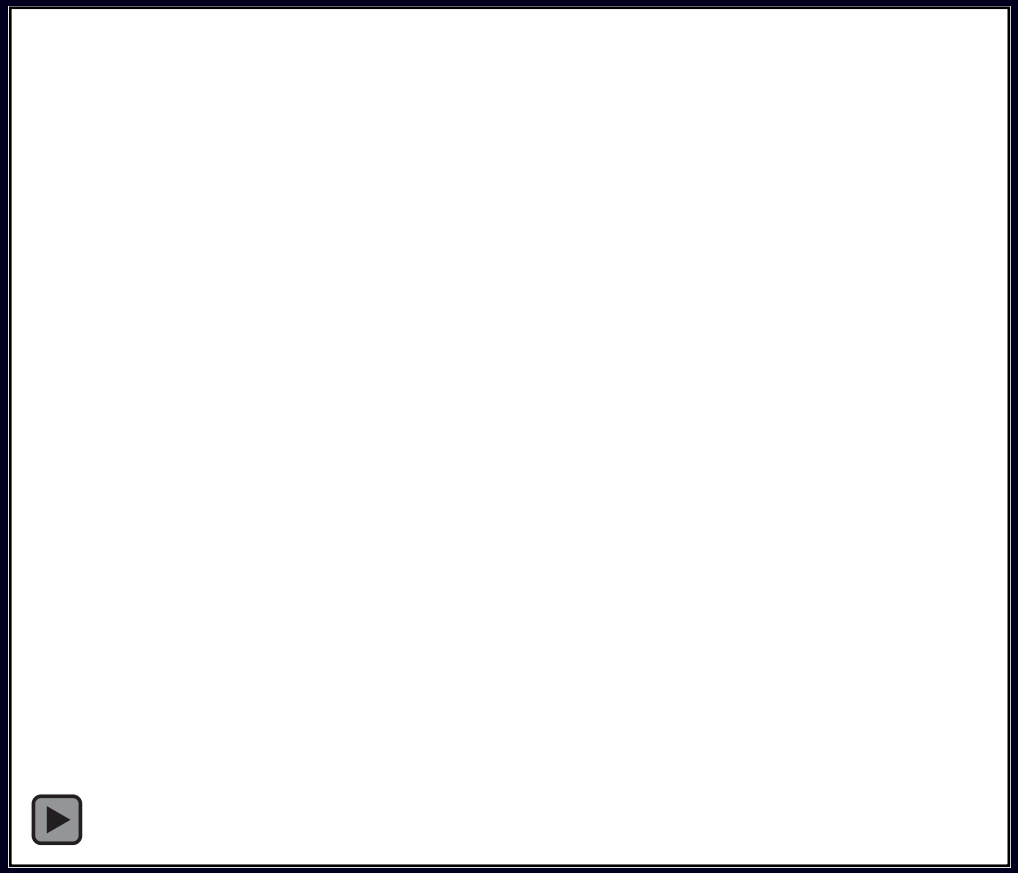
TAMPONÁDA 1

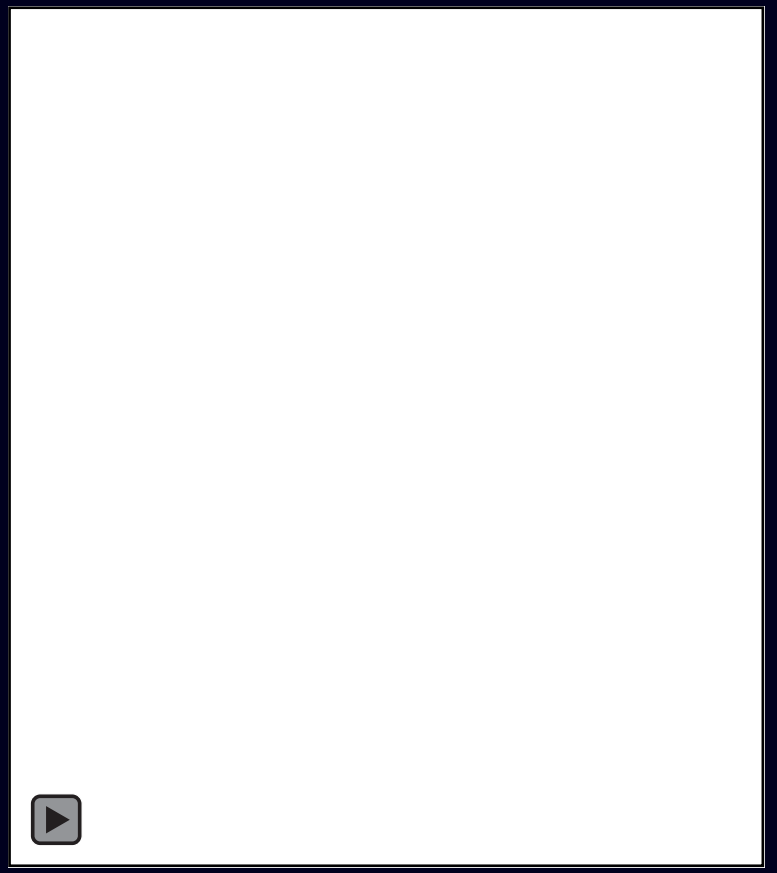
TAMPONÁDA 2





TROMBÓZA - PE





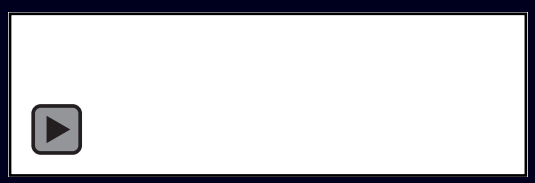
MOŽNOSTI VYUŽITÍ POCUS-CA

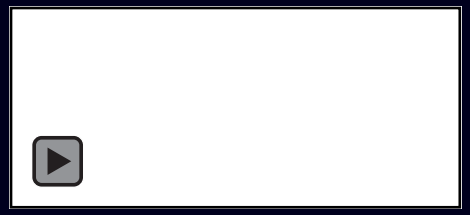
PROGNÓZA

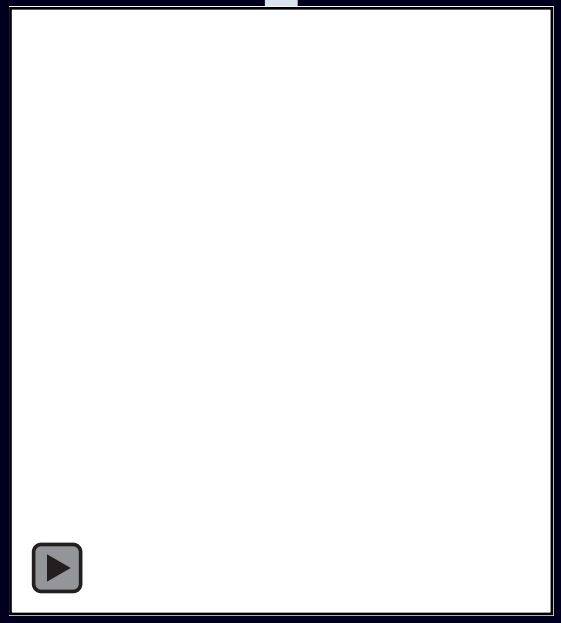
VF

PEA

ASYSTOILE







SPONTÁNNÍ KONTRAKCE LK

VF	pseudoPEA	pseudoASY	asystolie



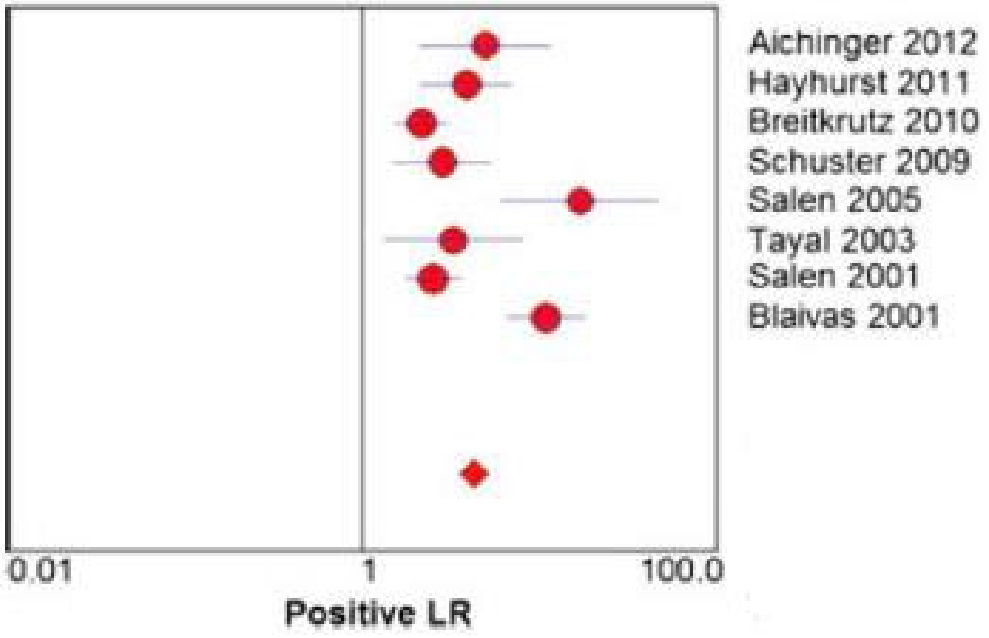

PROGNÓZA

Academic Emergency Medicine
Official Journal of the Society for Academic Emergency Medicine

STRUCTURED EVIDENCE-BASED MEDICINE REVIEW

Bedside Focused Echocardiography as Predictor of Survival in Cardiac Arrest Patients: A Systematic Review

Lacey Blyth, Paul Atkinson MB, BCh, BAO, BSc(Hons), MA(Cantab), MRCP, FCEM, Kathleen Gadd, MLIS, and Eddy Lang, MD, CCFP(EM)



- 8 studií
- 568 pacientů
- LH 4.26 (2.63-6.92)
- senzitivita 92 %
- specificita 80 %

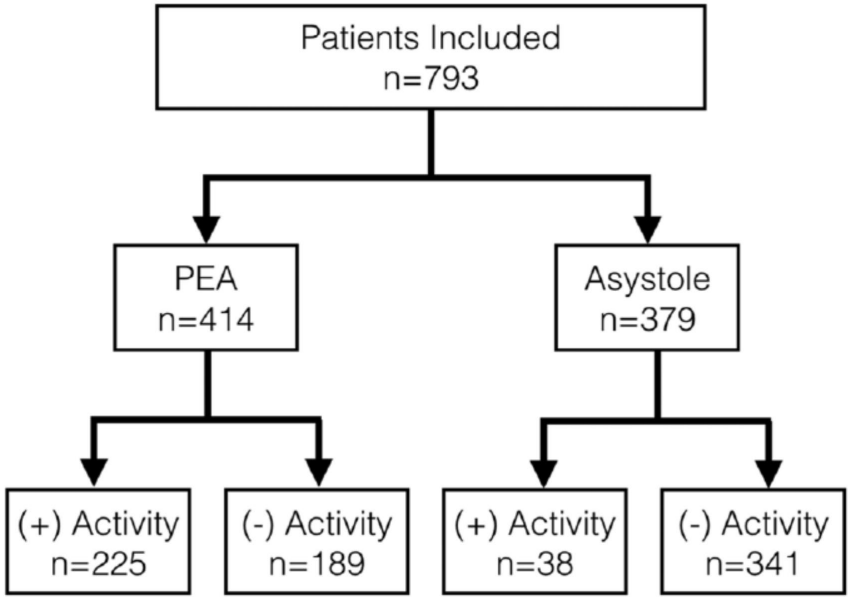
PROGNÓZA

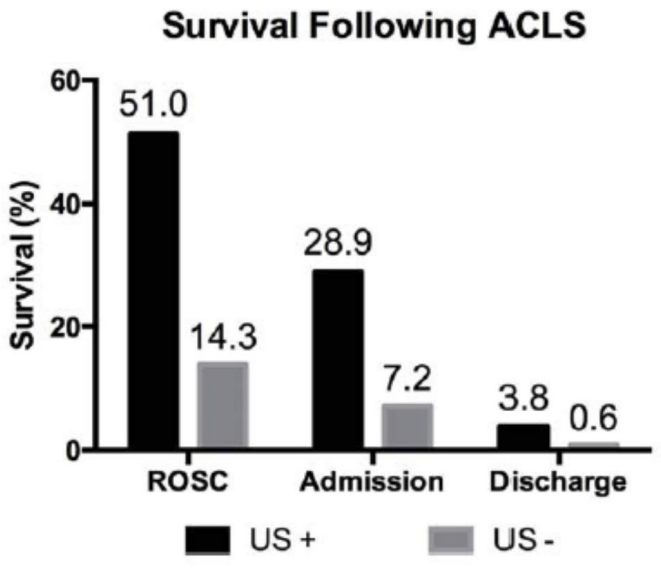
RESUSCITATION
EUROPEAN RESUSCITATION COUNCIL

CLINICAL PAPER | VOLUME 109, P33-39, DECEMBER 01, 2016

Emergency department point-of-care ultrasound in out-of-hospital and in-ED cardiac arrest

Romolo Gaspari • Anthony Weekes • Srikar Adhikari • ... Louise Rang • Will Scruggs • Christopher Raio • Show all authors





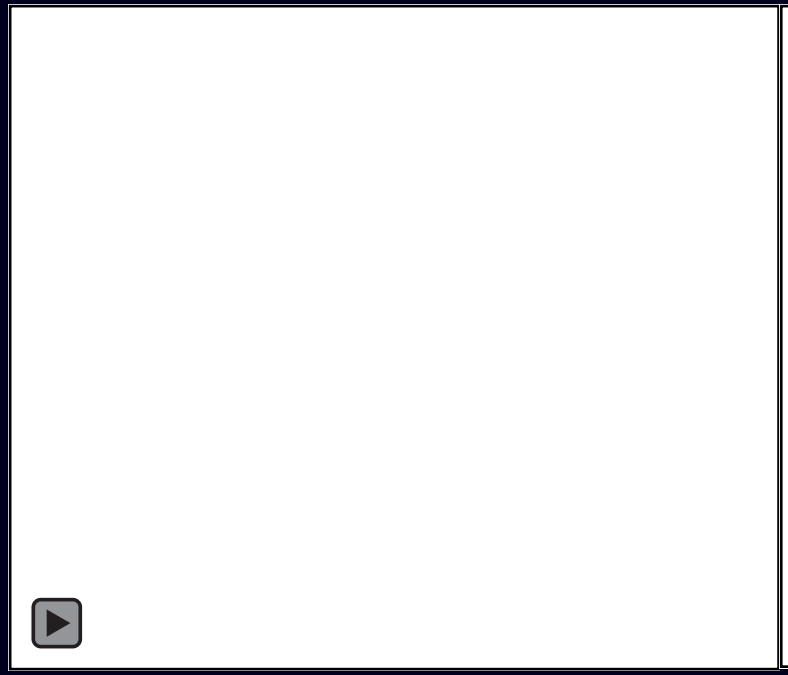
- ROSC 51 vs 14 %, p<0.001, přijetí do nemocnice 29 vs 7 %, p<0.001, propuštění z nemocnice 4 vs 0,6 %, p=0.04

PROGNÓZA U VF

Physiol. Res. 67: 391-399, 2018 *https://doi.org/10.33549/physiolres.933716*

Novel Patterns of Left Ventricular Mechanical Activity During Experimental Cardiac Arrest in Pigs

R. SKULEC[1,2,3], D. ASTAPENKO[1], R. CERNA PARIZKOVA[1], B. FURST[4], M. BILSKA[2], T. PARIZEK[2], T. HOVANEC[5], N. PINTEROVA[6], J. KNOR[3,7], J. DUDAKOVA[3], A. TRUHLAR[1,8], V. RADOCHOVA[9], Z. ZADAK[10,11], V. CERNY[1,2,10,12]



PROGNÓZA U VF

Physiol. Res. 67: 391-399, 2018 *https://doi.org/10.33549/physiolres.933716*

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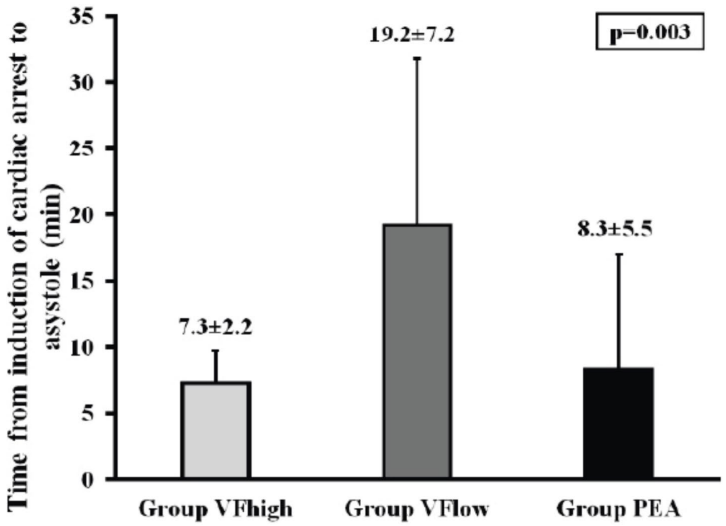


Fig. 1. Time from induction of cardiac arrest to development of asystole in experimental groups.

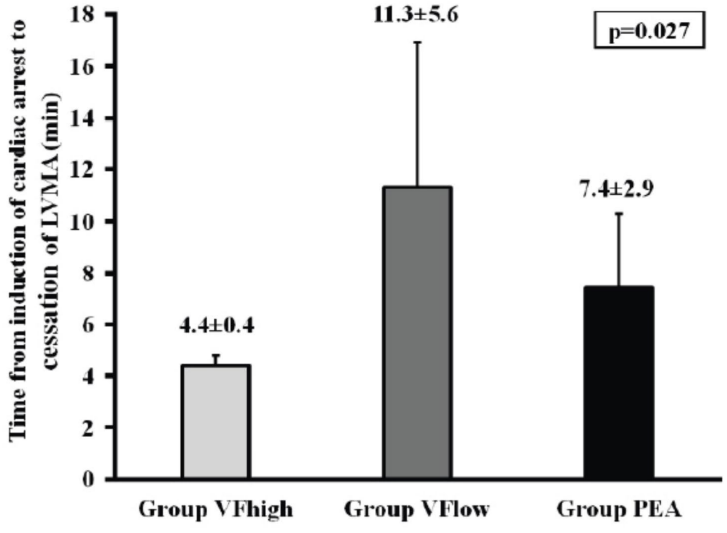
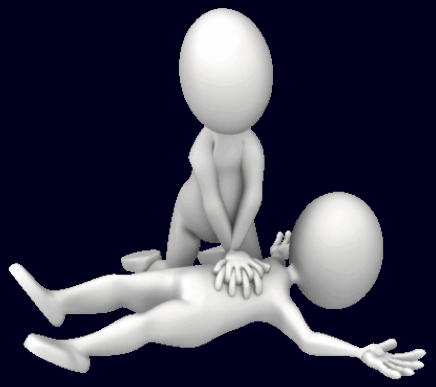


Fig. 2. Time from induction of cardiac arrest to cessation of LVMA in experimental groups. LVMA – Left ventricular mechanical activity.

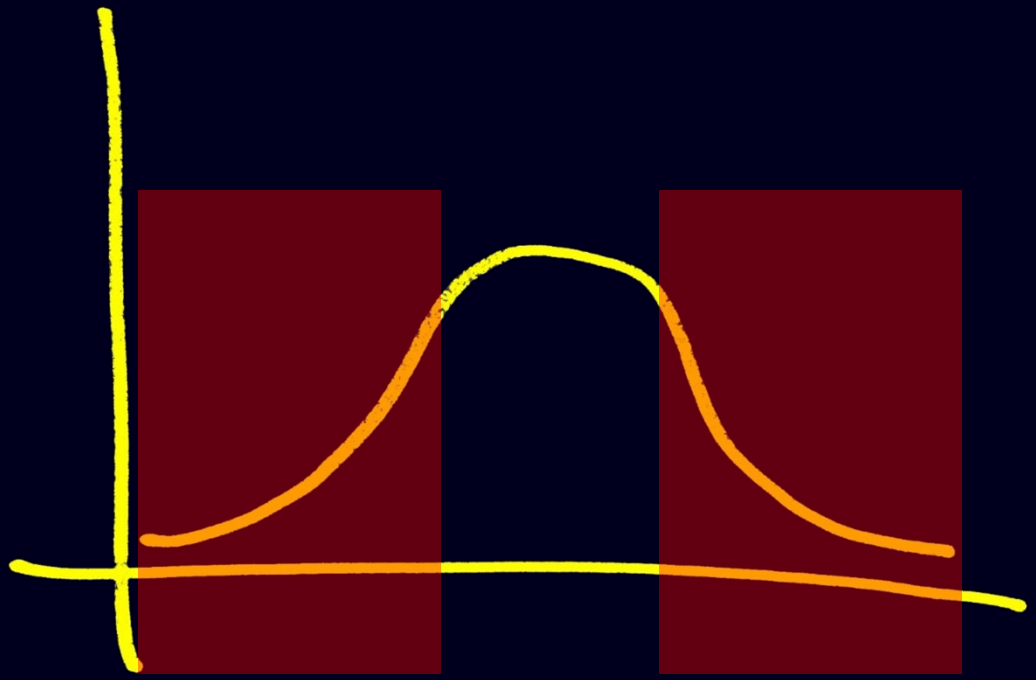
MOŽNOSTI VYUŽITÍ POCUS-CA

NIC NENÍ PRO VŠECHNY

- střed hrudníku
- 5-6 cm
- 100-120/min



- klinický konsenzus



CO JE TO INDIVIDUÁLNÍ OPTIMALIZACE KPR?

- **individuálně upravený postup KPR, který vede k maximální možné hemodynamické účinnosti**
- **standardní unifikovaný postup – většina bere vše**

PODSTATA OPTIMALIZACE

- vhodný parametr (parametry)
- znalost cílové hodnoty parametru, která reflektuje optimální hemodynamický účinek KPR
- možnost ovlivnění resuscitačního postupu tak, aby bylo možné dosáhnout cílovou hodnotu sledovaného parametru

MECHANIZUS SRDEČNÍ MASÁŽE

- srdeční pumpa (cardiac pump)
- hrudní pumpa (thoracic pump)
- pumpa levé síně (left atrial pump)

INDIVIDUALIZACE - PARAMETRY

Hemodynamic–directed cardiopulmonary resuscitation during in–hospital cardiac arrest*

Robert M. Sutton[a], Stuart H. Friess[b], Matthew R. Maltese[a], Maryam Y. Naim[a], George Bratinov[a], Theodore R. Weiland[a], Mia Garuccio[a], Utpal Bhalala[c], Vinay M. Nadkarni[a], Lance B. Becker[d], and Robert A. Berg[a,*]

- $EtCO_2$ >15 mm Hg
- diastolický krevní tlak >25 mm Hg
- koronární perfuzní tlak >20 mm Hg

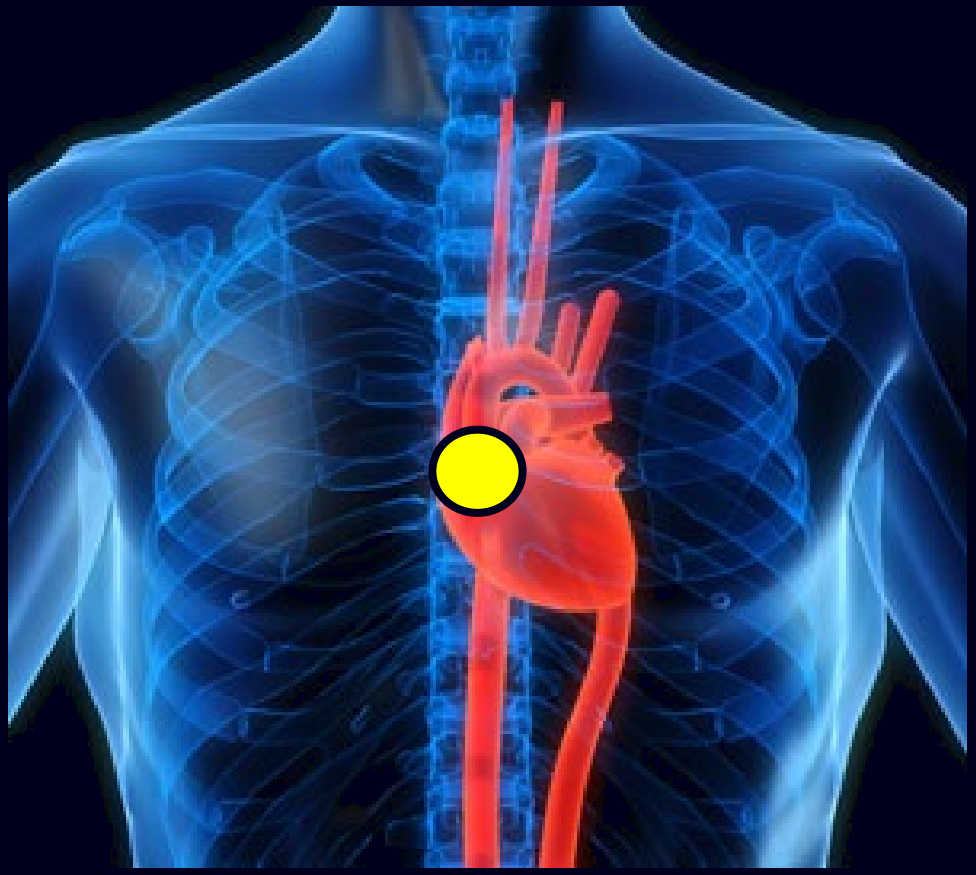
PROČ ULTRASONOGRAFIE?

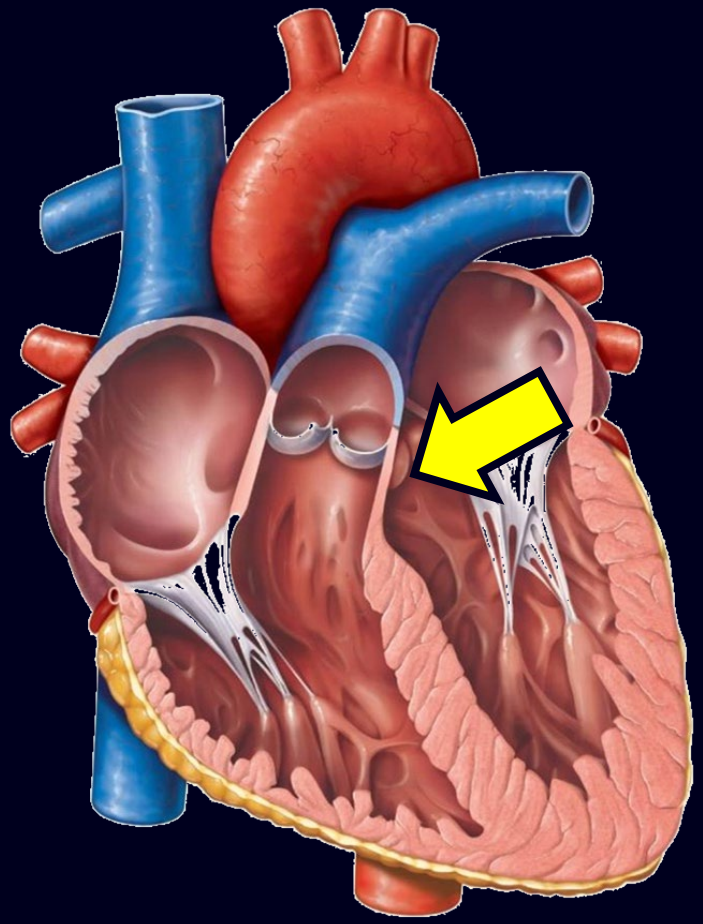
- implementovaná metoda do procesu KPR, ať už probíhá kdekoliv
- neinvazivní
- semikontinuální
- TTE (TEE)
- nekonvenční využití nikoliv během kontroly rytmu, ale naopak během srdeční masáže

CO MŮŽEME ZMĚNIT?

CO MŮŽEME ZMĚNIT?

LOKALIZACE KOMPRESÍ

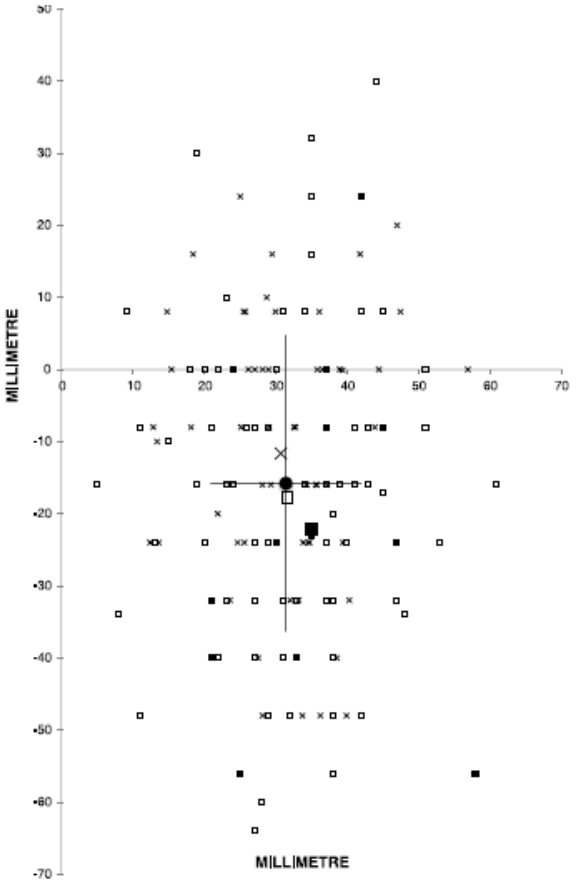


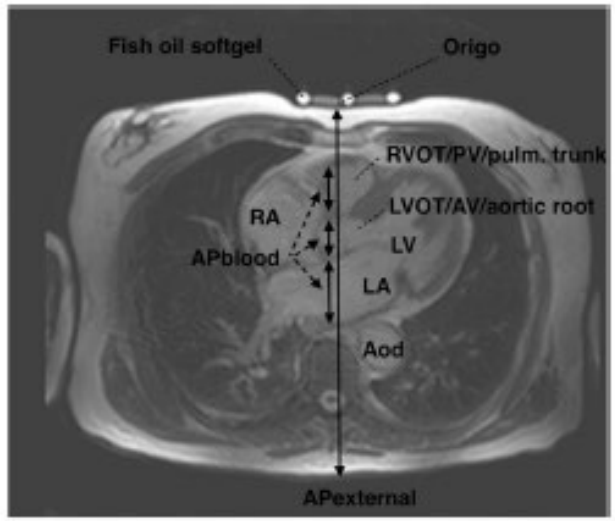


LOKAIZACE KOMPRESÍ

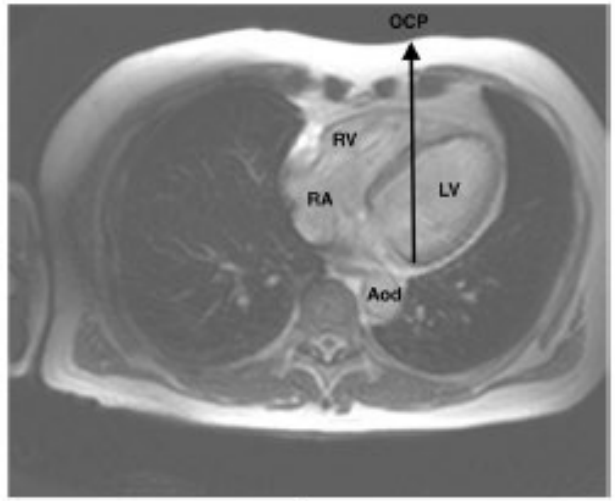
Radiological assessment of chest compression point and achievable compression depth in cardiac patients

Sverre Nestaas[1*], Knut Haakon Stensæth[2], Vigdis Rosseland[3] and Jo Kramer-Johansen[1,4]





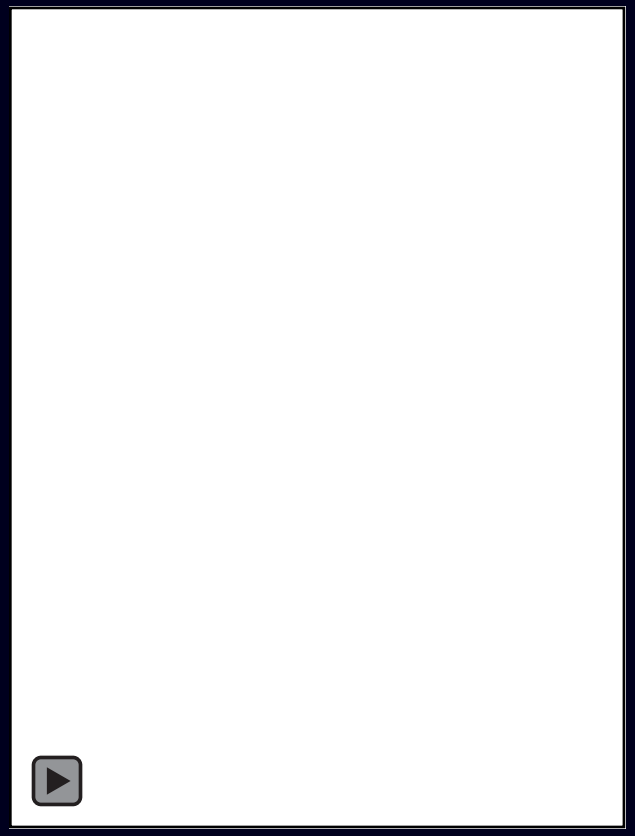
a



b

LOKALIZACE KOMPRESÍ

střed hrudníku



$EtCO_2$ 16 mm Hg

kaudální posun

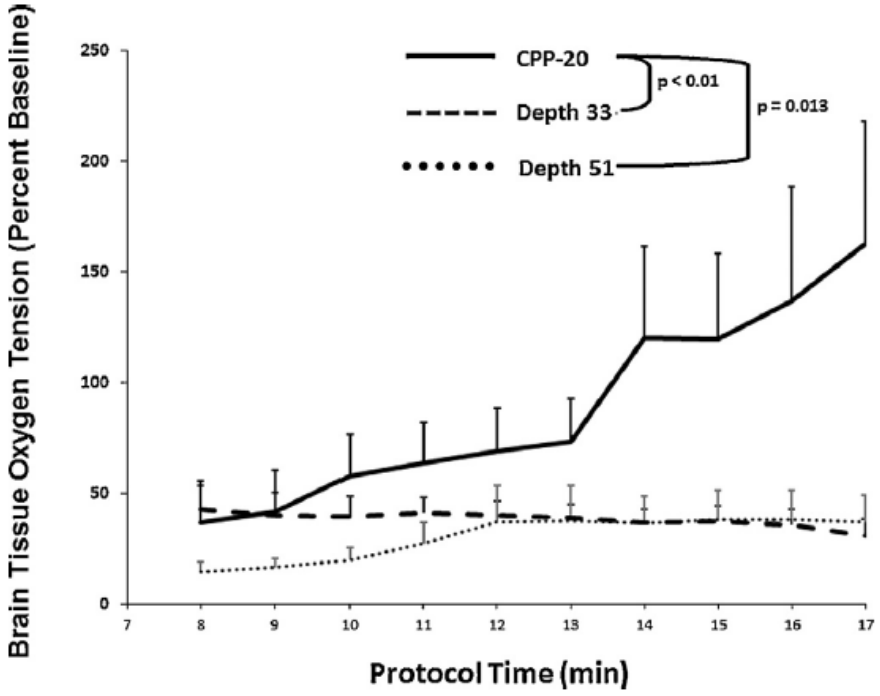
$EtCO_2$ 23 mm Hg

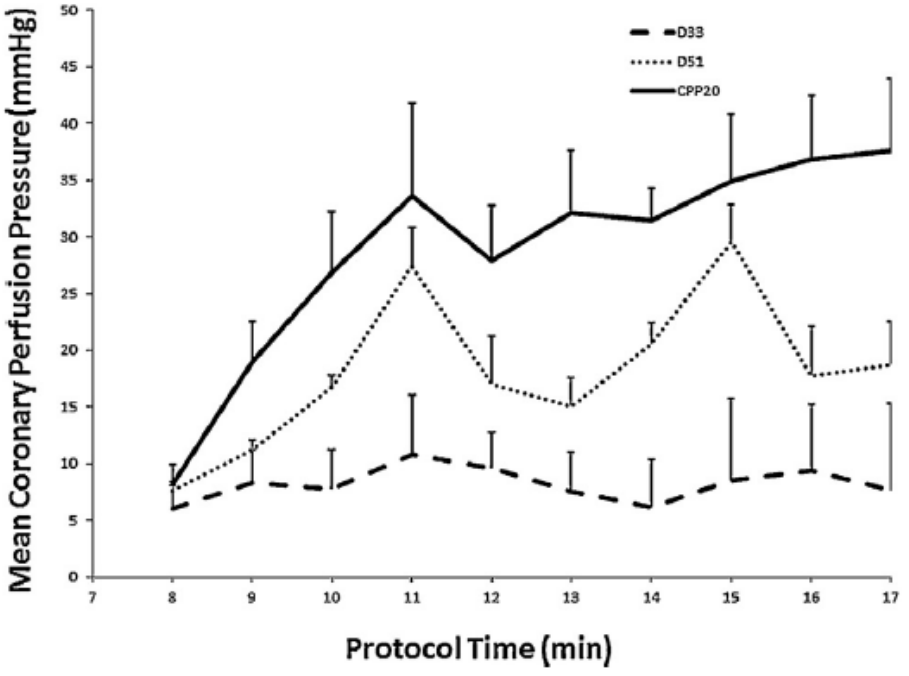
CO MŮŽEME ZMĚNIT?

HLOUBKA KOMPRESÍ

Hemodynamic directed CPR improves cerebral perfusion pressure and brain tissue oxygenation☆,☆☆

Stuart H. Friess[a,*], Robert M. Sutton[b], Benjamin French[c], Utpal Bhalala[d], Matthew R. Maltese[b], Maryam Y. Naim[b], George Bratinov[b], Silvana Arciniegas Rodriguez[b], Theodore R. Weiland[b], Mia Garuccio[b], Vinay M. Nadkarni[b], Lance B. Becker[e], Robert A. Berg[b]





ÚČINNOST KPR V PRAXI

Skulec *et al. Critical Care* (2019) 23:334
https://doi.org/10.1186/s13054-019-2607-2

Critical Care

RESEARCH Open Access

Correlation between end-tidal carbon dioxide and the degree of compression of heart cavities measured by transthoracic echocardiography during cardiopulmonary resuscitation for out-of-hospital cardiac arrest

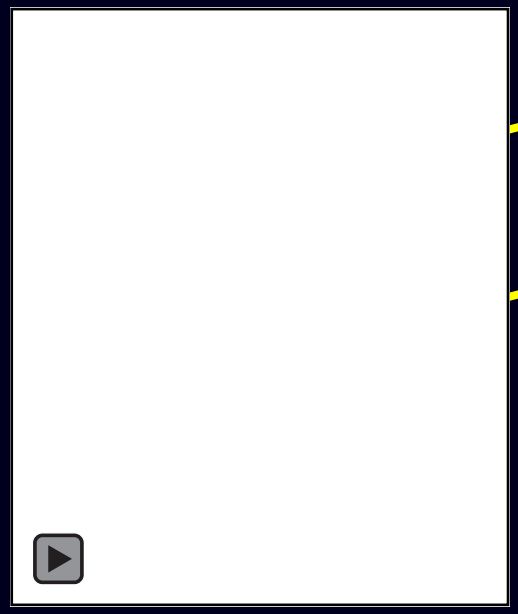
Roman Skulec[1,2,3*], Petr Vojtisek[1,4] and Vladimir Cerny[1,2,5,6]

ÚČINNOST KPR V PRAXI

- pacienti resuscitovaní pro mimonemocniční náhlou zástavu oběhu netraumatické etiologie s jakýmkoliv rytmem
- standardní ALS
- co nejdříve TRACE protokol, poté 3x záznam srdce v subkostální projekci během masáže a zápis $EtCO_2$
- vyšetření přístrojem Vscan Dual Probe

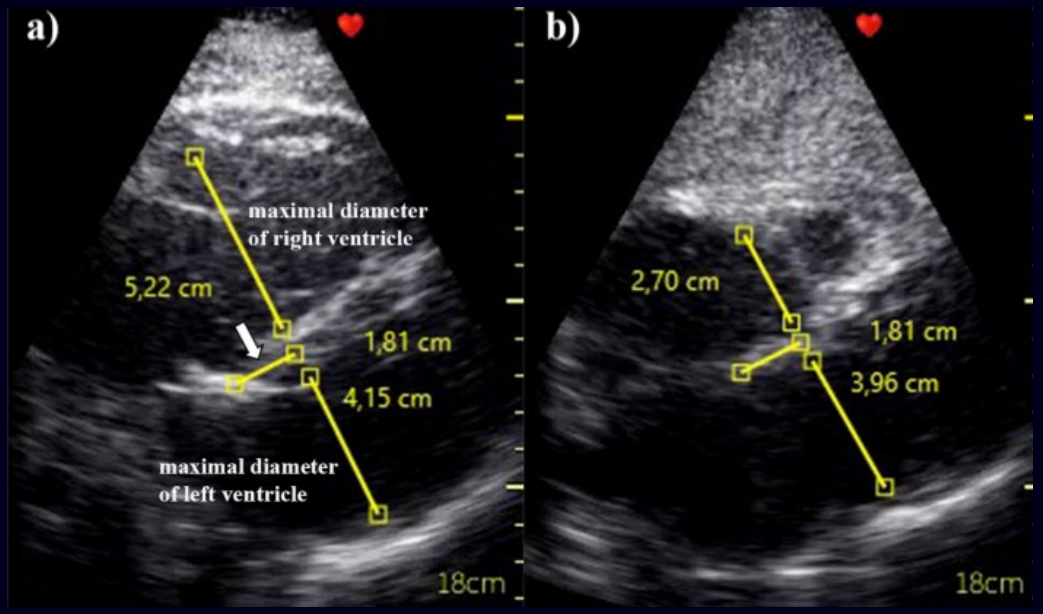
ÚČINNOST KPR V PRAXI

- 20 pacientů, echokardiografický záznam hodnotitelný u 13 z nich
- u každého pacienta 3 měření, celkem 39 měření kompresibility LV a RV



RV

LV



ÚČINNOST KPR V PRAXI

Table 1 Utstein style clinical characteristics of the patients

Number of the patients	18
Men/women (*n*)	13/5
Age (years ± SD)	66.6 ± 12.6
Location of OHCA (*n* (%))	
Home	12 (66.7)
Workplace	3 (16.7)
Street	1 (5.5)
EMS ambulance car	2 (11.1)
Aetiology of OHCA (*n* (%))	
Cardiac	11 (61.1)
Hypoxia	5 (27.8)
Pulmonary embolism	1 (5.5)
Metabolic	1 (5.5)
Witnessed OHCA (*n* (%))	18 (100.0)
First monitored rhythm (*n* (%))	
Ventricular fibrillation	6 (33.3)
Pulseless electrical activity	7 (38.9)
Asystole	5 (27.8)
Bystander CPR* (*n* (%))	
Compression and ventilation	2 (11.1)
Any ROSC	12 (66.7)
Sustained ROSC	8 (44.4)
30-day survival or survival to discharge (*n* (%))	6 (33.3)
30-day favourable neurological outcome ((CPC score 1 or 2) (*n* (%))	5 (27.8)

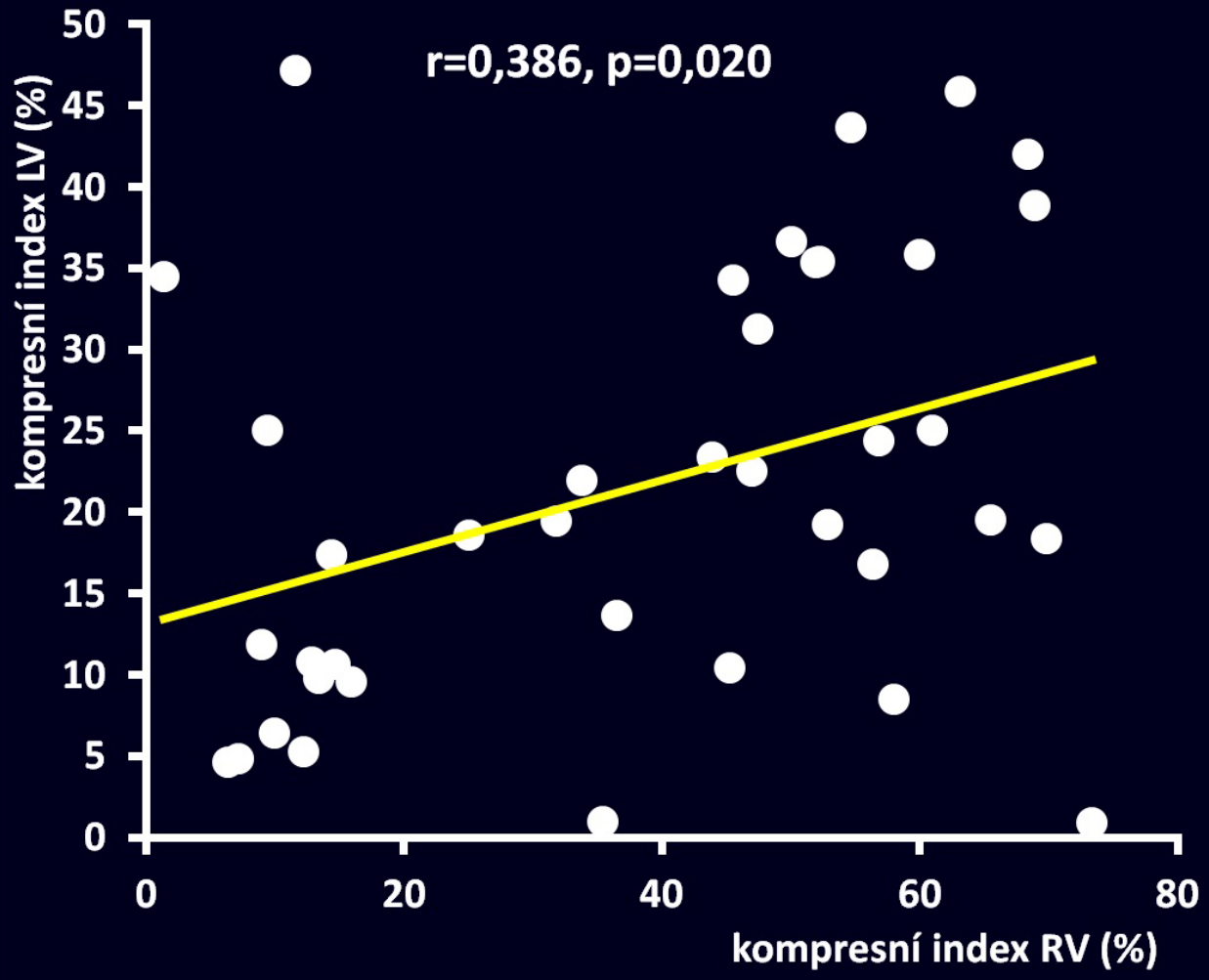
OHCA out-of-hospital cardiac arrest, *EMS* emergency medical services, *CPR* cardiopulmonary resuscitation, *BLS* basic life support, *ALS* advanced life support, *ROSC*

Time from collapse to ROSC or CPR termination (s ± SD)	2571 ± 1210
Defibrillation time** (s ± SD)	467 ± 248
Any ROSC	12 (66.7)
Sustained ROSC	8 (44.4)
30-day survival or survival to discharge (*n* (%))	6 (33.3)
30-day favourable neurological outcome ((CPC score 1 or 2) (*n* (%))	5 (27.8)

OHCA out-of-hospital cardiac arrest, *EMS* emergency medical services, *CPR* cardiopulmonary resuscitation, *BLS* basic life support, *ALS* advanced life support, *ROSC*

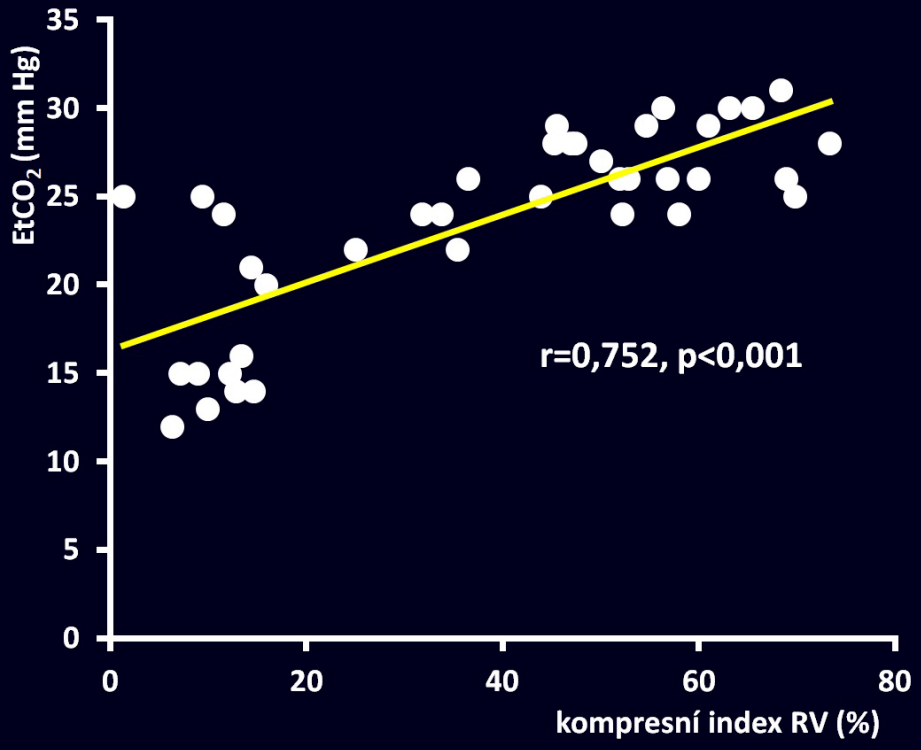
ÚČINNOST KPR V PRAXI

kompresní index RV vs. kompresní index LV

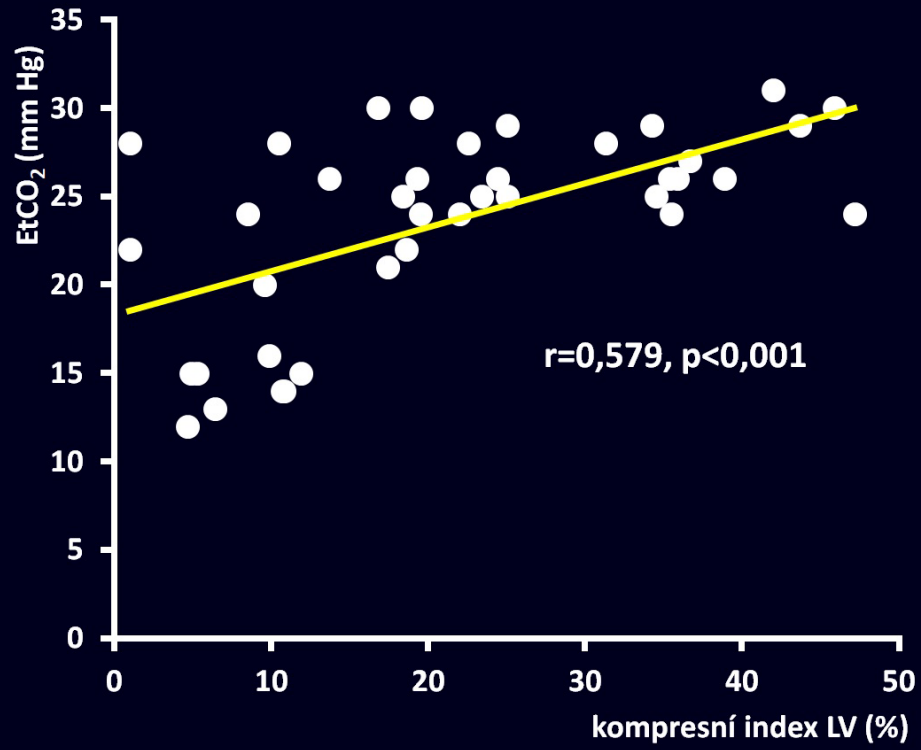


ÚČINNOST KPR V PRAXI

kompresní index RV vs. EtCO2

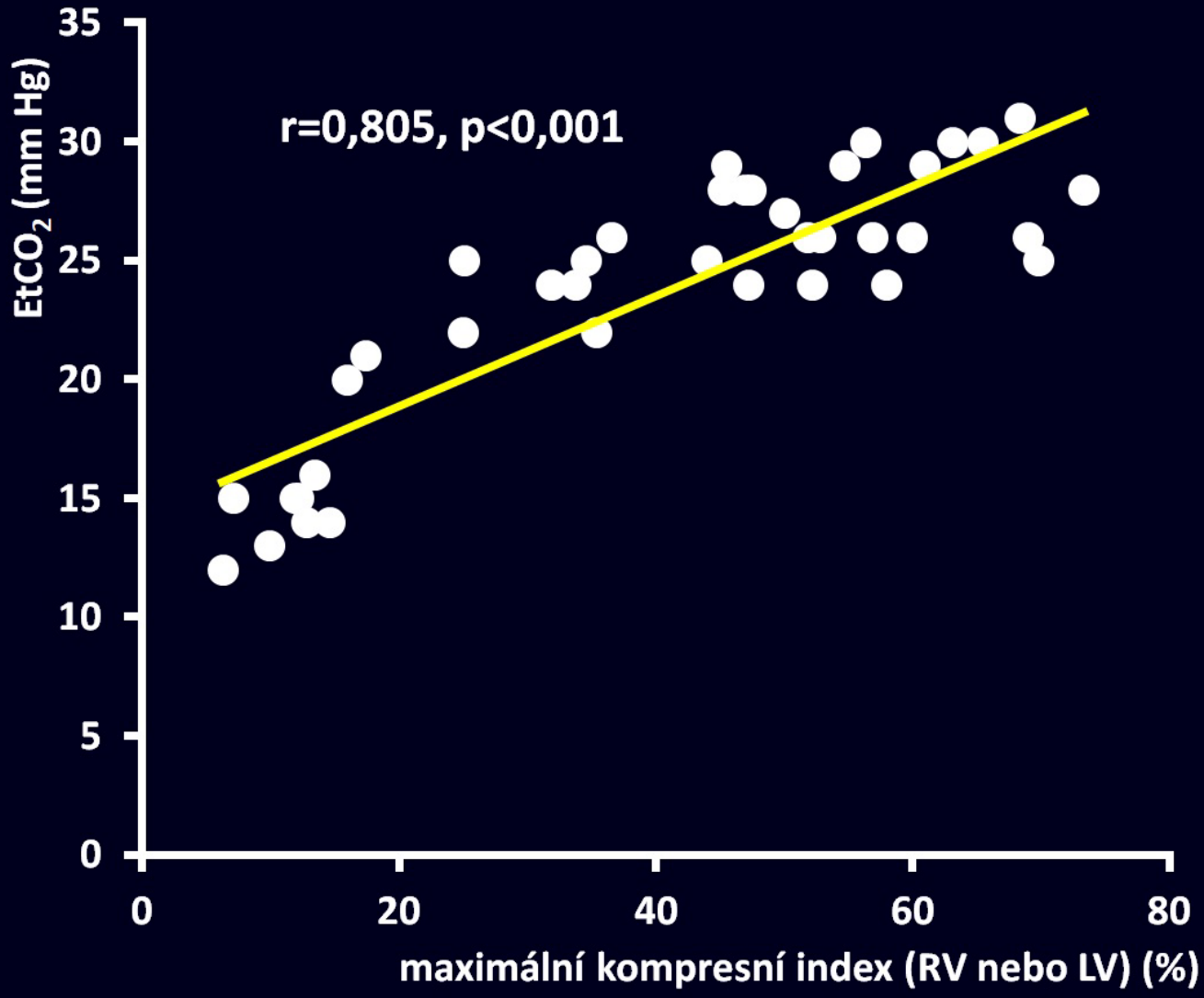


kompresní index LV vs. EtCO2



ÚČINNOST KPR V PRAXI

maximální kompresní index RV nebo LV vs. $EtCO_2$



ÚČINNOST KPR V PRAXI

Table 4 CImax cut-off levels for prediction of $EtCO_2$ levels above different thresholds

$EtCO_2$ (mmHg)	CImax cut-off level (%)	Best Youden's index	Sensitivity (%)	Specificity (%)	Positive predictive value	Negative predictive value
> 15	15.25	0.952	95.2	100.0	100.0	83.3
> 20	17.35	1.000	100.0	100.0	100.0	100.0
> 25	35.92	0.742	100.0	74.2	74.2	72.4

ÚČINNOST KPR V PRAXI

ULTRASOUND-GUIDED CHEST COMPRESSIONS IN OUT-OF-HOSPITAL CARDIAC ARRESTS

Mirko Zanatta, MD, PHD,* Carlo Lorenzi, MD,† Margherita Scorpiniti, MD,‡ Vito Cianci, MD,*[1] Roberto Pasini, MD,§ and Agata Barchitta, MD||

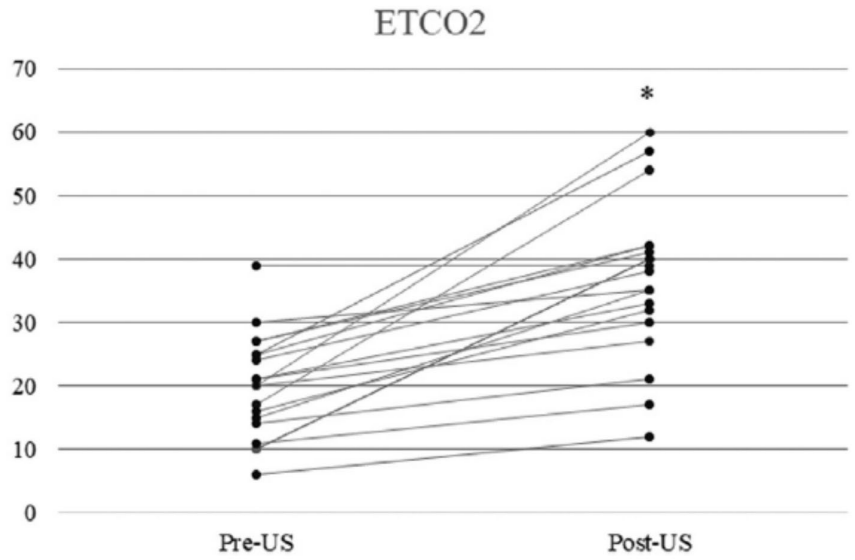
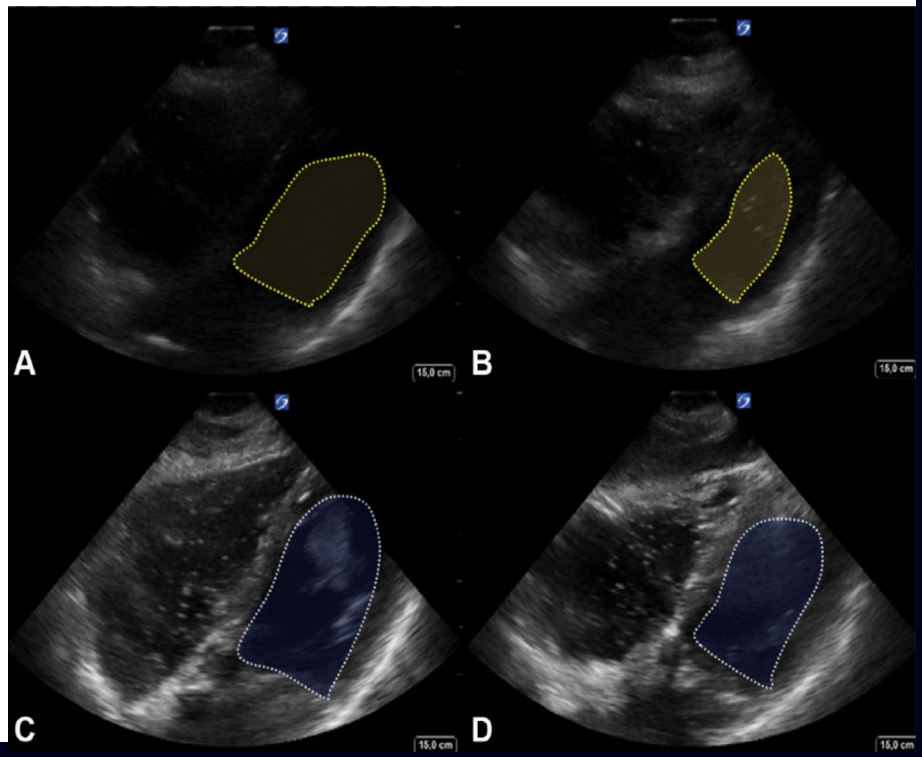


Figure 3. $ETCO_2$ values prior to (Pre-ultrasound: 20.37 ± 7.84 mm Hg) and after (Post-ultrasound 37.10 ± 11–75 mm Hg) the ultrasound check. *$p < 0.05$. $ETCO_2$ = end-tidal carbon dioxide; US = ultrasound.



ÚČINNOST KPR V PRAXI

Clinical paper

Carotid Doppler blood flow measurement during cardiopulmonary resuscitation is feasible: A first in man study☆

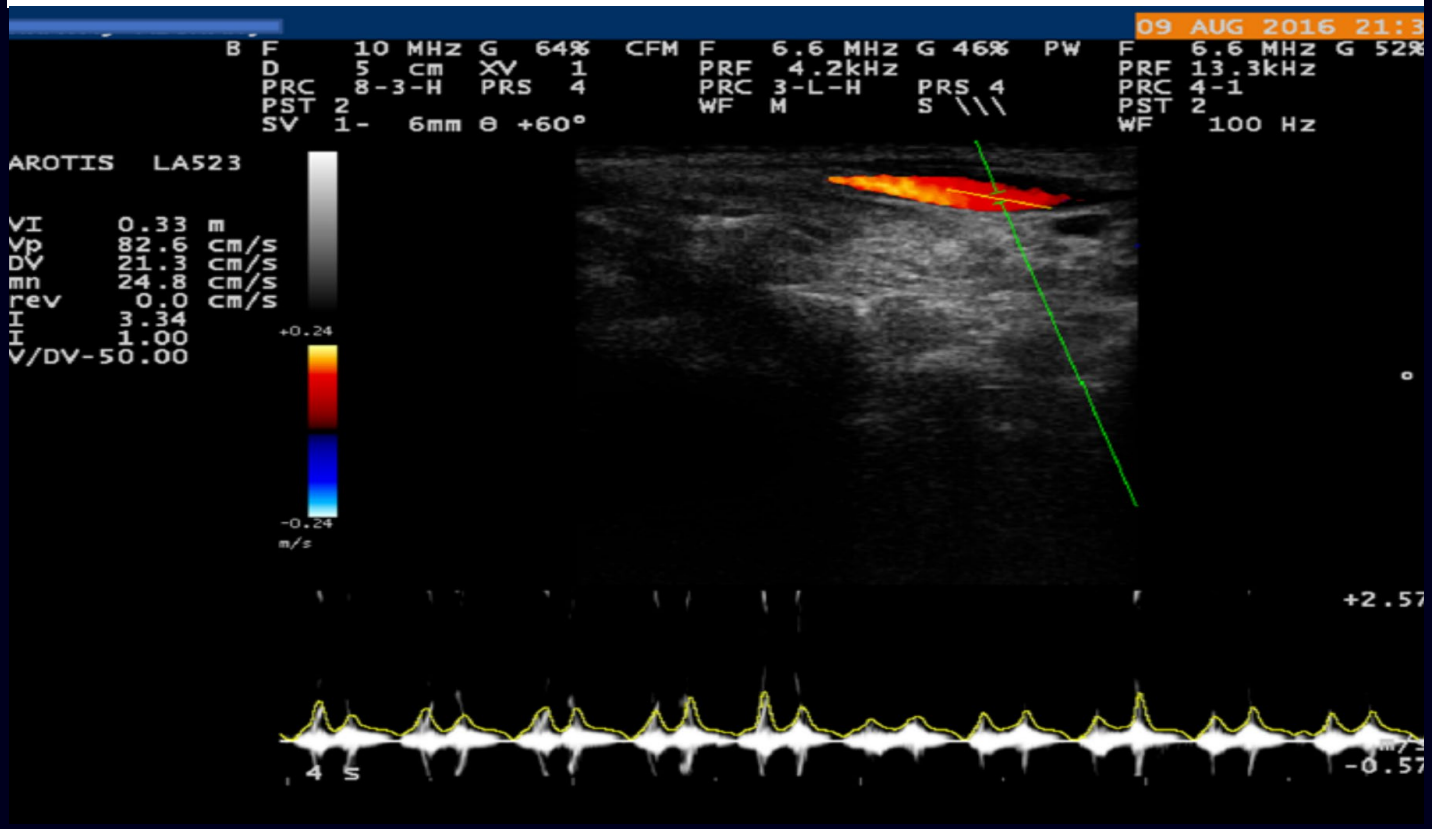
Adeyinka A. Adedipe[a,b,*], Deborah L. Fly[b], Scott D. Schwitz[a], Dawn B. Jorgenson[c], Haris Duric[c], Michael R. Sayre[a,b], Graham Nichol[a,b]

ÚČINNOST KPR V PRAXI

Original Contribution

A comparison of carotid doppler ultrasonography and capnography in evaluating the efficacy of CPR

Gökhan Yilmaz MD [a], Mustafa Silcan MD [b], Süha Serin MD [c], Bahadır Caglar MD [d], Özkan Erarslan MD [b], İsmet Parlak MD [e]



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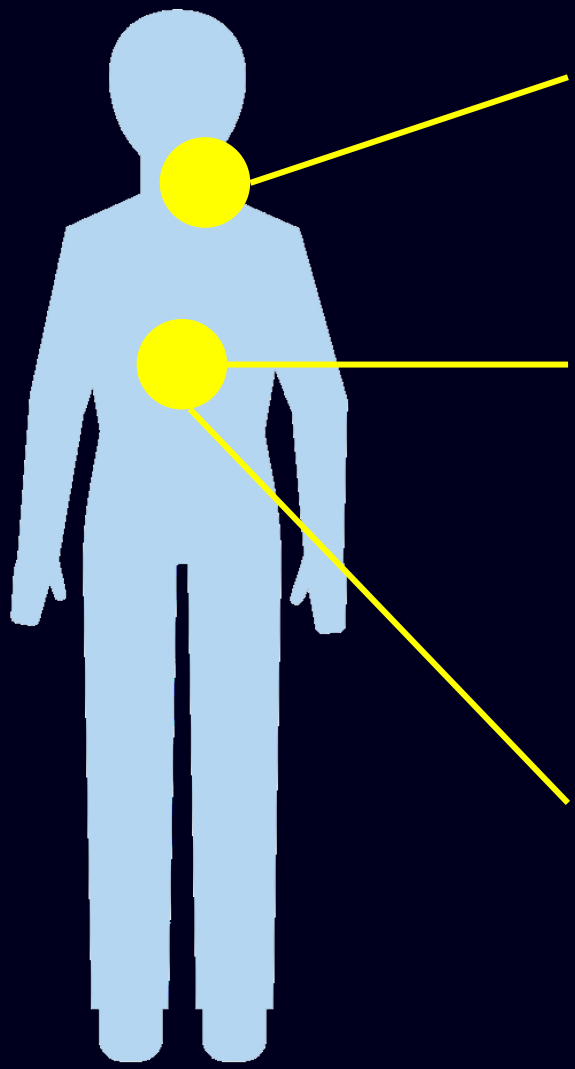

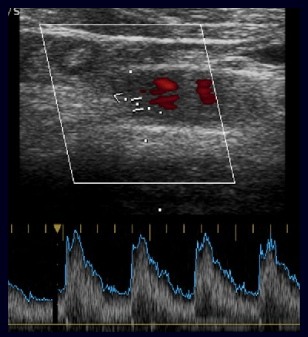

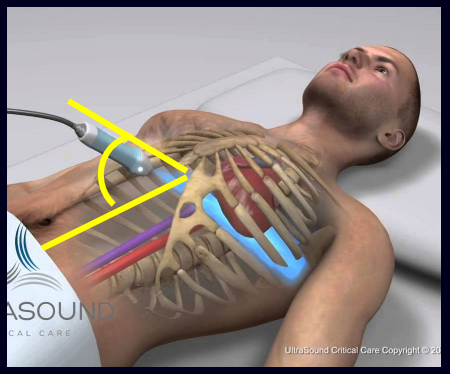

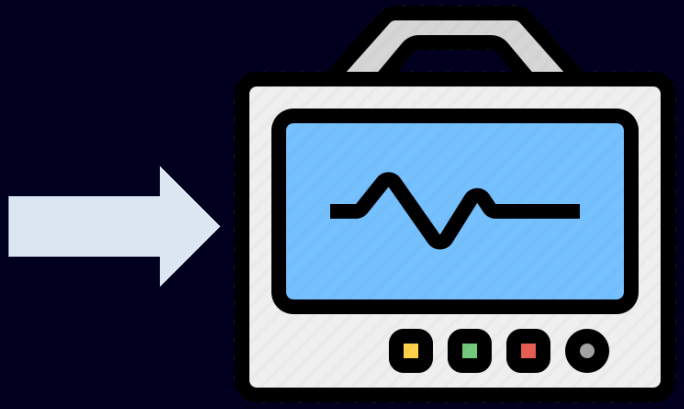

ZÁVĚRY

- POCUS během srdeční zástavy umožňuje rozpoznat příčinu a doprovodné problémy
- POCUS má prognostický význam
- POCUS je kandidátní metoda pro praktickou a automatickou realizaci konceptu ultrasound-guided CPR
- nebojte se používat POCUS během kardiopulmonální resuscitace

děkuji za pozornost

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