



Extracorporeal CPR is Coming

Erik Osborn MD

Director Adult Extracorporeal Support

Inova Fairfax Hospital

April 2019



- I have no disclosures
- The views presented in this talk do not reflect those of the United States Military, Department of Defense, or Inova Health System



Q1. In 5 years from now, the use of eCPR will...

- A. Increase
- B. Decrease
- C. No change

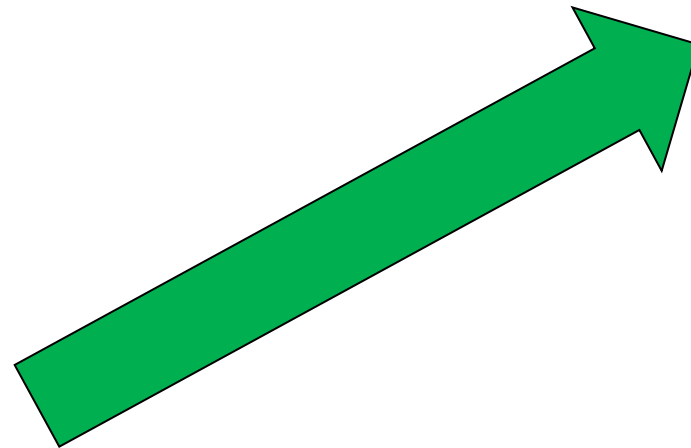


9%

AHA Heart Disease and Stroke Statistics 2018.
Circulation. 2018;137:e67-e492



9%



30%



- If an experienced, expert, and well trained team could select patients well, initial data suggests at least a 30% survival rate...
- 356,000 arrests
 - 9%
 - 32,040 survive with a good outcome
- 356,000 arrests
 - 30% survival with a good outcome
 - 106,800 lives
- Difference: **74,760 lives saved**

- Witnessed arrest
- No flow time less than 5 minutes
- Low flow time (CPR) less than 60 minutes before ECMO
- No known chronic organ dysfunction
- Age less than 75
- Lactate less than 16
- pH greater than 7.0
- End tidal CO₂ > 10
- Possible reversible cause
 - Case by case evaluation

- Early is better, initiate eCPR after 10 minutes if no ROSC
- Signs of life: gag, cough, move, ROSC – better outcomes
- The longer the low flow period (longer CPR) - worse outcomes

Q2. Which patient below survived? All had fixed and dilated pupils...

- A. 45 female tourist from Jordan with large SAH from basilar artery aneurysm, s/p coiling and left P1 thrombus treated with 5mg local TPA. PEA/ VT arrest and lung failure, CPR 25 min with ROSC X1. Lactate 11, pH 7.1
- B. 63 male with prolonged PEA arrest after 8 hour redo total knee replacement. Massive MI s/p DES to totally occluded LAD and RCA. After PCI, brady, CHB, PEA arrest 50min with ROSC x2 and signs of life during code. Lactate 15, pH 7.0
- C. 28 female diffuse cerebral edema from meningitis, refractory ICP elevations > 30 for over 2 days despite medical therapy, 29 weeks pregnant, 55 minute VF/PEA code with ROSC x3. She had been in severe shock with escalating pressor and inotrope requirements for 4 hours before arrest. Lactate 18, pH 6.9

Which patients did we put on VA ECMO?



- Already made an exception -- criteria are guidelines
- eCPR best done in a high volume center, with years of ECMO experience
 - Multi disciplinary team
- Consent process
 - Tell family up front, or right after ECMO initiation, that it will be stopped if irreversible injury present or develops
- How do we know which patients will do well?
 - We actually are not as good as we think at predicting the future



Case review: Ballet Dancer - Jennifer

- 36 female ballet dancer massive effexor overdose, refractory seizures, acute liver failure, acute renal failure, admitted 24 hours ago...
- ECMO team called after PEA arrest for 65 minutes. ROSC x3, shock for VT/VF x4. EtCO2 above 12 during CPR.
- CT scan one hour before arrest shows diffuse edema and early partial uncal herniation
- Pupils fixed and dilated as per neuro critical care right before her arrest
- Realize upon arrival to bedside she had been in VT for 3 hours prior to PEA arrest with escalation to high doses of epinephrine, norepinephrine, neosynephrine
- pH 6.8, lactate 17, oxygen saturation 94% on vent 70% FiO2
- Health prior to overdose excellent



Pool or Ocean?

Do
We
Offer
eCPR?



Q3: What should we decide to do?

- A. Call palliative care and discuss comfort care pathway
- B. Continue current medical therapy
- C. Emergent VA ECMO



- 25F femoral venous drain, 15F femoral artery return, DPC 6F
- Flat EEG for 2 days, Pupils remain fixed and dilated, no response to deep pain, no gag, no corneal reflexes, off all sedation
- Liver and renal failure day 1-2 ECMO.
- Given lipid infusion for overdose. Emergent circuit change associated with hypotension



Picture of VA ECMO, DPC



Distal
Perfusion
cannula

Bleeding problems...
Blood loss from distal perfusion cannula connection

Active bleeding DPC
tubing

Lipids disrupted DPC
Circuit connections?

Unable to follow labs
After lipids...





Day 2, worsening gas exchange, increasing pressors



CXR Day 2 ECMO

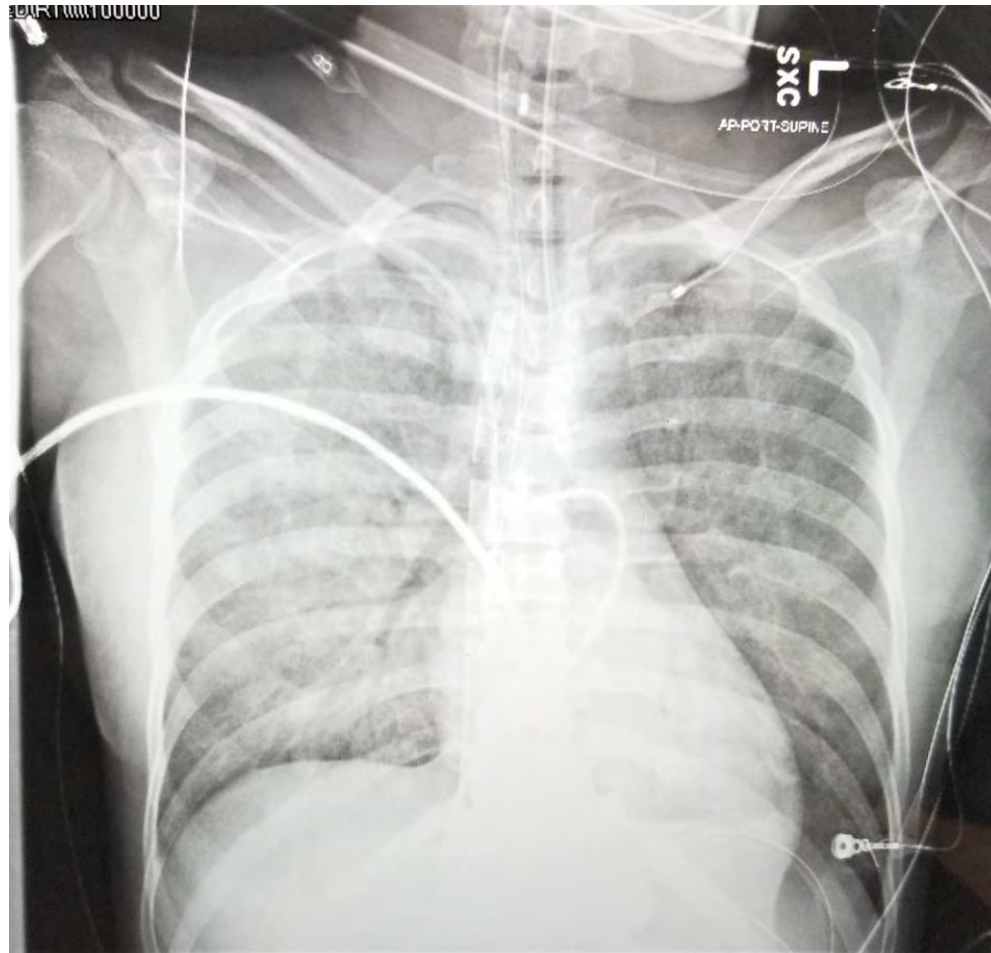
O2 sat 84% on
100% FiO2

CRRT for fluid
removal

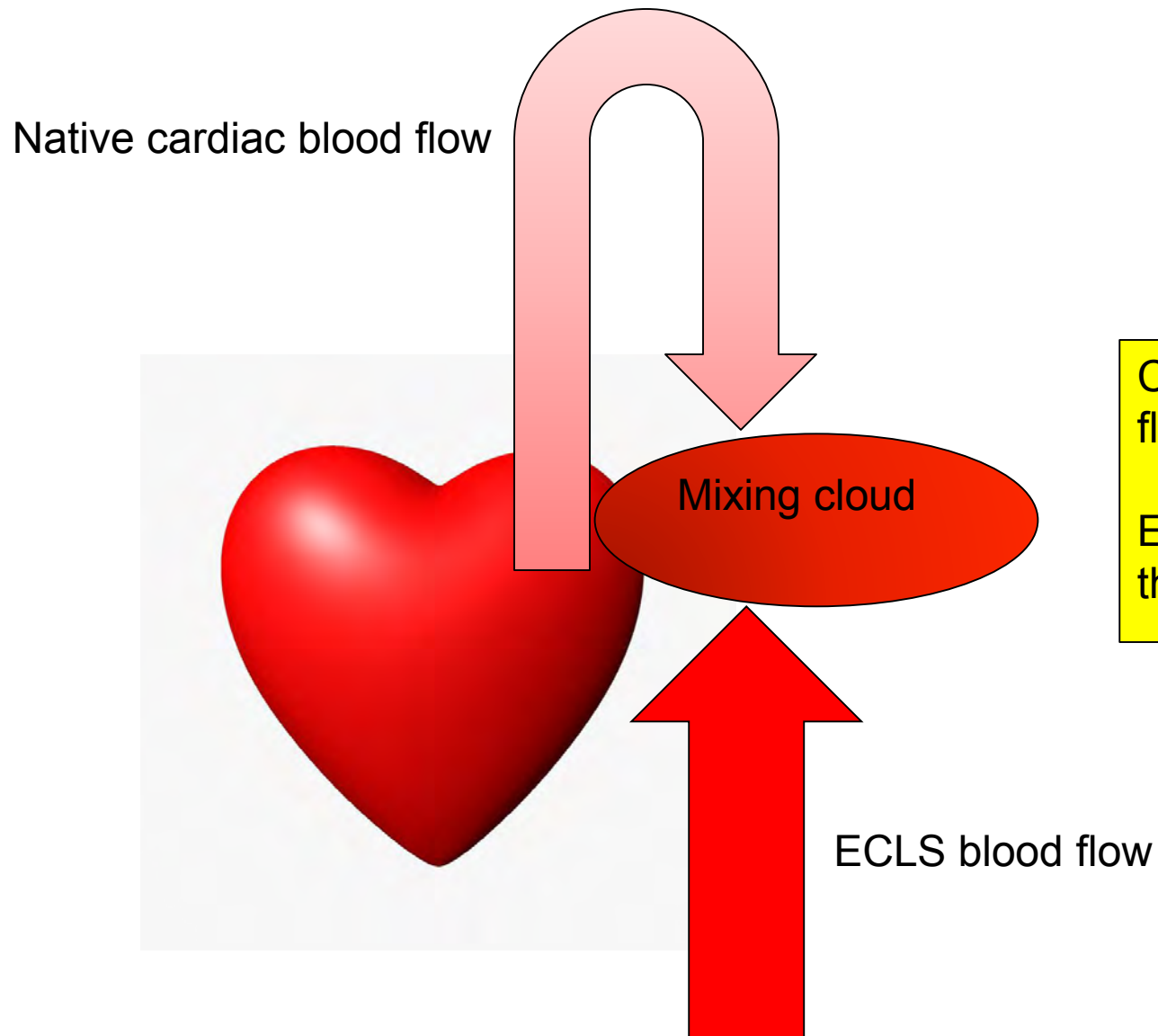
Still on norepi

Liver failure
slightly improved

EEG flat line

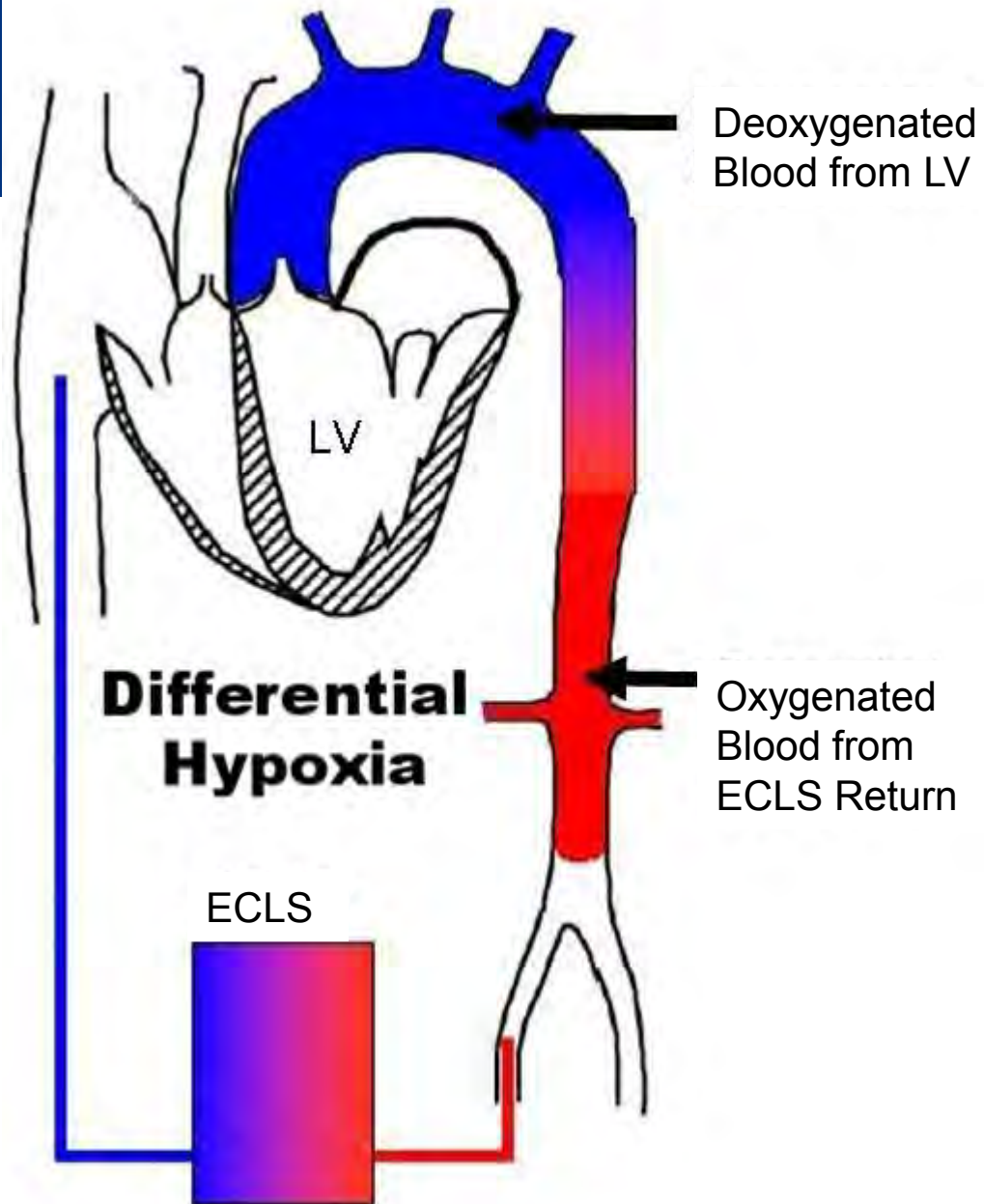


Blood flow in VA ECLS



Competing blood flows

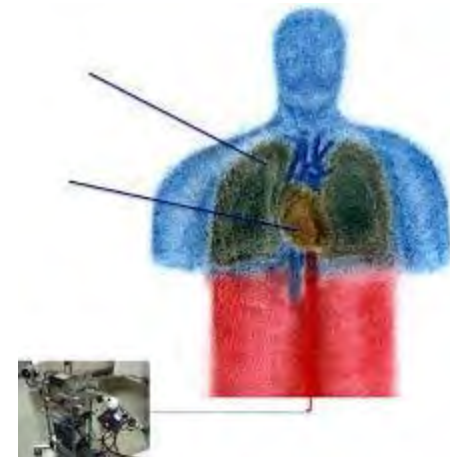
ECLS flow against the current

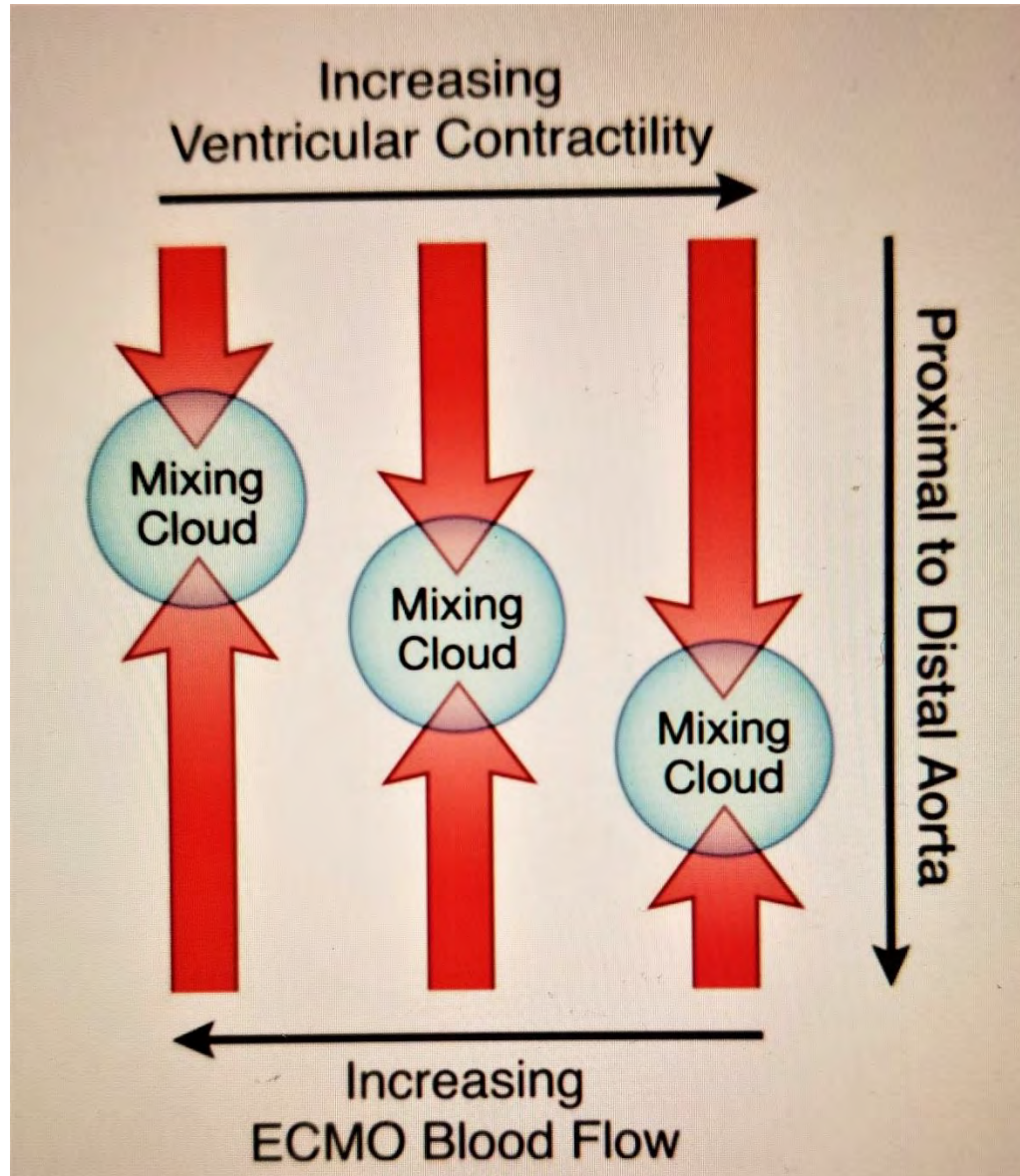


North south syndrome

Harlequin syndrome

Blue head Pink legs





- Clinical
 - pulmonary edema, pink sputum in ETT
 - increased O₂ requirements
 - Lack of pulsatility
- Hemodynamic
 - Hypo perfusion, low blood pressure
 - Drop in cardiac index if measured
- Quantitative
 - LV distension on ECHO: LV size end diastole > 6cm
 - pulmonary artery diastolic pressure > 25



Manage LV distension without venting

- No vent, or while deciding how to vent LV
 - Increase PEEP
 - Increase inotropic support (epi) for contractility
 - Check cannula positions – drain in RA
 - Correct volume overload with diuresis, CRRT
 - Decrease ECLS flow if possible

- Accept lower mean arterial pressure even w no pulsatility
- Low flow rates 3-4L if lactate levels decrease
- Restrict fluids
- High PEEP
- No reason to vent LV in patients with high chance of recovery
 - Reversible process, clearing lactates and acidosis, improving ECHO

Q4. Family considering withdrawal after speaking with neuro critical care...

Neuro critical care and neurology state that flat line EEG, neuro exam close to brain death portends grave prognosis or severe permanent disability. Neuro recommends palliative care consult. What do you say to the family about withdrawing at this time?

- A. Agree with neuro critical care – comfort care pathway
- B. Too early, continue full support, unable to accurately predict neuro outcome at day 2



Q5. How do we want to manage her pulmonary edema and increasing vent requirements?

- A. Lung protective ventilation, increase fluid removal with CRRT and pulsatility with epinephrine
- B. Place an LV vent – Impella CP
- C. Lasix infusion, inhaled vasodilators (veletri), increase pressors and inotropes

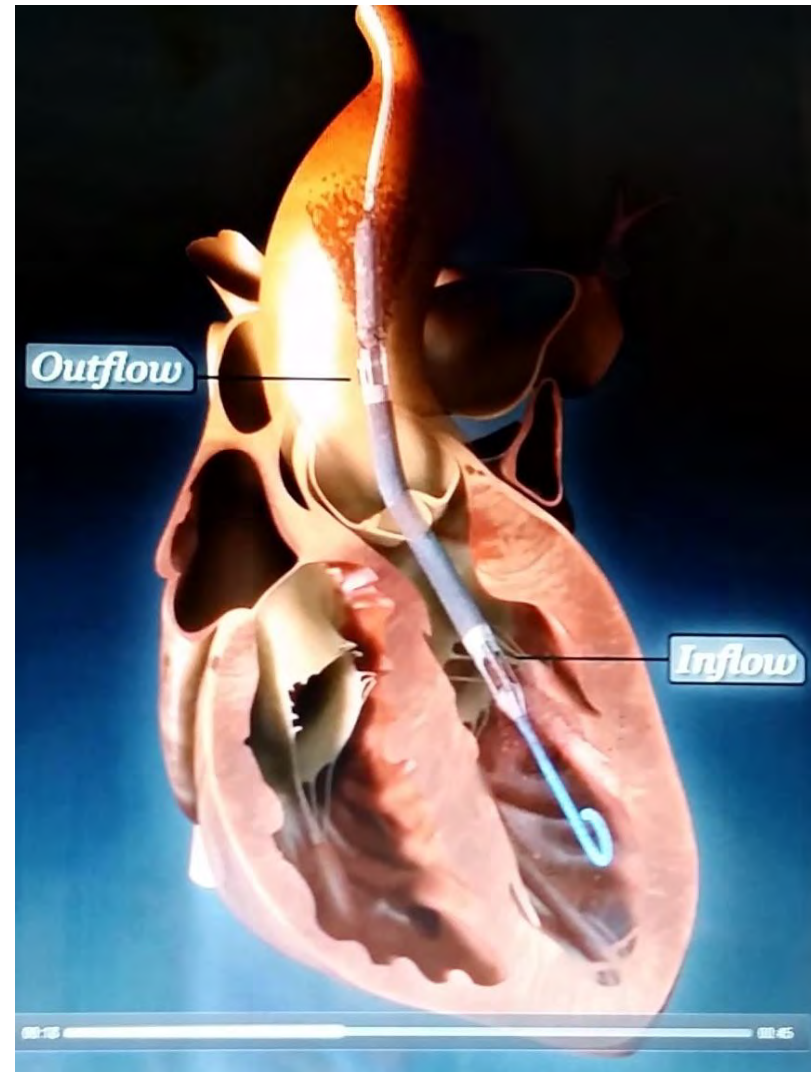


Impella

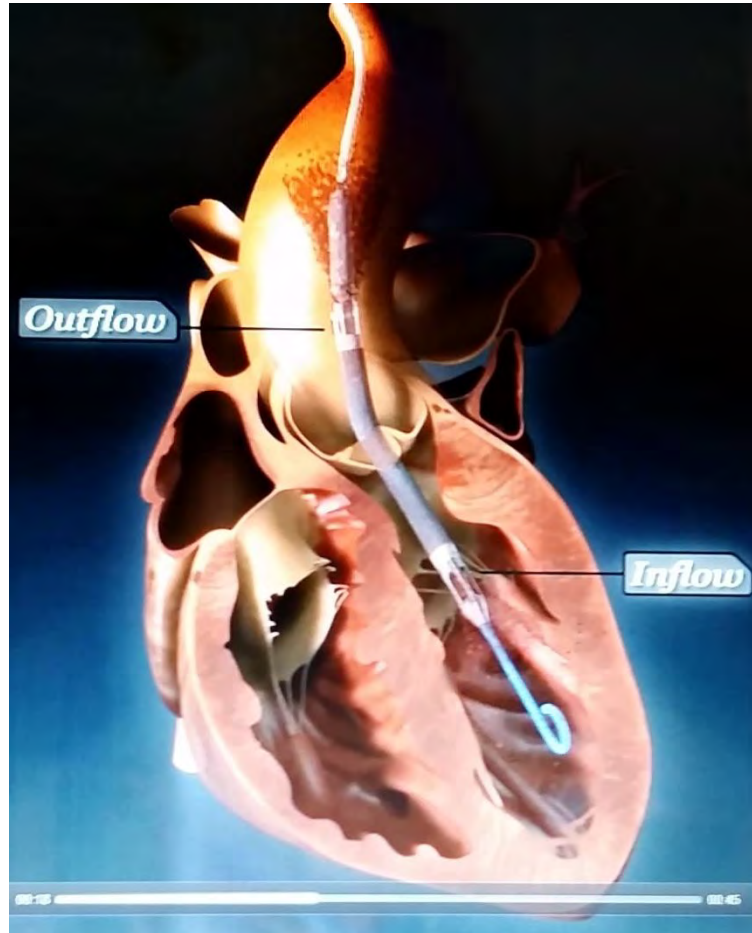
CP 4L
5.0 5L
2.5L
Right sided 3L

Requires additional Heparin
Increase hemolysis
Bleeding from site
Limb ischemia

Can use as bridge to recovery, VAD,
or transplant



Percutaneous LV assist devices - Impella



CP 4L - 13F

5.0L – 22F

**Placed across aortic valve via Fem A
5.0 longer placement time for
Surgical cutdown**

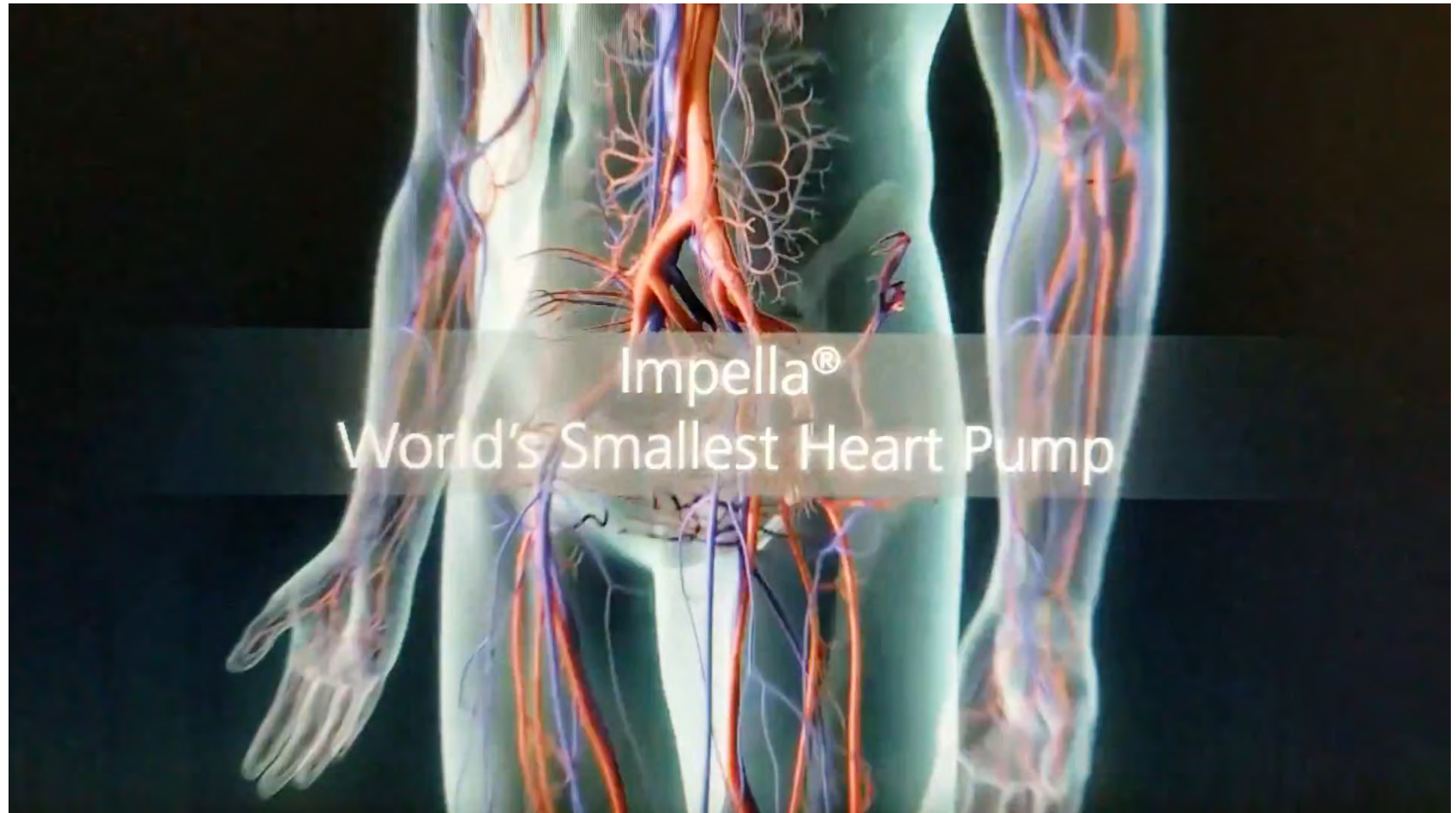
Axial flow

**Lower risk limb ischemia
than VA ECLS or TH**

Active cooling not possible



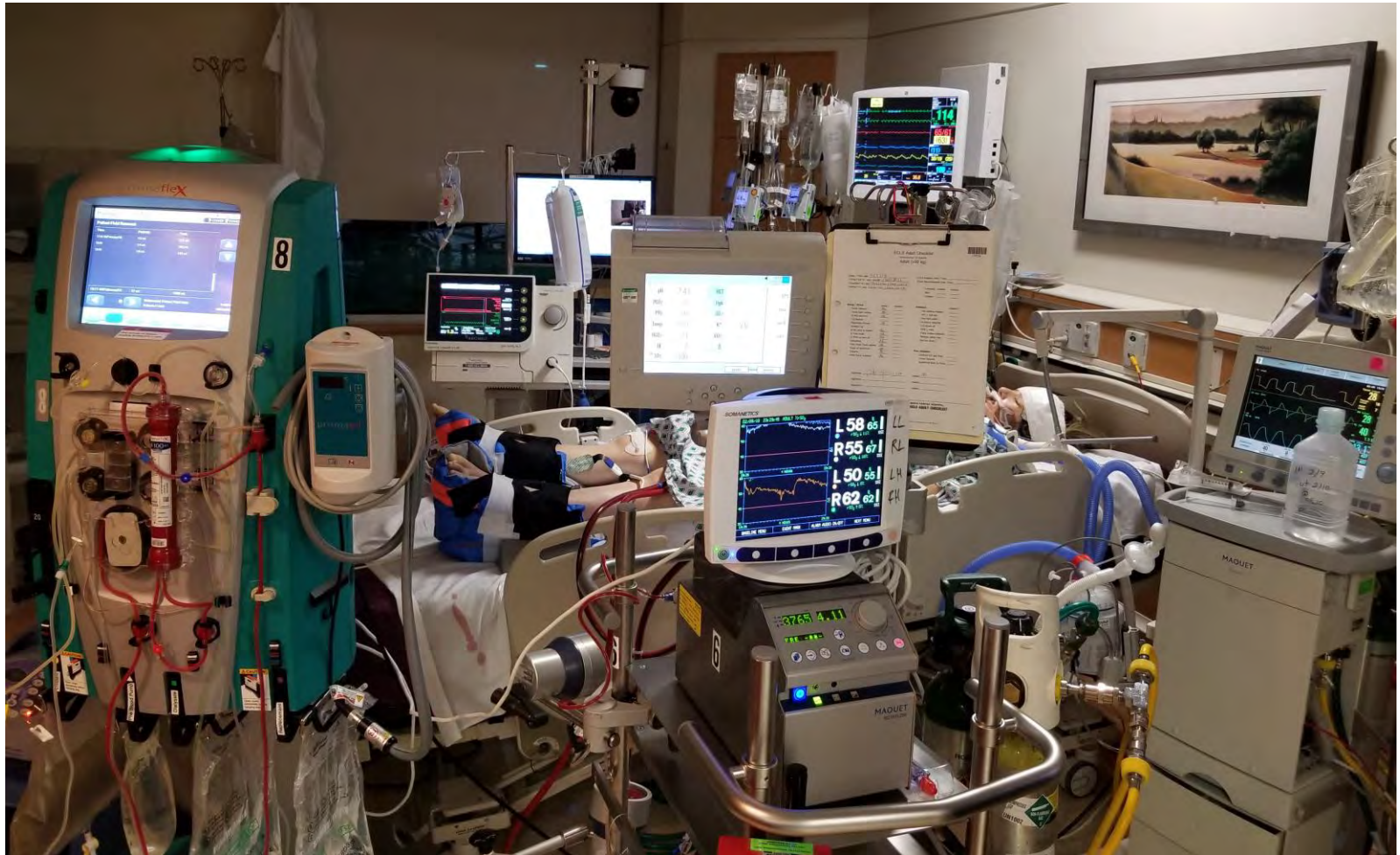
Overview of Impella



Video of Impella on ECHO

Impella in LV
3.5cm from
AV





- Code for complex video:
- Big cat = ECMO team
- Small cat = Cardiac Arrest



Small Cat = Cardiac Arrest
Big Cat = ECMO Team



Family wants to withdraw – what do we do?

- Seizures refractory – loaded with anti epileptics
- Vtach – VT/VF arrest, 60 minutes CPR
 - Prolonged hypoperfusion...
- Multiorgan failure – heart, lungs, liver, kidney, brain
- 3 days – EEG flat, neuro exam approaches brain death...
 - Neuro critical care – will not wake
- May lose R leg, R BK – high dose pressors
- Husband – she would not want to live if leg amputated

Q6. Should we withdraw?

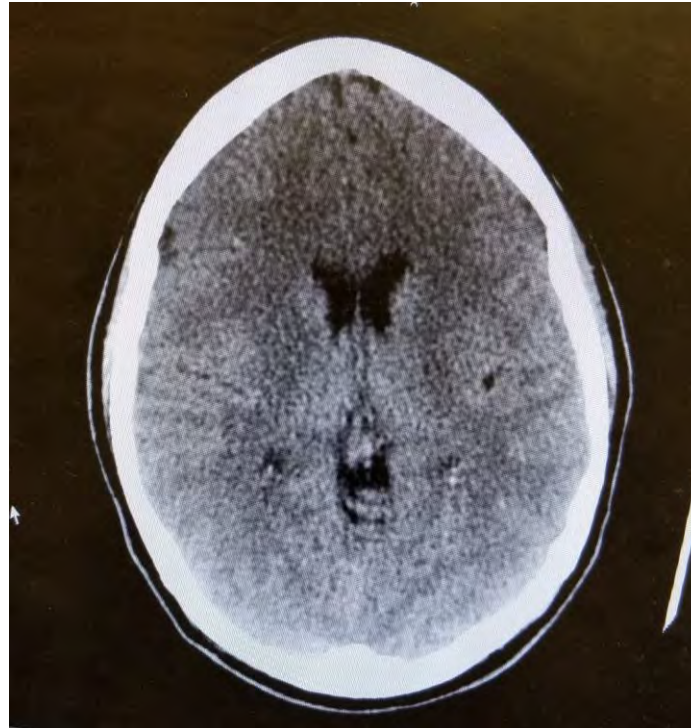
- A. Yes
- B. No
- C. Call ethics and palliative



Head CT

Improved edema

Early herniation resolved



Day 4

Opens her eyes

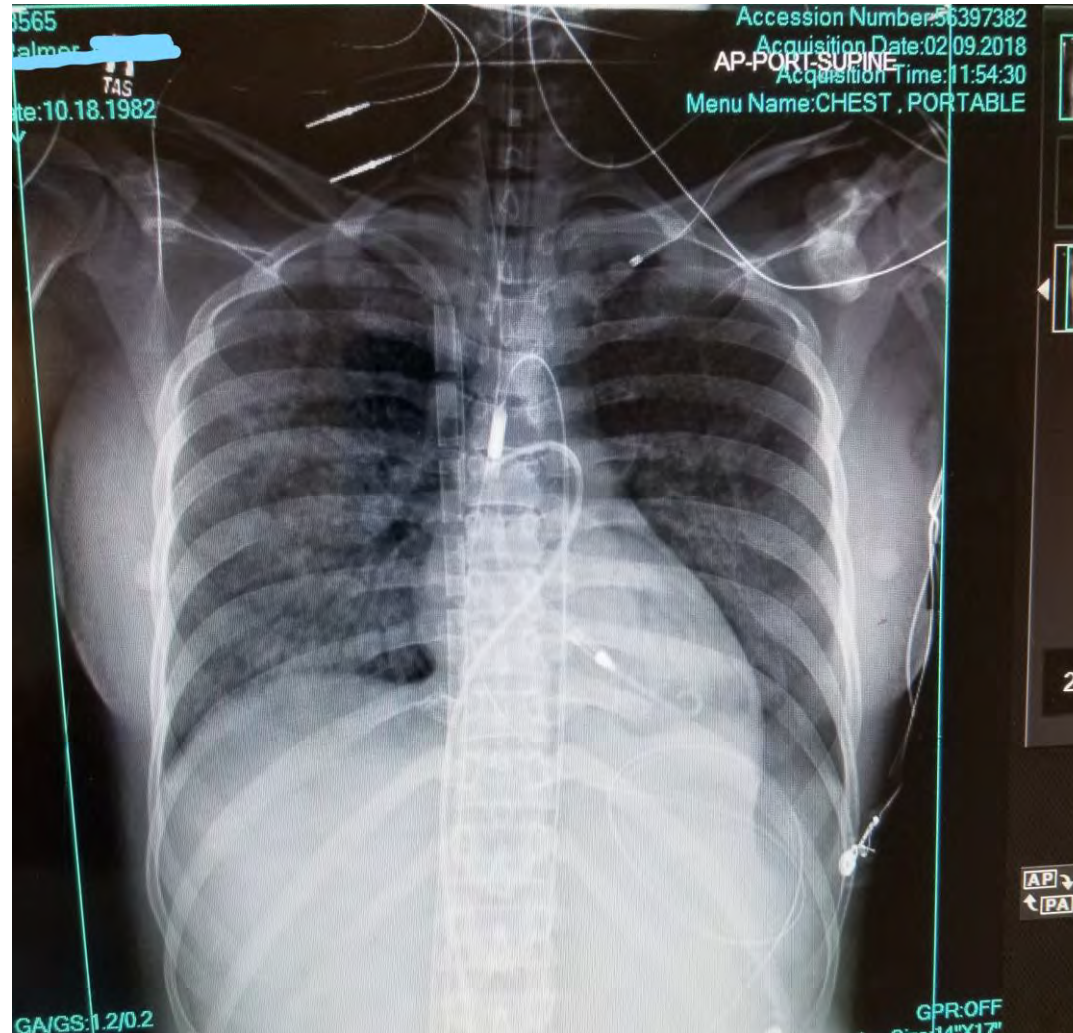
Day 5 – following commands



Day 5

Improved
greatly after
LV vent with
Impella CP

CRRT fluid
removal



- Organ function improving, but significant bleeding at cannulation sites – ECMO cannula, Impella. Not ready to come off ECMO yet.
 - Hgb drops to 6.7, platelets 80K
 - Hgb drops despite receiving a unit of blood overnight
 - Xa 0.21 below goal of 0.3-0.5, PTT 109, AT3 40%
 - TEG R time 58
 - Systemic heparin at 34 units/kg/hr
 - Purge heparin at full strength

Q7. What should we do next?

- A.** Hold all heparin
- B.** Give thrombate due to low AT3, low Xa level, high heparin dose
- C.** Hold heparin and decrease purge heparin to $\frac{1}{4}$ strength



Day 9: Ramp study

Turn down ECMO flow

Pulsatility > 24hrs

Low dose pressors

Improving

Follow heart function

Blood pressure



Off ECMO after 9 days

- 9 days on VA ECMO
- Liver and Kidneys recover
- R BKA
- Excellent neurologic recovery – articulate and intelligent
- Went on to be instructor for her ballet school!



- Brain has greater regenerative capacity than we previously thought
- Longer is better
- Multimodal evaluation
 - Exam
 - Imaging – serial CT, MRI when able
 - Electric – EEG, evoked potentials
 - Biologic markers – neuron specific enolase
- Neuro EMCO Pathway
 - All eCPR
 - All patients with a known severe neurologic injury
 - All patients with severe exam
- Find markers that can justify continued support in patients without a clear marker that suggests a poor outcome

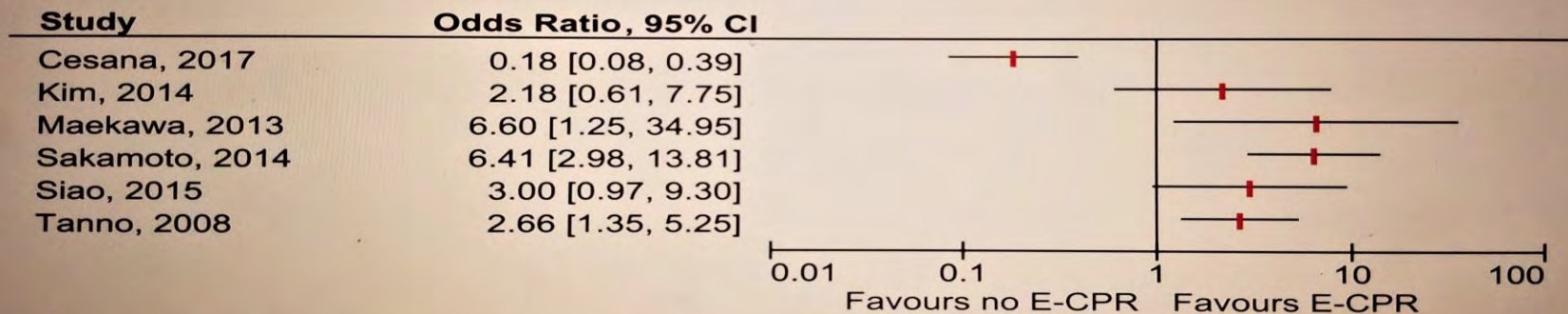


Summary of current evidence

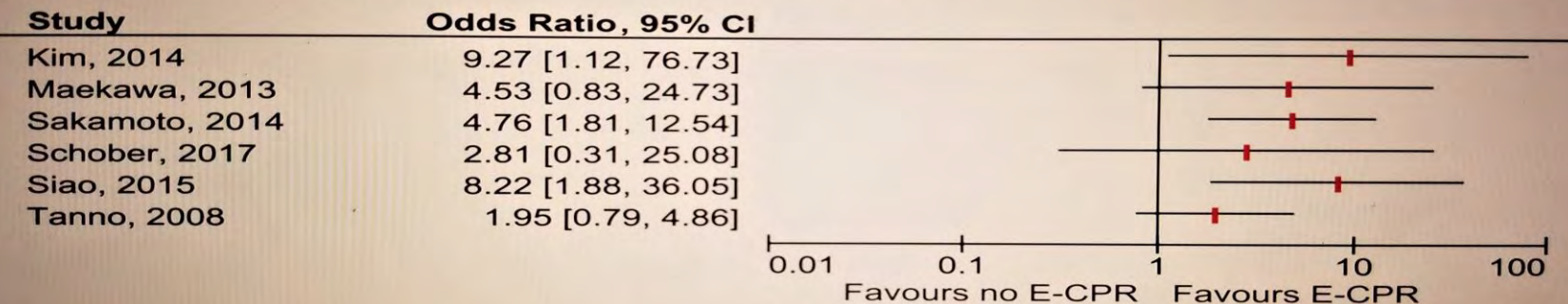
- Case series, cohort studies
 - Show potential survival benefit to eCPR
 - Show improved neurologic outcome with eCPR
- Multiple ongoing prospective randomized trials



B Adult OHCA: Long-term survival



D Adult OHCA: Long-term favorable neurological outcome



M.M. Beyea et al.

Resuscitation 130 (2018) 146–158

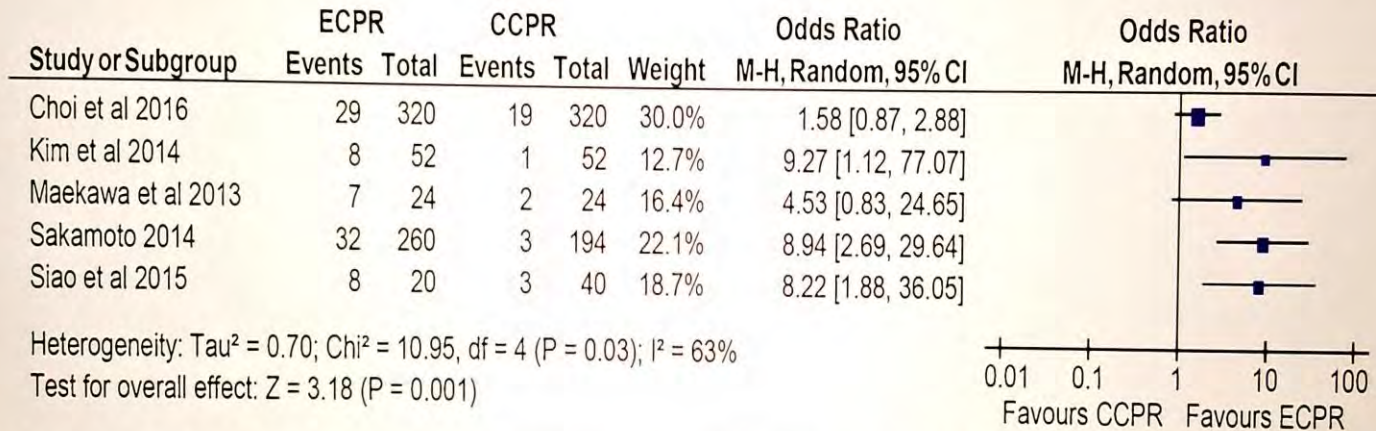
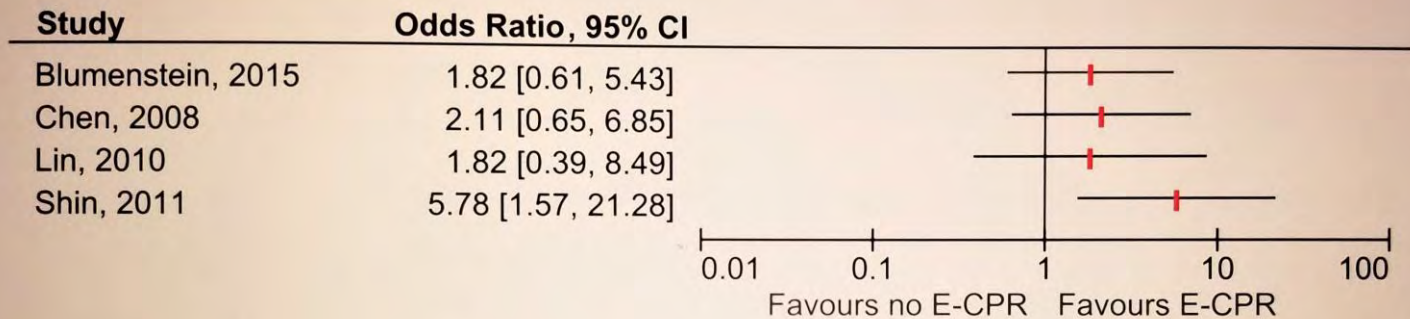


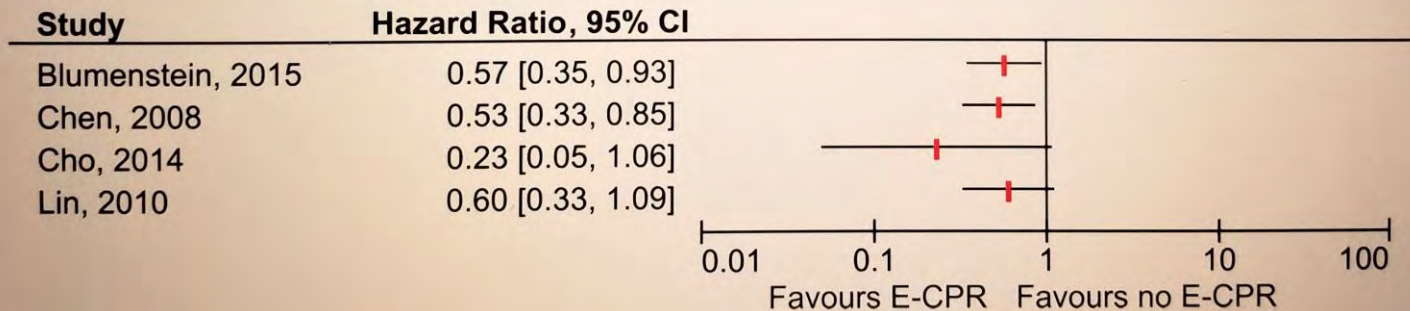
Fig. 2. Forest plot reporting the survival to discharge with good neurologic outcome (CPC1/2) among the 5 full-text studies with low risk of bias. For this analysis, the propensity score matched results were used for Maekawa et al. (2013), Kim et al. (2014), and Choi et al. (2016). Sakamoto et al. (2016) and Siao et al. (2015) both used a logistic regression analysis. Only one of these five studies, Sakamoto et al 2016, was a non-randomized, multicentre, prospective cohort design.



D Adult IHCA: Long-term favorable neurological outcome



E Adult IHCA: Survival analysis



Ongoing studies – results in soon

- Inception
 - Maastricht University Hospital Center, Netherlands multicenter
 - 2019 finish: 110 patients
- APACAR 2
 - Assistance Publique – Hopitaux Paris
 - Finish March 2020: 210 patients
- Czech study
 - Hyperinvasive Approach in Cardiac Arrest
 - 2019 May: 170 patients
- EROCA
 - University of Michigan - enrolling
- ANCHOR
 - Paris: ECMO for cardiogenic shock in acute myocardial infarction



Q8. In 5 years from now, the use of eCPR will...

- A. Increase
- B. Decrease
- C. No change



Building an eCPR program



- Existing ECMO expertise and experience
- Commitment from administration of resources and money
 - Personnel and training
- Develop clear system that people adhere to
- Rehearse roles in simulation



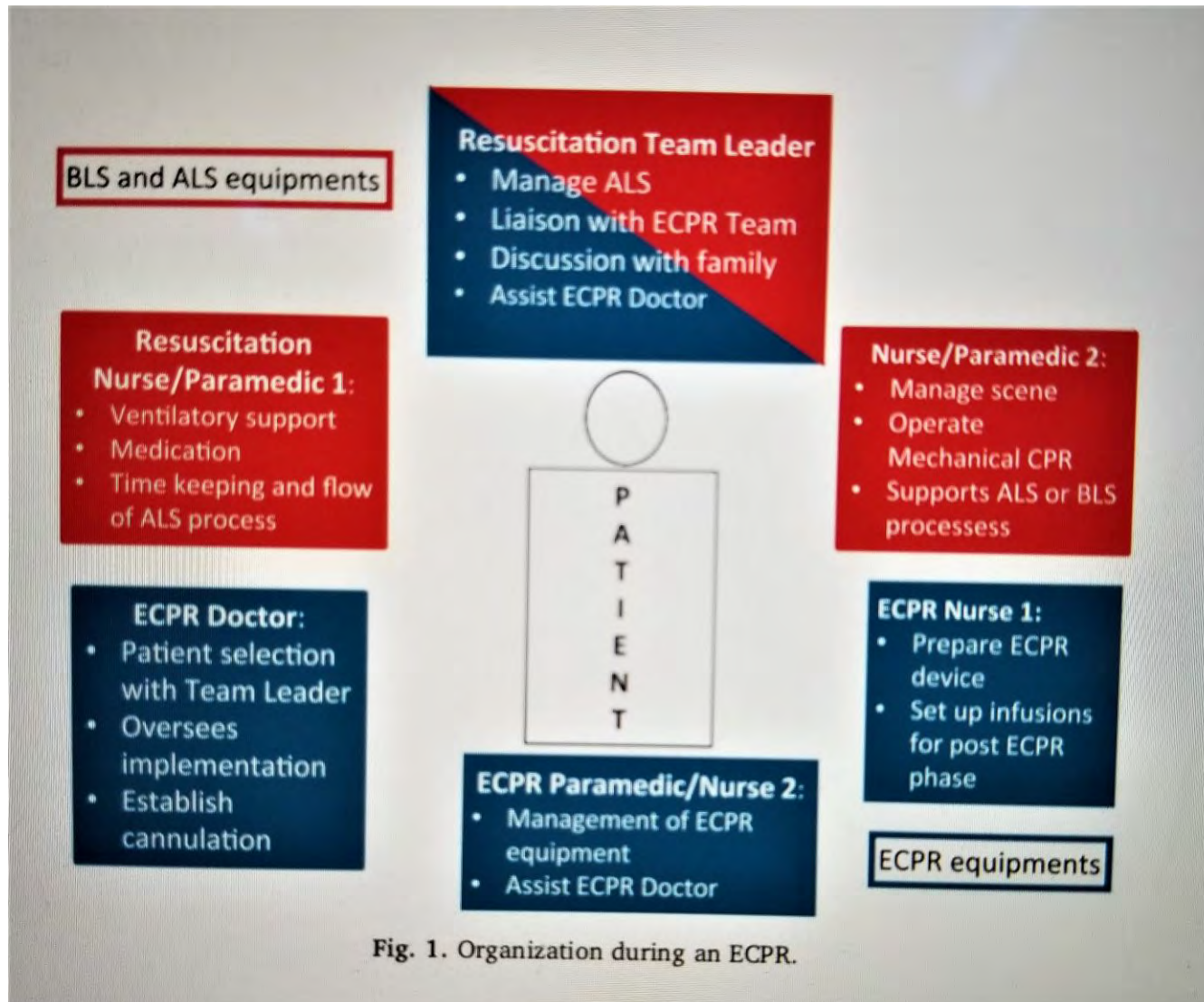


Fig. 1. Organization during an ECPR.

Team Training



- eCPR will be the standard of care for select patients in the near future
- Do we want to set the standard of care ... or wait and play catch up
- Requires significant resources, training, and a high volume ECMO program to do it well

Questions?

The first
Two
People to
Use the
Cardiohelp
In
Hawaii
2011



Erik Osborn
eeosborn@aim.com, mobile 808 294 6863

