



VFN PRAHA

ECPR

**Daniel Rob, Jan Bělohlávek
and others from Prague OHCA team**

**Complex Cardiovascular Center
General University Hospital in Prague
Czech Republic**

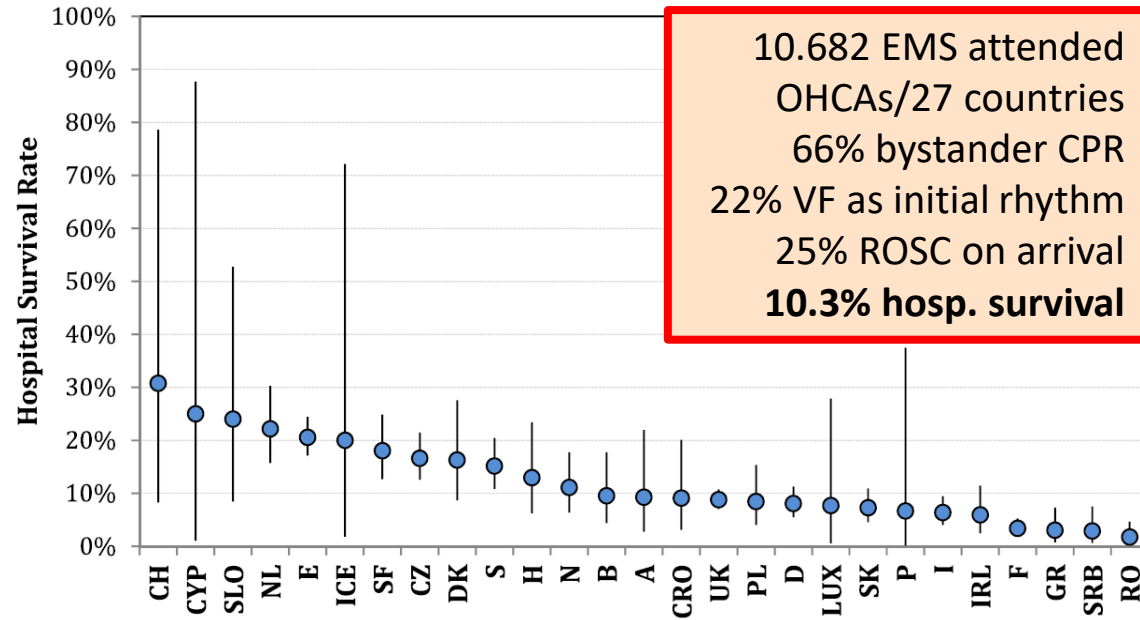


Disclosures

- Lecture fees or honoraria from Abiomed and Resuscitec
- ICU advisory board of Abiomed



Why do we need ECPR ?



Abbreviations for countries names are explained in Table 1.

Fig. 4. Percentage survival in cases with CPR attempted (discharged from hospital alive or alive at least 30 days after event). The vertical lines represent the 95% confidence intervals. The graph includes 6414 patients from 27 countries (range 4 – 1218). The overall rate is 10.3%. Abbreviations for countries names are explained in Table 1.

RELATIONSHIP BETWEEN TIME-TO-ROSC AND SURVIVAL IN OUT-OF-HOSPITAL CARDIAC ARREST ECPR CANDIDATES: WHEN IS THE BEST TIME TO CONSIDER TRANSPORT TO HOSPITAL?

Brian Grunau, Joshua Reynolds, Frank Scheuermeyer, Robert Stenstrom, Dion Stub, Sarah Pennington, Sheldon Cheskes, Krishnan Ramanathan, Jim Christenson

50 and 90% survivors reached ROSC in 8th and 24th minute

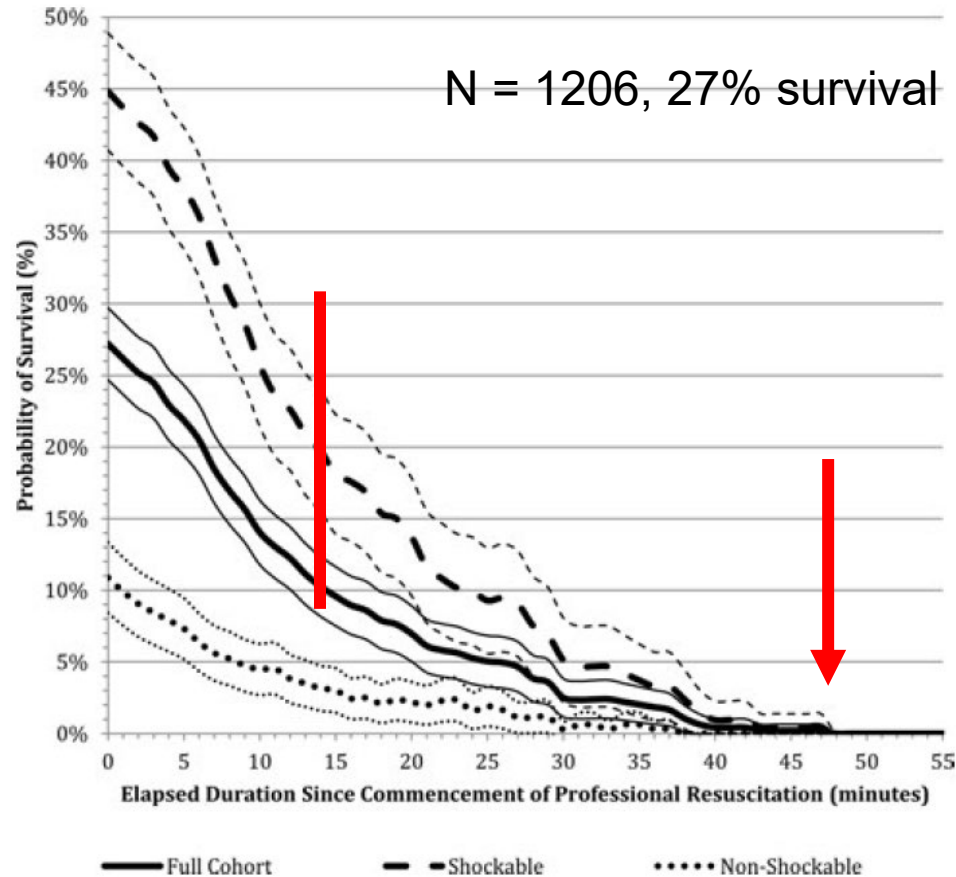
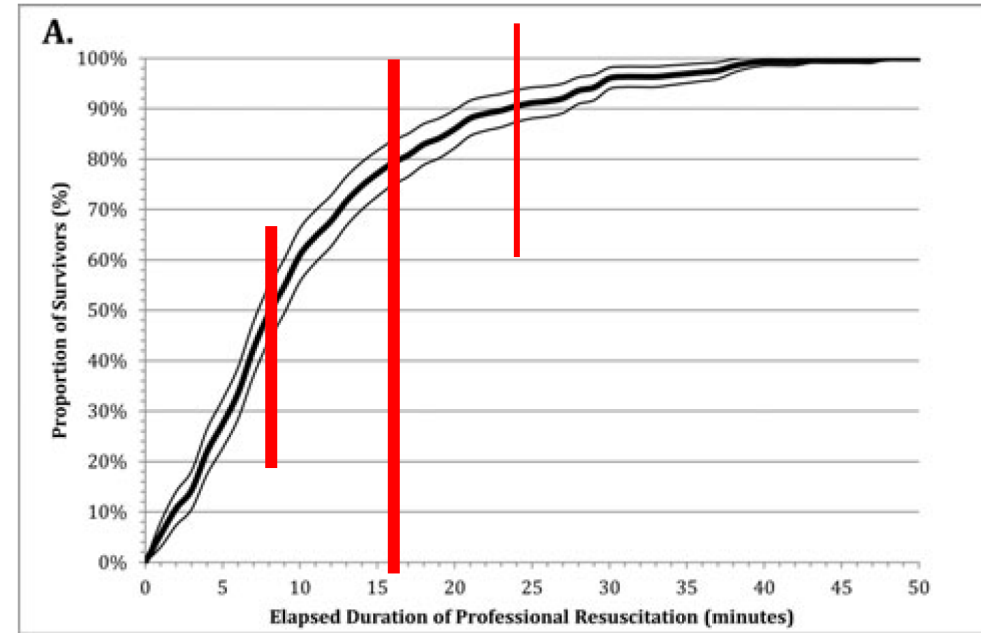


FIGURE 3. Probability of survival among pulseless patients, at increasing durations of time since commencement of resuscitation (with 95% CI).

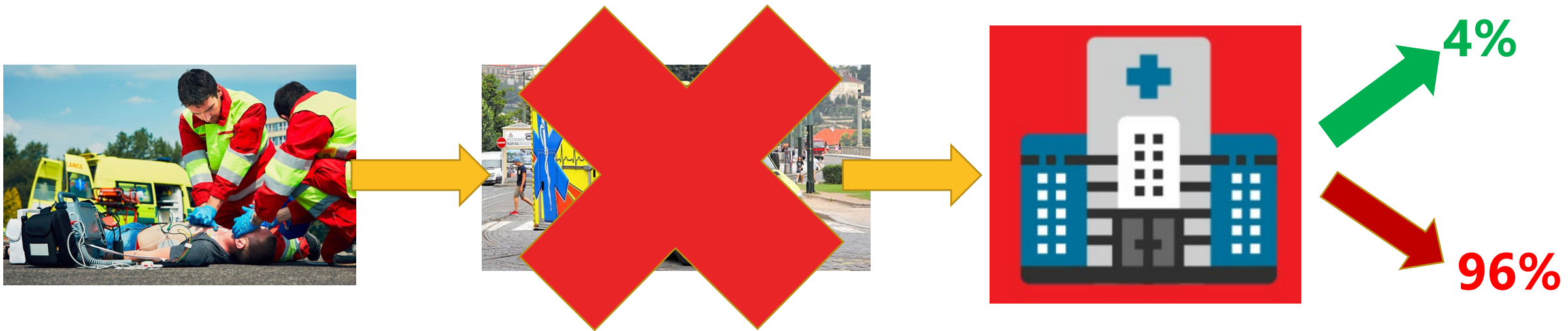


Percent of survivors who reached ROSC
Minute 16 is a breaking moment



What is the natural course of refractory OHCA ?

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

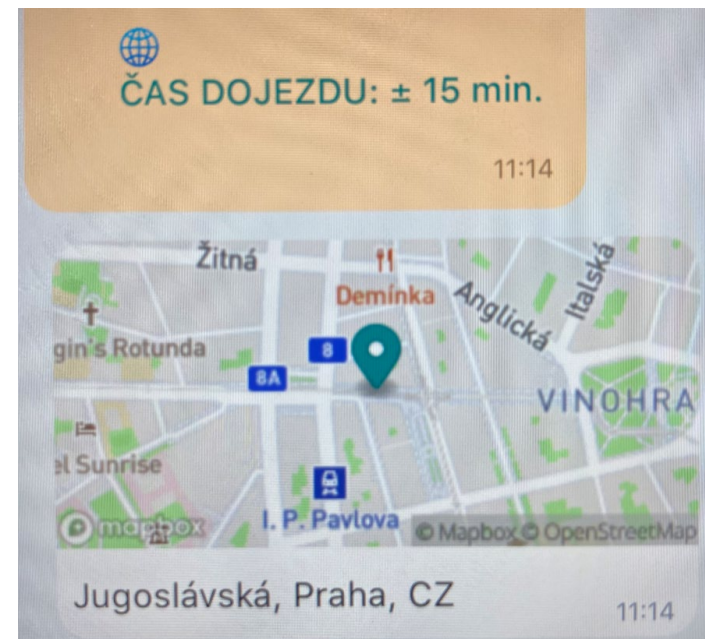
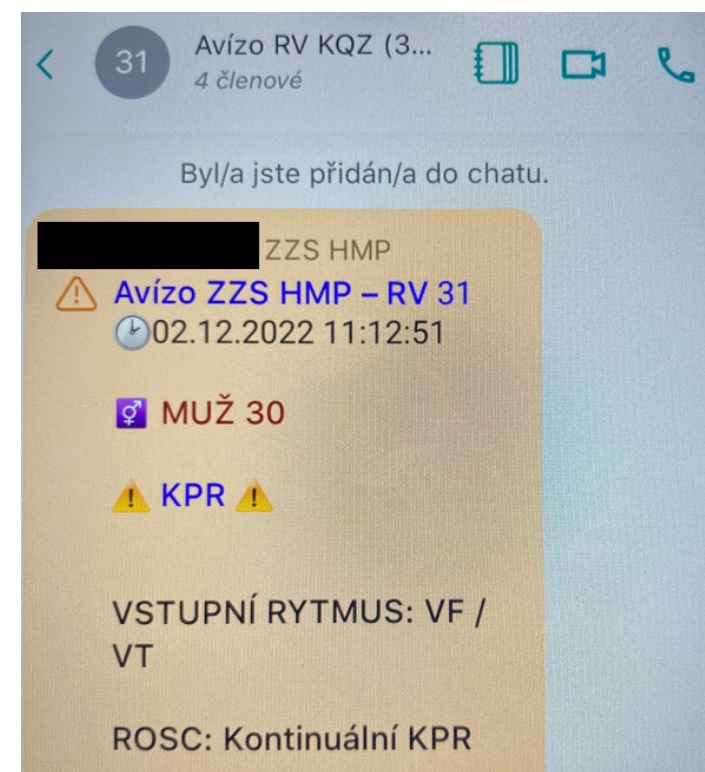


- Wampler, D. A., Collett, L., Manifold, C. A., Velasquez, C., & McMullan, J. T. (2012). Cardiac arrest survival is rare without prehospital return of spontaneous circulation. *Prehospital Emergency Care*, 16(4), 451-455.
- I.R. Drennan, S. Lin, D.E. Sidalak, et al. Survival rates in out-of-hospital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



ECPR works

- 31y old male, cigarettes smoker
- Sudden collapse tram station - **10:50 AM - witnessed**
- 112 call time **10:53**
- TANR - **10:54 –bystander CPR**
- EMS arrival **11:00 (7 min)**, initial rhythm **VFIB**
- ACLS per guidelines, 3 shocks, 300mg amiodarone, 1mg adrenalin iv., OTI – **call to our center 11:12**





Hospital arrival

- **11:27** – very fast transport – **15 min**
+ 3 more defibrillations
- Ongoing **VFIB**, no intermittent ROSC
- **11:37 - VA ECMO started – 10 min**
- **Time from collapse to ECMO = 47 min**
- Ongoing VFIB – defibrillation not successful

I.D. pacienta				
Příjmení pacienta				
Jméno pacienta				
Typ vzorku	Arteriální			
T	37,0 °C			

V PRAZE
VSELEČNÍ
02
004

(A)

Hodnoty krevních plynů				
pH	<u>6,782</u>		[-
pCO ₂	9,13	kPa	[-
pO ₂	21,7	kPa	[-
Hodnoty oximetrie				
ctHb	137	g/L	[-
sO ₂	96,1	%	[-
FMetHb	0,8	%	[-
Hodnoty elektrolytů				
cK ⁺	2,3	mmol/L	[-
? cNa ⁺	144	mmol/L	[-
cCa ²⁺	1,23	mmol/L	[-
cCl ⁻	108	mmol/L	[-
Hodnoty metabolitů				
cGlu	12,4	mmol/L	[-
? cLac	<u>16</u>	mmol/L	[-
Acidobasický status				
cHCO ₃ -(P,st),c	7,6	mmol/L		
cBase(B),c	-25,4	mmol/L		
cHCO ₃ -(P),c	10,2	mmol/L		
ctCO ₂ (B),c	25,2	Vol%		
Baro.	99,3	kPa		



21:07 (10hours since collapse)

- Early signs of awakening despite propofol + sufentanyl
- Fast rewarming to 36.5 degrees
- Patient obeying verbal commands, stable on VA ECMO

*** With patient consent**



ICU course

- Day 2 LVEF 20%
- Day 3 LV improvement (LVEF 30%)
- Day 5 ECMO decannulation



*** With patient consent**



Follow-up

- Day 10 - discharged home – echocardiography
- 6 months FU - NYHA I, working, +10kg after smoking cessation

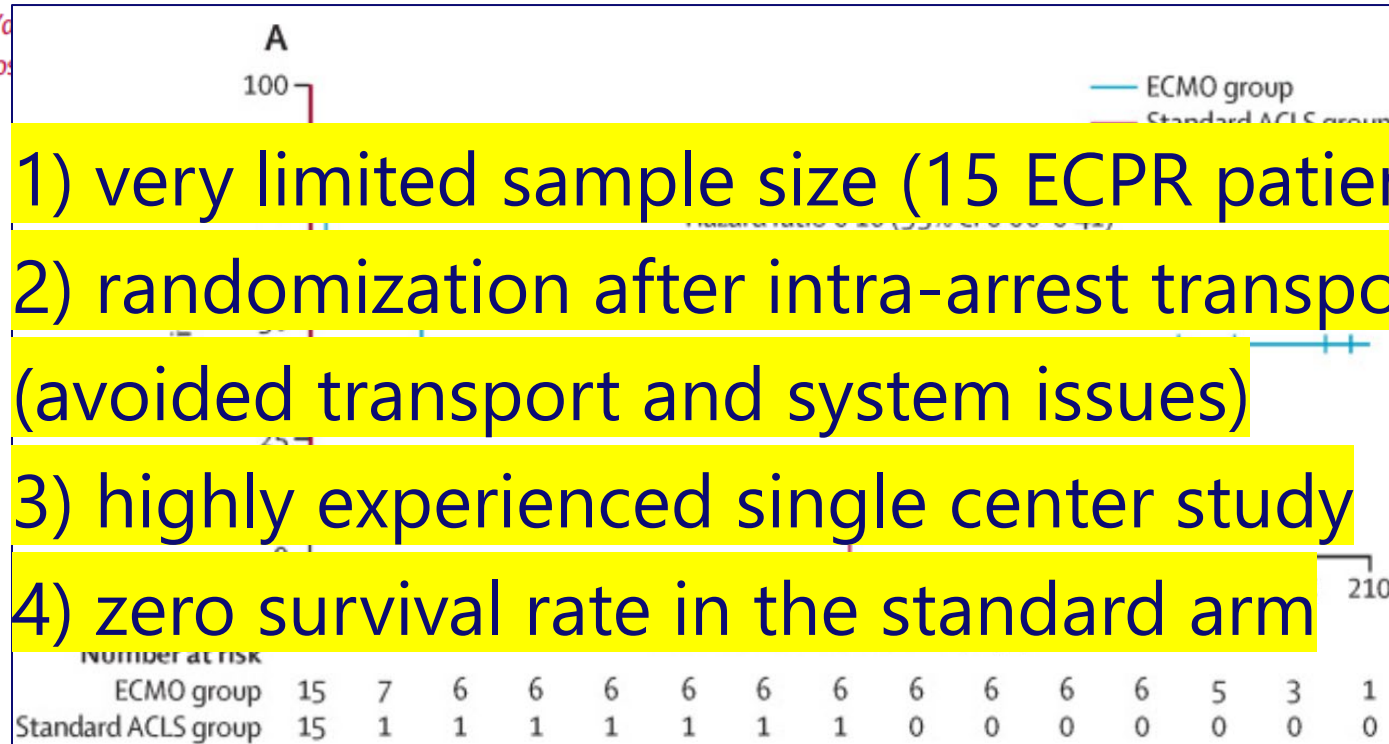


ECPR works

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 Y... alra,
Marinos Ko... heide



- 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



IHCA – ECPR works

Table 1 Notable published studies of ECPR

Type of study	No. of subjects	Outcome measurement	Results ^a	
IHCA				
Chen [14]	Propensity-score matched analysis	46 matched pairs	Survival to discharge with CPC 1–2	ECPR vs CPR 30.4% vs 15.2%; HR 0.51, [0.35–0.74], $p < 0.0001$ ^b
Shin [15]	Propensity-score matched analysis	60 matched pairs	Two-year survival with minimal neurological impairment	ECPR vs CPR 20% vs 5%; HR = 0.53, [0.36–0.80] $p = 0.002$
Ouweneel [37]	Meta-analysis of matched pairs analyses	195 matched pairs	30-day survival with CPC 1–2	ECPR vs CPR 23% vs 9.7%, RR 0.85, ^c ARR 13%, [7–20%], $p = 0.0001$
IHCA and OHCA with in-hospital ECPR				
Lunz [40]	Multicenter retrospective study	IHCA: 165 OHCA: 258	3-month survival with CPC 1–2	IHCA vs OHCA 34.2% vs 9%; RR 0.72, ^c $p < 0.01$

Abrams D, Bělohlávek J, Combes A et al. Intensive Care Medicine 2021



It is not about the ECMO... Prague OHCA trial design



ECPR

Invasive arm

Intraarrest transport



NO ROSC

OHCA CENTER

ROSC

ROSC

**Pronounced
dead**

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

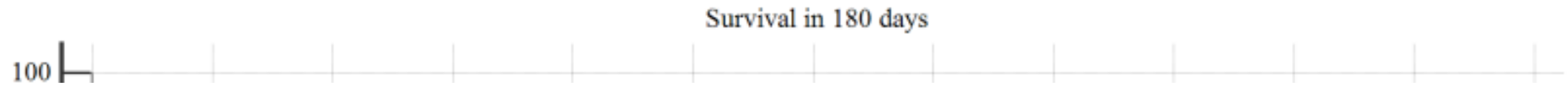
Standard arm

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

Time (days), all patients observed to death or 180 days

Number at risk	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
Group: Invasive	124	57	52	48	45	43	42	42	41	41	41	41	40	39					
Group: Standard	132	44	43	42	40	39	35	33	32	31	31	31	31	31					

Belohlavek, J., Smalцова, J., Rob, D., Franek, O., Smid, O., Pokorna, M., ... & Prague OHCA Study Group. (2022). *JAMA*, 327(8), 737-747.

Rob, D., Smalцова, J., Smid, O., Kral, A., Kovarnik, T., Zemanek, D., ... & Belohlavek, J. (2022). *Critical Care*, 26(1), 1-9.

Rob, D., Komárek, A., Šmalcová, J., & Bělohávek, J. (2023). *Chest*.

Intraarrest transport, extracorporeal cardiopulmonary resuscitation, and early invasive management in refractory out-of-hospital cardiac arrest: an individual patient data pooled analysis of two randomised trials

Jan Belohlavek,^{a,g,*} Demetris Yannopoulos,^{b,g} Jana Smalcova,^a Daniel Rob,^a Jason Bartos,^b Michal Huptych,^c Petra Kavalkova,^a Rajat Kalra,^b Brian Grunau,^d Fabio Silvio Taccone,^e and Tom P. Aufderheide^f

^a2nd Department of Medicine – Department of Cardiovascular Medicine, General University Hospital and 1st Faculty of Medicine, Charles University in Prague, Czech Republic

^bCenter for Resuscitation Medicine, University of Minnesota Medical School, Minneapolis, MN, USA

^cCzech Institute of Informatics, Robotics and Cybernetics (CIIRC), Czech Technical University in Prague, Czech Republic

^dDepartment of Emergency Medicine, St Paul's Hospital, and University of British Columbia, 1081 Burrard St, Vancouver, BC, Canada

^eDepartment of Intensive Care, Hôpital Universitaire de Bruxelles (HUB), Université Libre de Bruxelles (ULB), Route de Lennik 808, Brussels 1070, Belgium

^fDepartment of Emergency Medicine, Medical College of Wisconsin, Milwaukee, WI, USA

Summary

Background Refractory out-of-hospital cardiac arrest (OHCA) treated with standard advanced cardiac life support (ACLS) has poor outcomes. Transport to hospital followed by in-hospital extracorporeal cardiopulmonary resuscitation (ECPR) initiation may improve outcomes. We performed a pooled individual patient data analysis of two randomised controlled trials evaluating ECPR based approach in OHCA.



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Pooled ARREST and Prague OHCA analysis

Survival with CPC 1 or 2 at 180 days

Panel A. Intention to treat analysis in the whole population of both trials.

Outcomes	Invasive (N = 139)	Standard (N = 147)	Absolute difference (CI), %	P value
Primary outcome				
Survival with minimal or no neurologic impairment at 180 days	45 (32.4 %)	29 (19.7 %)	12.7 (2.5-22.6)	0.015
Secondary outcomes				
Survival with minimal or no neurologic impairment at 30 days	44 (31.7 %)	24 (16.3 %)	15.4 (5.5-25)	0.003
Cardiac recovery at 30 days	60 (43.2 %)	46 (31.3 %)	11.9 (0.7-22.7)	0.05

Panel B. Intention to treat analysis in patients presenting with shockable rhythm.

Outcomes	Invasive (N = 87)	Standard (N = 99)	Absolute difference (CI), %	P value
Primary outcome				
Survival with minimal or no neurologic impairment at 180 days	41 (47.1)	28 (28.3)	18.8 (7.6-29.4)	0.01
Secondary outcomes				
Survival with minimal or no neurologic impairment at 30 days	40 (46)	24 (24.2)	21.8 (10.8-32.2)	0.002
Cardiac recovery at 30 days	49 (56.3)	42 (42.4)	13.9 (2.3-25.0)	0.08

NNT = 8

NNT = 5!!!



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

Hospital arrival			
No. of patients			2§
Median interval (IQR) — min		2)	NA
Start of arrest to			
No. of patients		44	2§
Median interval (IQR) — min		74 (63 to 87)	NA
Cannulation			
No. of patients		43	2§
Median duration (IQR) — min		20 (11 to 25)	NA



Why are the results so different ?

- Three trials seem comparable at first glance, but
- Different methodology, randomization, I/E criteria, location...

PRAGUE OHCA RANDOMIZATION



ARREST RANDOMIZATION



? %

? %

INCEPTION RANDOMIZATION

Eligible patients ECPR for OHCA – in hospital cannulation

Inclusion criteria

- Age ≤ 70 years presumed or known
- Witnessed OHCA
- Bystander CPR
- Presumed cardiac or unknown cause
- An initial documented shockable rhythm (VF or pulseless VT)
- Minimum of 10 min of ACLS without sustained ROSC or at least 3 defibrillations for ongoing VF/pVT
- Body morphology able to accommodate a mechanical chest compression device
- ECPR team and ICU capacity in the center available
- Estimated transfer time from scene to the hospital ≤ 30 mins
- Eligible for intensive care without restrictions

Exclusion criteria

- Age > 70 years
- Non-shockable initial rhythm (PEA or asystole)
- Unwitnessed collapse
- Known limitations in care or a Do not resuscitate (DNR) order
- Known severe disease making 180-day survival unlikely
- Known bleeding diathesis or acute or recent intracranial bleeding
- Obvious or suspected pregnancy
- Conscious patient
- Known pre-arrest severe cognitive dysfunction (cerebral performance category CPC ≥ 3 or mRAS ≥ 4)



Conclusions

- ECPR is a system of care, not a single procedure
- ECPR works for properly selected refractory CA patients
- ECPR is complex, and success never guaranteed
- Many key questions about ECPR has to be answered
- Great promise of prehospital ECPR and new technologies



Thank you



We invite you cordially to attend the meeting and share experiences, visions and plans together.

Yours,

Jan Bělohlávek



Marcel van de Poll



Demetris Yannopoulos

