ECPR v CPR guidelines 2025

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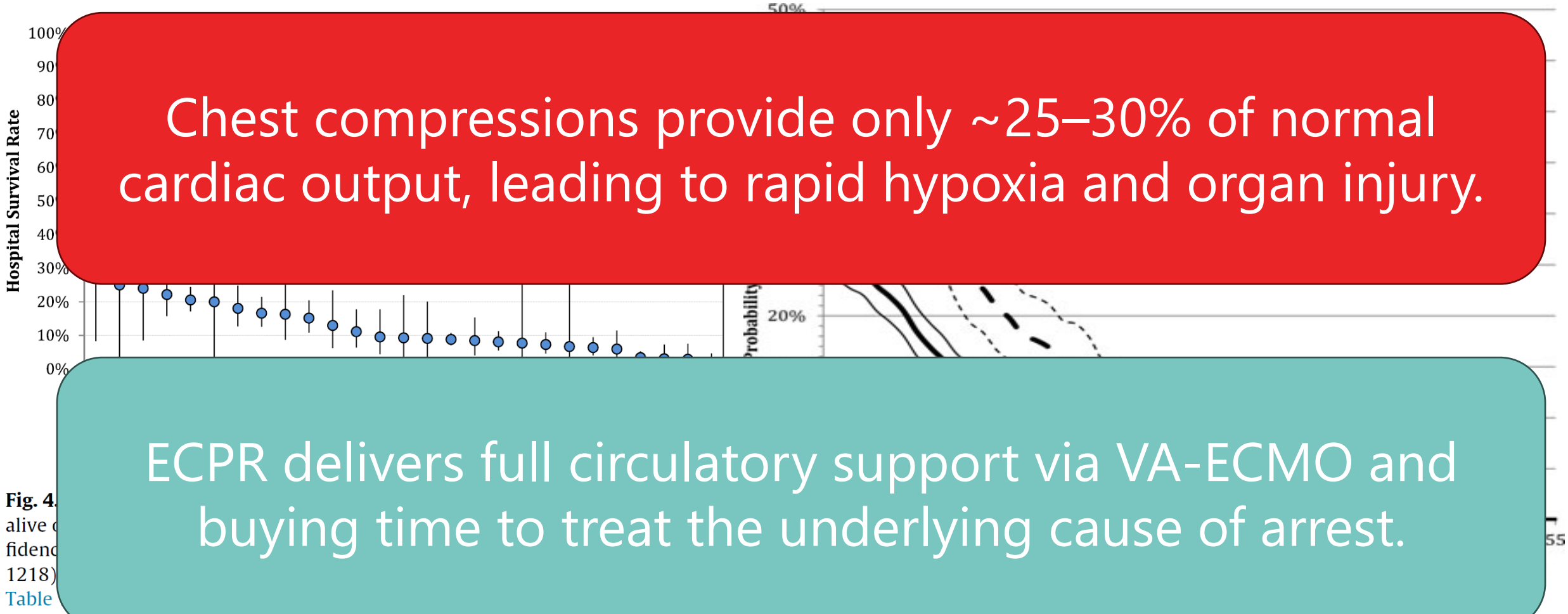
Why do we need ECPR ?

Chest compressions provide only ~25–30% of normal cardiac output, leading to rapid hypoxia and organ injury.

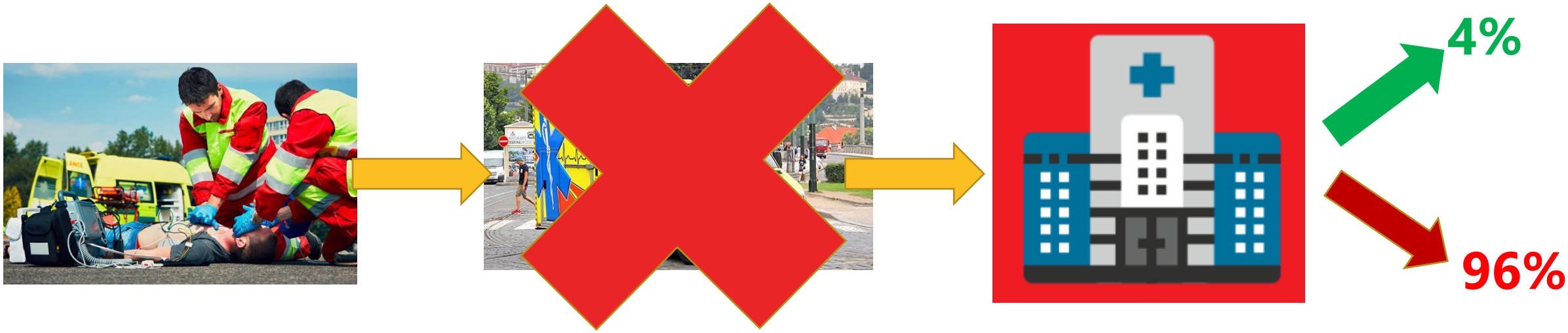


ECPR delivers full circulatory support via VA-ECMO and buying time to treat the underlying cause of arrest.

Gräsner, J. T., Lefering, R., Koster, R. W., Masterson, S., Böttiger, B. W., Herlitz, J., ... & Zeng, T. (2016). Resuscitation, 105, 188-195.
Grunau, B., Reynolds, J., Scheuermeyer, F., Stenstom, R., Stub, D., Pennington, S., ... & Christenson, J. (2016). Prehospital Emergency Care, 20(5), 615-622.

What is the natural course of refractory OHCA ?

- Patients without prehospital return of spontaneous circulation (ROSC) bear a grave prognosis.



- Wampler, D. A., Collett, L., Manifold, C. A., Velasquez, C., & McMullan, J. T. (2012). Cardiac arrest survival is rare without prehospital return of spontaneous circulation. *Prehospital Emergency Care*, *16*(4), 451-455.
- I.R. Drennan, S. Lin, D.E. Sidalak, et al.Survival rates in out-of-hospital cardiac arrest patients transported without prehospital return of spontaneous circulation: an observational cohort study Resuscitation, 85 (2014), pp. 1488-1493

Tři nové RCTs od roku 2020

Since 2020, three RCTs of ECPR have been published. The Advanced Reperfusion Strategies for Patients with OHCA and Refractory Ventricular Fibrillation Trial (ARREST) demonstrated higher survival to hospital discharge with ECPR compared to conventional CPR in OHCA patients with an initial shockable rhythm.[597] The Prague OHCA study found improved survival with a favourable neurological outcome at 30 days but not at six months (primary outcome) among 264 patients with all-rhythms refractory OHCA.[598] Of note, these were both single-centre trials performed in well-established ECPR systems. A third, multi-centre trial conducted in 10 cardiosurgical centres, Early Initiation of Extracorporeal Life Support in Refractory OHCA Trial (INCEPTION) showed no difference between ECPR and conventional CPR in OHCA patients with an initial shockable rhythm.[599] Additionally, a small pilot RCT, the Extracorporeal Cardiopulmonary

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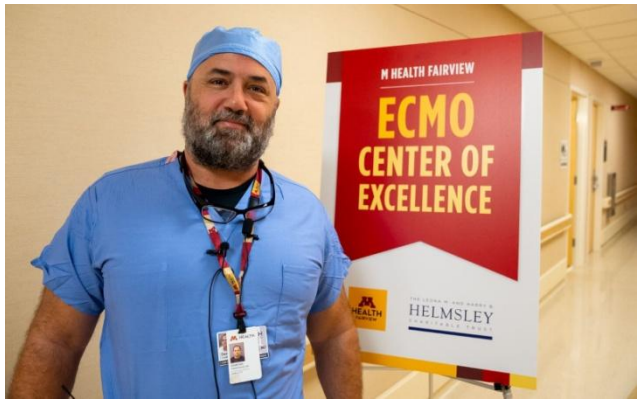
ECPR works

Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial

Demetris Yannopoulos, Jason Bartos, Ganesh Raveendran, Emily Walser, John Connett, Thomas A Murray, Gary Collins, Lin Zhang, Rajat Kalra, Marinos Kosmopoulos, Ranjit John, Andrew Shaffer, R J Frascone, Keith Wesley, Marc Conterato, Michelle Biros, Jakub Tolar, Tom P Aufderheide

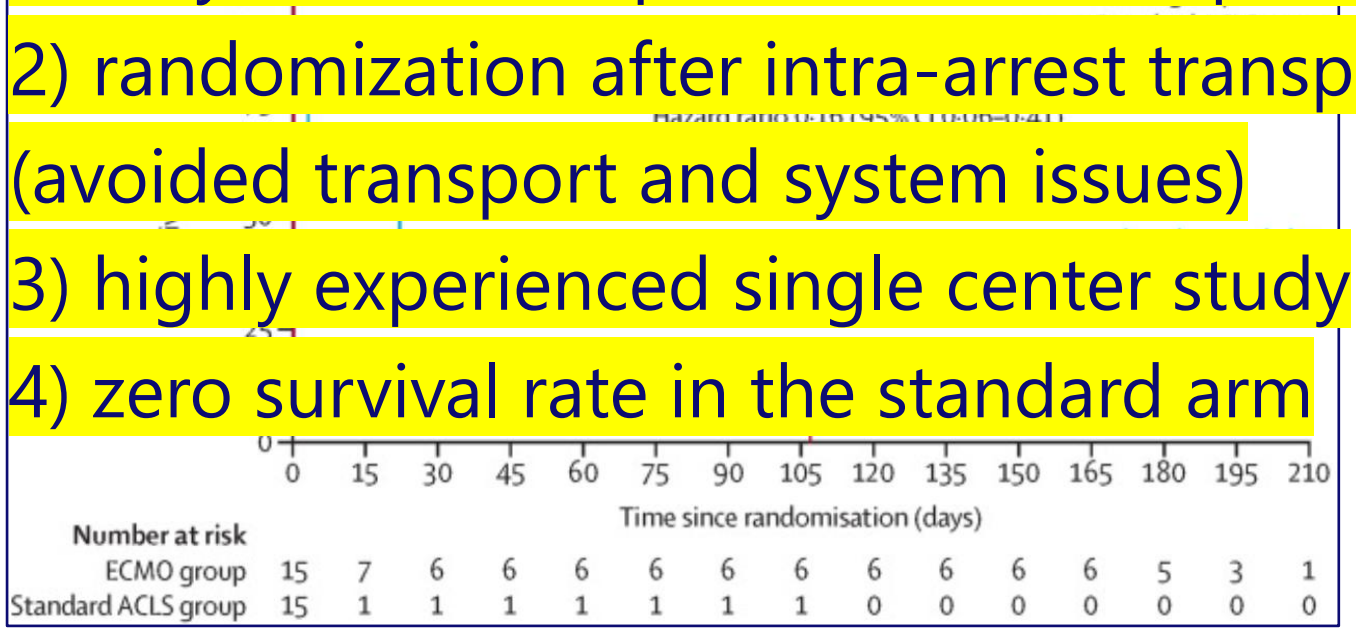


1) very limited sample size (15 ECPR patients)

2) randomization after intra-arrest transport (avoided transport and system issues)

3) highly experienced single center study

4) zero survival rate in the standard arm



Yannopoulos, D., Bartos, J., Raveendran, G., Walser, E., Connett, J., Murray, T. A., ... & Aufderheide, T. P. (2020). Advanced reperfusion strategies for patients with out-of-hospital cardiac arrest and refractory ventricular fibrillation (ARREST): a phase 2, single centre, open-label, randomised controlled trial. *The Lancet*, *396*(10265), 1807-1816.

It is not about the ECMO… Prague OHCA trial design

Randomization

Inclusion criteria	Exclusion criteria
Age ≥18 and ≤ 65 years	OHCA of presumed non-cardiac cause
Witnessed OHCA of presumed cardiac cause	Unwitnessed collapse
Minimum of 5 minutes of ACLS performed by emergency medical service team without sustained ROSC	Suspected or confirmed pregnancy
Unconsciousness[1]	ROSC within 5 minutes of ACLS performed by EMS team
ECLS team and ICU bed capacity in cardiac center available	Conscious patient

Invasive arm

Intraarrest transport

NO ROSC

ECPR

ROSC

OHCA CENTER

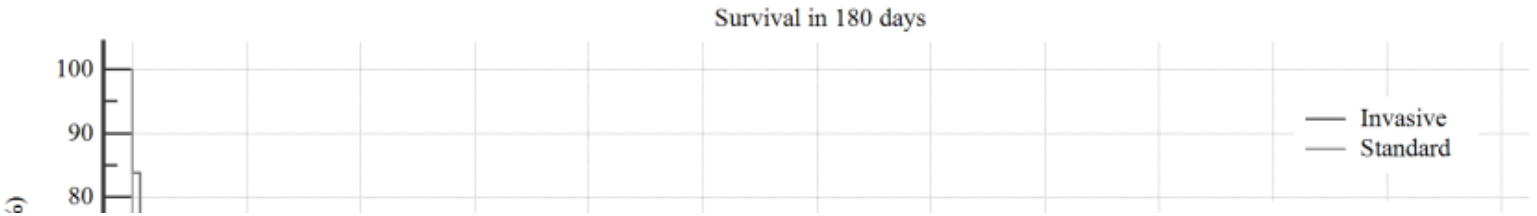
ROSC

Pronounced dead

Standard arm

ACLS on site

Is ECPR system superior compared to CCPR?



Factor	Hazard ratio	95% CI	*P* value
Sex (female)	0.89	0.6–1.3	0.55
Age (per year)	1.02	1.01–1.03	**0.008**
Initial rhythm (PEA/Asystole)	2.19	1.59–3.0	**< 0.001**
Prehospital ROSC (yes)	0.10	0.06–0.16	**< 0.001**
Collapse to EMS arrival (per minute)	1.02	0.99–1.05	0.22
CPR time (per minute)	1.01	1.01–1.02	**< 0.001**
Place of cardiac arrest (public)	1.01	0.72–1.42	0.95
Successful PCI (yes)	0.77	0.52–1.12	0.18
ECPR (yes)	0.21	0.14–0.31	**< 0.001**

9.5% (95% CI, -1.3% to 20.1%);
odds ratio, **1.63** (95% CI, 0.93 to 2.85); *P* = .09

Belohlavek, J., Smalcova, J., Rob, D., Franek, O., Smid, O., Pokorna, M., ... & Prague OHCA Study Group. (2022). *JAMA*, *327*(8), 737-747.
Rob, D., Smalcova, J., Smid, O., Kral, A., Kovarnik, T., Zemanek, D., ... & Belohlavek, J. (2022). Critical Care, 26(1), 1-9.
Rob, D., Komárek, A., Šmalcová, J., & Bělohlávek, J. (2023). Chest.

Can the results be generalized?

1) absence of EMS and hospital protocols and ECPR experience
2) prolonged interval from cardiac arrest to ECPR
3) different time point of randomization
4) unplanned post-randomization exclusions
5) low volume centers, low recruitment rate
6) limited sample size (46 ECPR)
7) many protocol deviations
8) early decannulation and withdrawal of care
9) low rate of CAG and PCI

	51	2∫
	16 (11 to 22)	NA
	44	2∫
	74 (63 to 87)	NA
	43	2∫
	20 (11 to 25)	NA

Metaanalýzy...

favourable neurological outcome with ECPR compared to conventional CPR.[601] A Bayesian meta-analysis found a posterior probability of a clinically relevant ECPR-based treatment effect on 6-month neurologically favourable survival of 71% in patients with all rhythms and 76% in shockable rhythms.[602] For IHCA, RCTs have not been conducted, and a meta-analysis of observational data found that ECPR was effective in improving survival and favourable neurological outcomes.[603]

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Doporučení ILCOR - ERC

The use of ECPR during cardiac arrest was addressed by an ILCOR systematic review in 2022, which was updated in 2024.[192,596] The ILCOR ALS Task suggested, and the ERC recommends that ECPR may be considered as a rescue therapy for selected adults with IHCA and OHCA when conventional CPR is failing to restore spontaneous circulation in settings where this can be implemented (weak recommendation). The overall certainty of evidence was rated as low for OHCA and as very low for IHCA (downgraded further because all evidence was in OHCA).[1]

ECPR může být zváženo u selektovaných IHCA a OHCA pacientů

ECPR provádět tam, kde je systém

Kritéria k indikaci ECPR

ECPR is not intended for the entire population of cardiac arrest patients, with only approximately 10 % of OHCA cases being eligible candidates.[598] However, there are no universally agreed selection criteria for ECPR, and practices vary widely among centres, particularly regarding the inclusion of older patients, those with initial non-shockable rhythms (pulseless electrical activity or asystole), and those with longer low-flow times. A recent systematic review and meta-analysis found that younger age, initial shockable rhythm, witnessed arrest, immediate CPR, pre-cannulation ROSC at any time, and shorter low-flow times are associated with increased likelihood of survival with favourable neurological outcome.[604] Adopting more liberal selection criteria impacts survival and survival with favourable neurological outcome[605–607] but also influences organ donation rates.[608] Conversely, more restrictive criteria may exclude potential survivors and organ donors.

Restriktivní versus liberální kritéria
Selekce je klíčová

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Kritéria pro OHCA - ECPR

Vstupní a pokračující VF

Intermitentní ROSC

Krátké časy

Pacienti do 60 let

Asystolie

Nespatřená zástava

Dlouhý no-flow time

Nad 60 minut

Pacienti nad 70let

ETCO2 konstantně pod 10

Rozhodnutí se nestaví na 1 ale více kritériích.

- Presence of signs of life during CPR.
- $ETCO_2$ > 10 mmHg (1.3 kPa).
- Mechanical CPR during transport.

Prehospital ECPR ? Další česká stopa

Whether initiating ECPR for OHCA in the pre-hospital setting is superior to in-hospital setting remains uncertain,[609–611] and ongoing clinical trials aim to address this question (ON-SCENE [ClinicalTrials.gov NCT04620070], RACE [NCT06789978], PACER [NCT06177730]).

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Conclusions

- ECPR as a method works for properly selected refractory CA patients.
- Many key questions about ECPR has to be answered.
- Is an ECPR-based **system** superior to a CCPR system for OHCA?
- Can an ECPR-based system be successfully implemented in **various cities and countries**?

How can we progress further in the ECPR field?

1. Improved patient selection
2. Streamlined and effective systems – logistics, timing
3. Evaluating Pre-hospital vs In-hospital vs Hub-and-Spoke
4. Exploring treatments addressing reperfusion injury
5. Enhancing post-arrest care in ECPR recipients
6. Multicenter trial with proper design and execution

OSIRIS multicenter multinational trial (14 centers)

Prehospital Prague ECPR pilot trial