

When your heart stops beating

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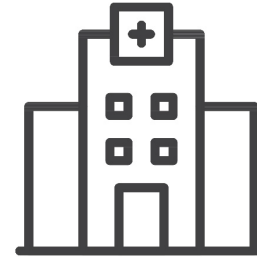
Conflicts of interest

- No financial conflicts of interest
- Board member, Laerdal Foundation
- Basic Life Support Task Force, International Liaison Committee on Resuscitation (ILCOR)
- Science Advisory Committee, International Liaison Committee on Resuscitation (ILCOR)
- Advanced Life Support Science and Education Committee, European Resuscitation Council (ERC)

If your heart stops in Norway...



- 3723 persons
- 423 survived



- 1016 patients
- 266 survived



If your heart stops in Norway...



66% at home



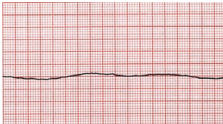
44% unwitnessed



9 min response time



85% bystander CPR



53% Asystole



**Where are we – science,
guidelines, ideas...**

CPR goals

- Increase recognition of cardiac arrest
- Decrease time to CPR
- Improve CPR quality

Recognition

Recognition – dispatcher/call taker

Call first

Use speakerphone / headphones



Dispatch recognition

_Systematic review: 46 observational studies

Sensitivity:

20% (95% CI 16, 26) to 98 (95% CI 96, 98)

Specificity:

32% (95% CI 29, 36) to 100% (95% CI 100, 100)

ILCOR review: Dispatcher recognition
costr.ilcor.org



RCT - Machine learning assisted dispatch

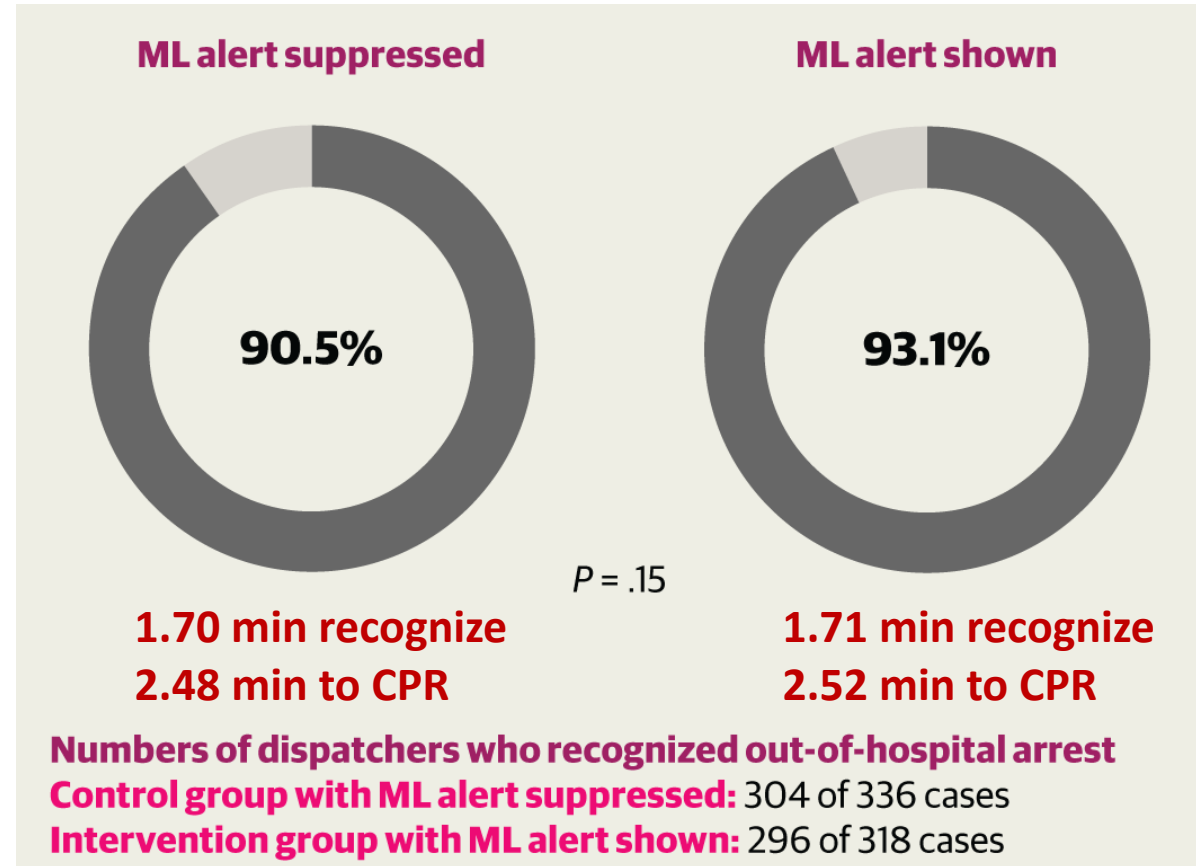
Copenhagen dispatch center

169 049 calls

5254 ML suspected CA calls

654 confirmed CA

*Randomized to ML support vs.
no ML support*



Blomberg et al *JAMA Network Open* 2021

Time to CPR

Dispatch instructions



- 16 studies:

t-CPR vs. no t-CPR offered

~ 27 more ROSC/ 1 000 OHCA

~ 9-14 more intact survivors / 1000 OHCA

→ **Good system better than bad system**

ILCOR review: Dispatcher instruction in CPR
costr.ilcor.org

Dispatch instructions

- 14 studies:

t-CPR vs. no CPR

- ROSC: ORadj 1.51 (1.32, 1.73)
- Intact survival: ORadj 1.54 (1.35, 1.76)

→ Any CPR is better than no CPR

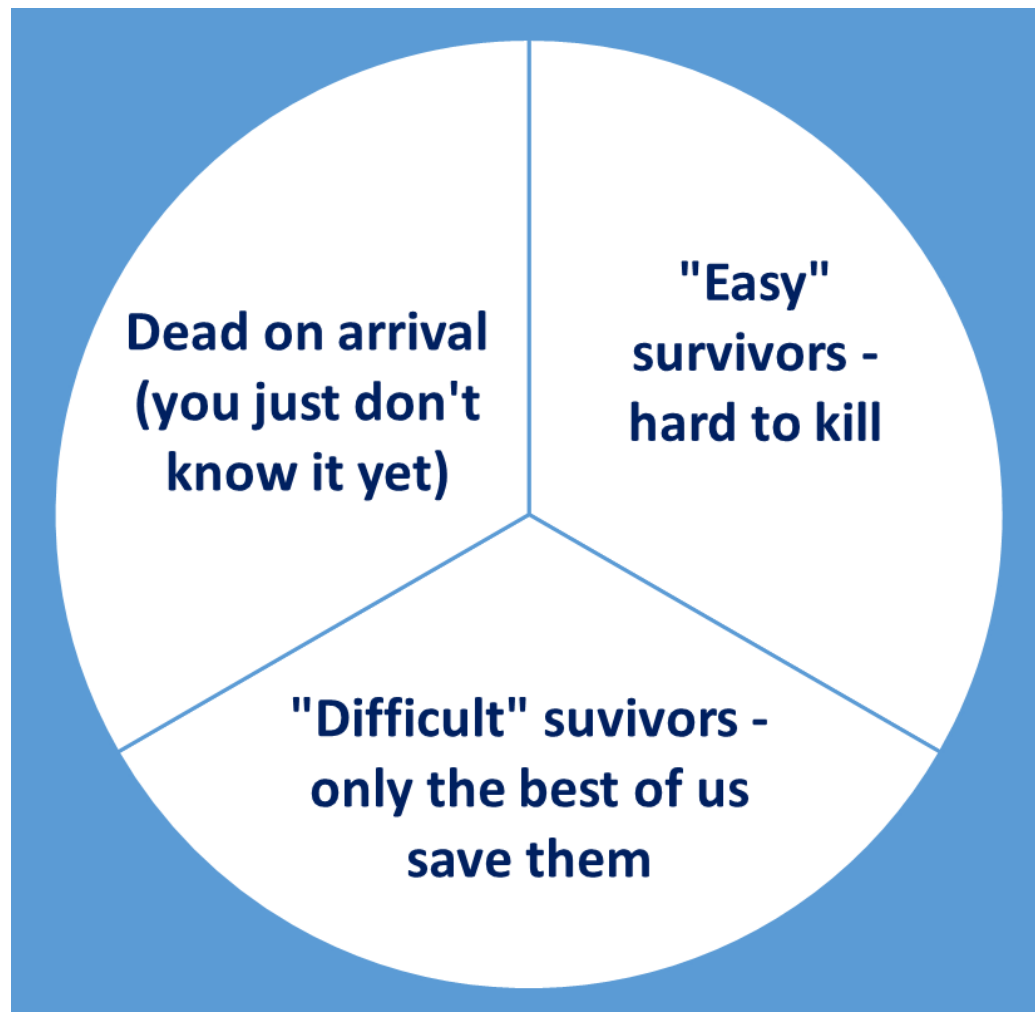
t-CPR vs. standard CPR

- ROSC: ORadj 1.04 (0.94, 1.14)
- Intact survival: ORadj 1.12 (0.94, 1.34)

→ t-CPR is as good as standard CPR!

ILCOR review: Dispatcher instruction in CPR
costr.ilcor.org

CPR quality



Video-dispatch assisted CPR

Copenhagen dispatch center

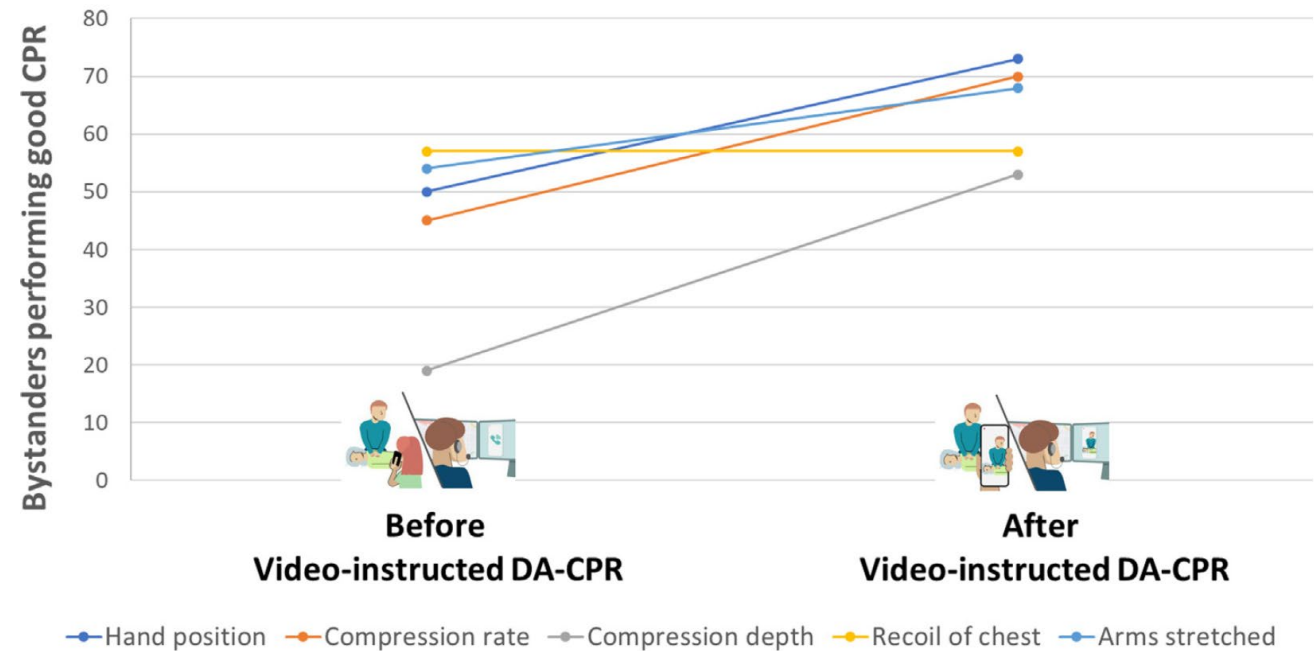
52 OHCA calls

90 bystanders

Video on after CPR was started

All quality parameters improved!

RESUSCITATION 168 (2021) 35–43



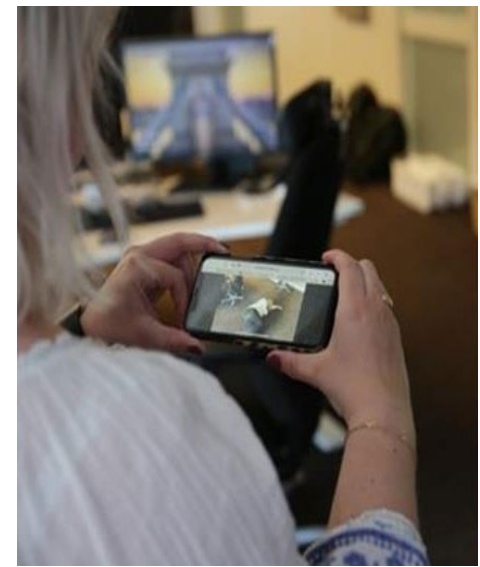
Linderoth et al *Resuscitation* 2021

Video-dispatch assisted CPR

- 2 Observational studies
- 1720 + 2109 OHCA, South Korea
- Second person available for video
 - Unadjusted odds: OR 1.89 ✓ & OR 3.30 ✓
 - Adjusted odds: adjOR 1.28 ✗ & adjOR 2.11 ✓
 - PSM OR 0.91 ✗

Lee et al
Resuscitation 2020

Lee et al
Resuscitation 2021



Audiovisual feedback assisted CPR



CPR quality

- 1 cluster RCT (Hostler et al. 2011, n=1586), statistically significant differences

Compression rate -5 / min,

depth +1.6 mm,

CPR fraction +2%,

- 9 obs studies (n=2263)

-> 11/20 CPR metrics statistically significant differences

Survival

- 1 cluster RCT (Hostler et al. 2011) -> No effect on any survival outcomes

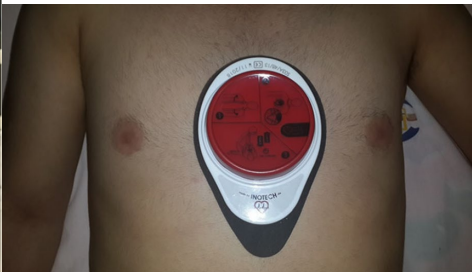
-9 obs studies -> 2/22 survival outcomes with effect

ILCOR review: Feedback devices

Audio/tactile feedback devices



Cardio First Angel™
Gorhani et al 2019



CPR quality

- No data!

Survival

2 RCTs (n=980)

- Vahedian-Azimi et al. 2016;

80 ICU pt, 72 % vs. 35 % ROSC

- Goharani et al. 2019;

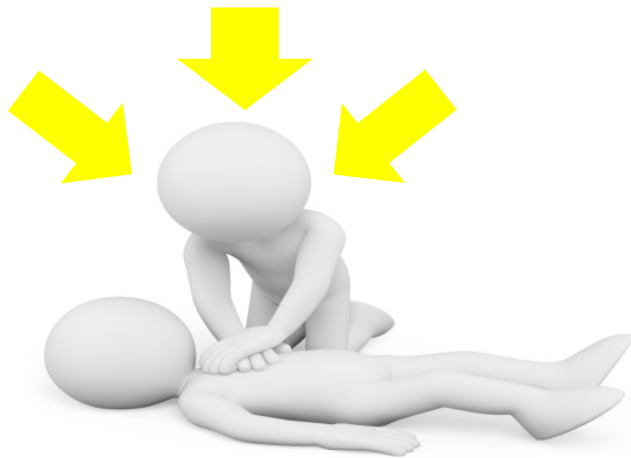
8 ICUs, 9 month period 2015

900 ICU pt, 54% vs. 28.4% survival

ILCOR review: Feedback devices

CPR Quality

Provider



Compression rate, depth, recoil
Ventilation rate (+ volume)

or

Patient



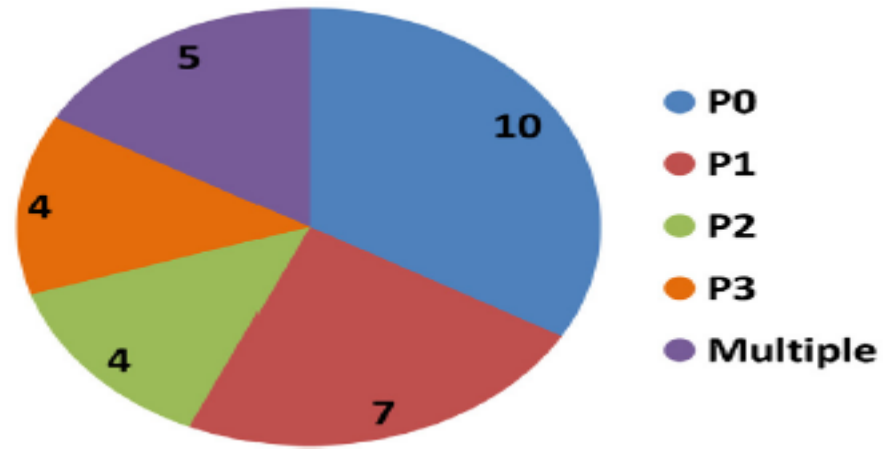
EtCO₂, NIRS, ART, CVP

Cardiac Output = HR x SV
(patient) (provider)

EtCO2

Compression rate
Compression depth
Correct hand position
Complete release

Feedback to increase cardiac output?



Pilot trial: 30 patients

Difference in EtCO₂ between hand positions

0.2–3.4 kPa (2–26 mmHg)

>1 kPa (8 mmHg) in half of the patients

Qvigstad et al. *Resuscitation* 2013

Physiologic feedback – EtCO₂ /dBP

POPULATION

575 Male
499 Female



Pediatric patients aged ≥ 37 weeks' corrected gestational age and < 18 years and underwent CPR while in the ICU

Median age: **0.6** years

LOCATIONS

18
Pediatric ICUs
in the US



INTERVENTION



1389 Events randomized
1074 Events analyzed

526

548

Bundled intervention

All ICU staff trained in CPR on manikins provided to their units and participated in monthly clinical event debriefings

Usual care

Usual care during cardiac arrest based on the existing resuscitation practices of each ICU

PRIMARY OUTCOME

Survival to discharge with favorable neurologic outcome by a Pediatric Cerebral Performance Category score of 1 to 3 or no change from baseline (score range, 1 [normal] to 6 [brain death or death])

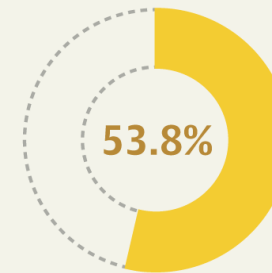
FINDINGS

© AMA

Survival to hospital discharge with favorable neurologic outcome

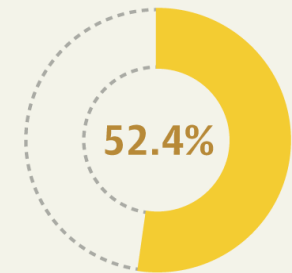
Bundled intervention

283 of 526 patients



Usual care

287 of 548 patients



No significant difference between groups:

Risk difference, **3.2%** (95% CI, -4.6% to 11.4%);

Odds ratio, **1.08** (95% CI, 0.76 to 1.53)

Sutton et al JAMA 2022

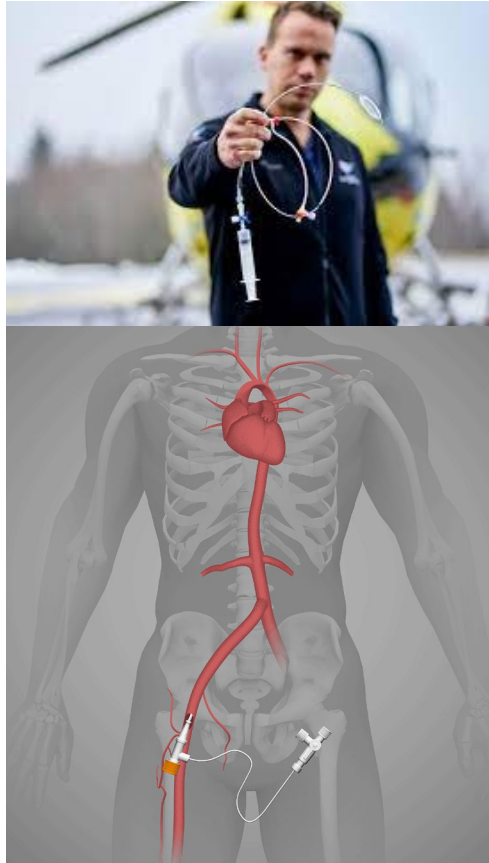


Physiologic feedback – EtCO₂ /dBP

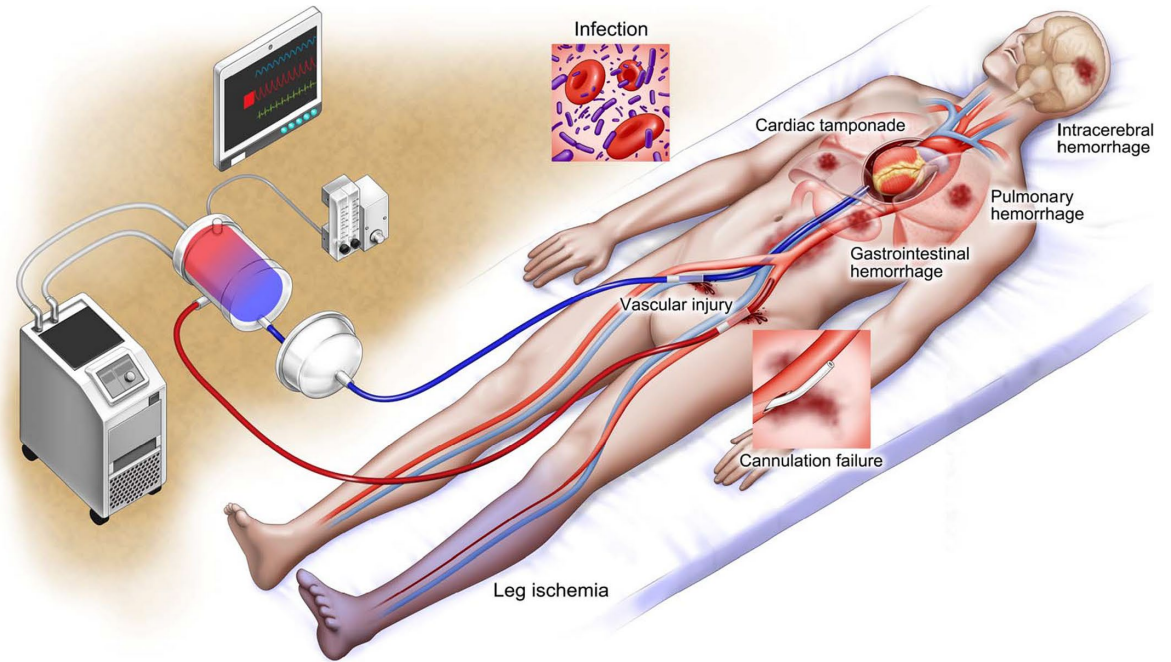
Event quality outcomes		
Adequate SBP ^g	143/197 (72.6)	127/195 (65.1)
Adequate DBP ^h	180/198 (90.9)	160/199 (80.4)
High-quality CPR with adequate SBP ⁱ	93/197 (47.2)	74/195 (37.9)
High-quality CPR with adequate DBP ^j	112/198 (56.6)	89/199 (44.7)
Target compression depth ^k	28/114 (24.6)	11/66 (16.7)
Target chest compression rate ^l	217/273 (79.5)	175/242 (72.3)
Target chest compression fraction ^m	196/273 (71.8)	177/242 (73.1)

Sutton et al *JAMA* 2022

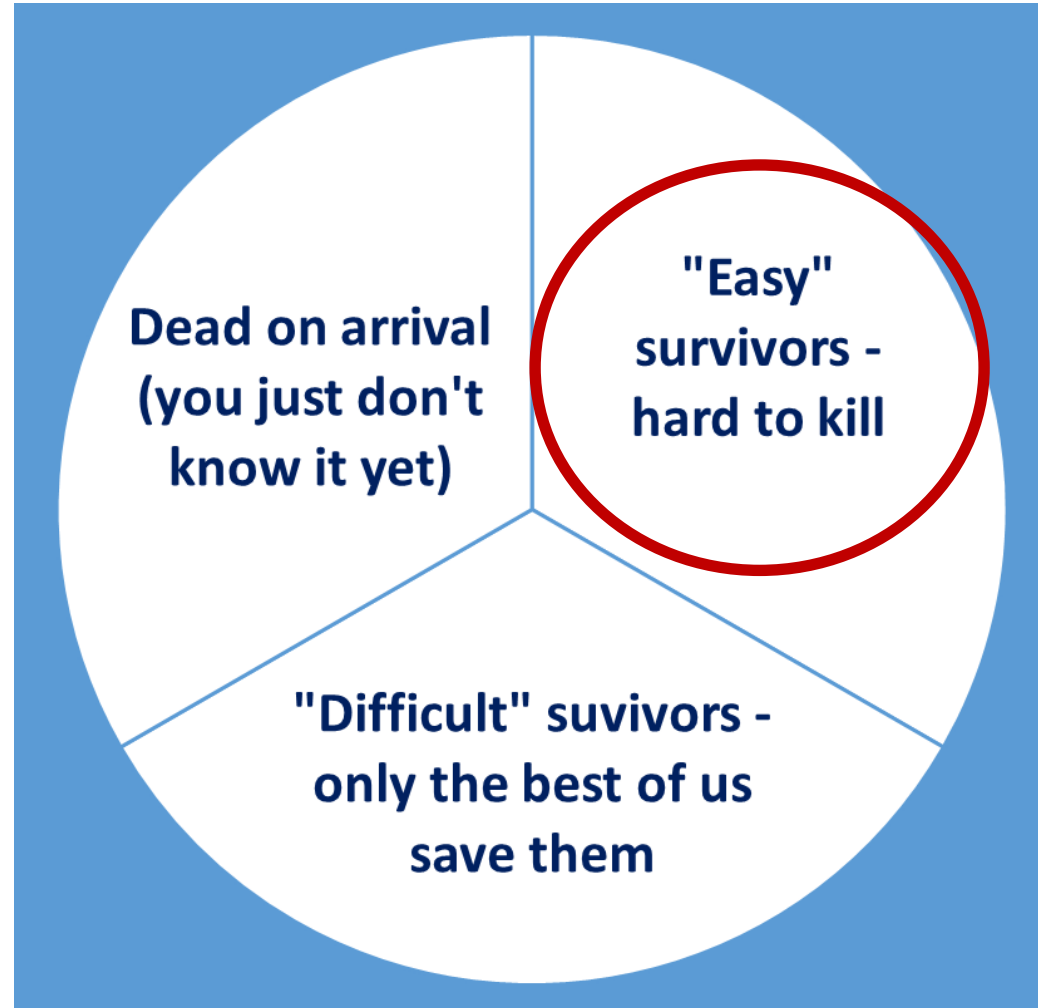
More invasive strategies...



Brede et al. *JAHA* 2019



Inoue et al. *JAHA* 2020



But don't mess up the basics...

Inclusion criteria

Presumed cardiac cause
 Witnessed arrest
 Bystander resuscitation
 Shockable first rhythm (VF or VT)
 Age 18–65
 Paramedic CPR within 15 min
 >10 min of ALS without ROSC
 <60 min from CA to ECMO cannulation

Outcome	All patients			ECPR candidates		
	Before n = 1086	After n = 3135	p-value	Before n = 48	After n = 100	p-value
Sustained ROSC* (%)	351 (32)	747 (24)	< 0.001	30 (63)	50 (50)	0.2
24-h survival (%)	278 (26)	743 (24)	0.2	29 (60)	52 (52)	0.3
30 days survival (%)	167 (15)	464 (15)	0.6	21 (44)	37 (37)	0.4
CPC score 1–2** (%)				21 (100)	30 (81)	0.03
ALS during transport and on arrival to hospital (%)	56 (5)	121 (4)	0.7	7 (15)	26 (26)	0.1
Time from CA to arrival at hospital						0.3
≤40 min				2	14	
41–59 min				2	8	
≥60 min				3	4	

Alm-Kruse et al *Resuscitation* 2021

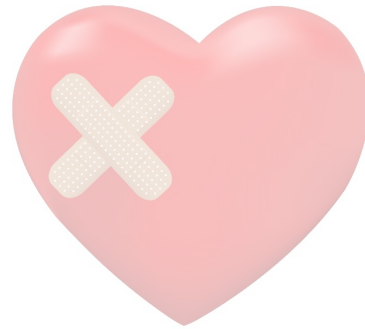
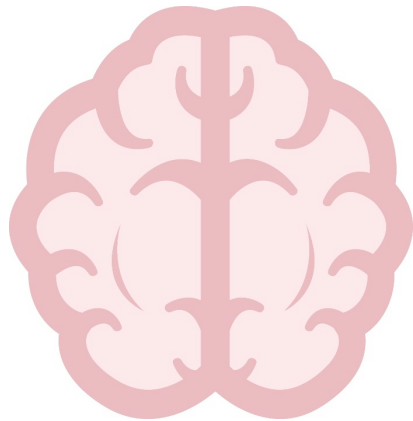
Main points

No 1. Don't mess up where we actually know what to do

No 2. Continue to push for margins and look for new therapies
(but not at the expense of No. 1)

No 3. We need improved tools to assess futility

Thank you!



Questions/comments:
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