Improving Rescue Following Resuscitation

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- No pertinent disclosures

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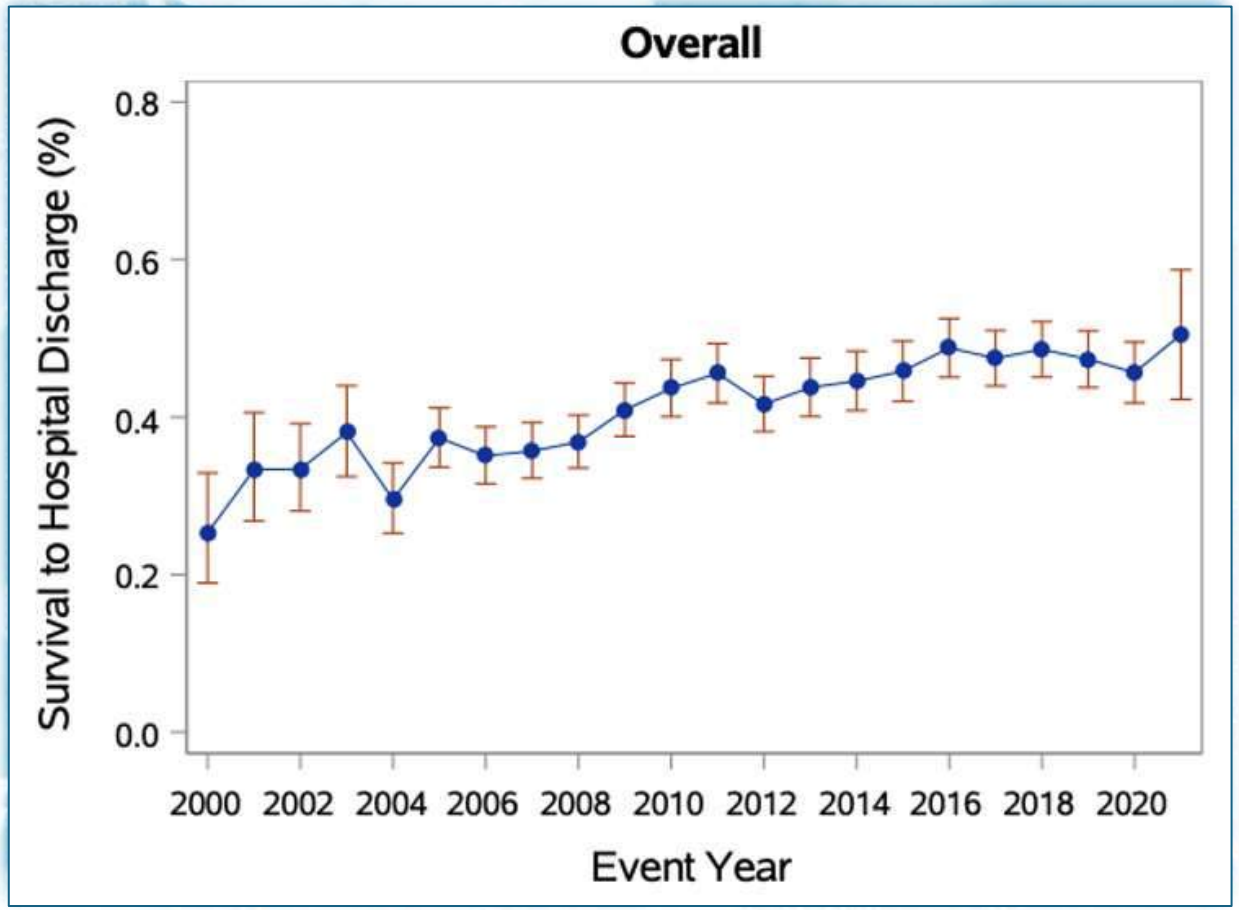
Pediatric cardiac arrest

- Estimated over 15,000 children suffer an in-hospital cardiac arrest in the US per year
- Variable survival based on location, but improving
  - OHCA: ~10-15% survival
  - IHCA: ~50% survival
- Children with heart disease are 2-3 times more likely to have an IHCA than those without



Survival for IHCA as reported to AHA GWTG

Okubo, 2020Berg CCM 2013, Jayaram JAHA 2015, Holmberg 2019, Benjamin Circulation 2018, Matos 2013

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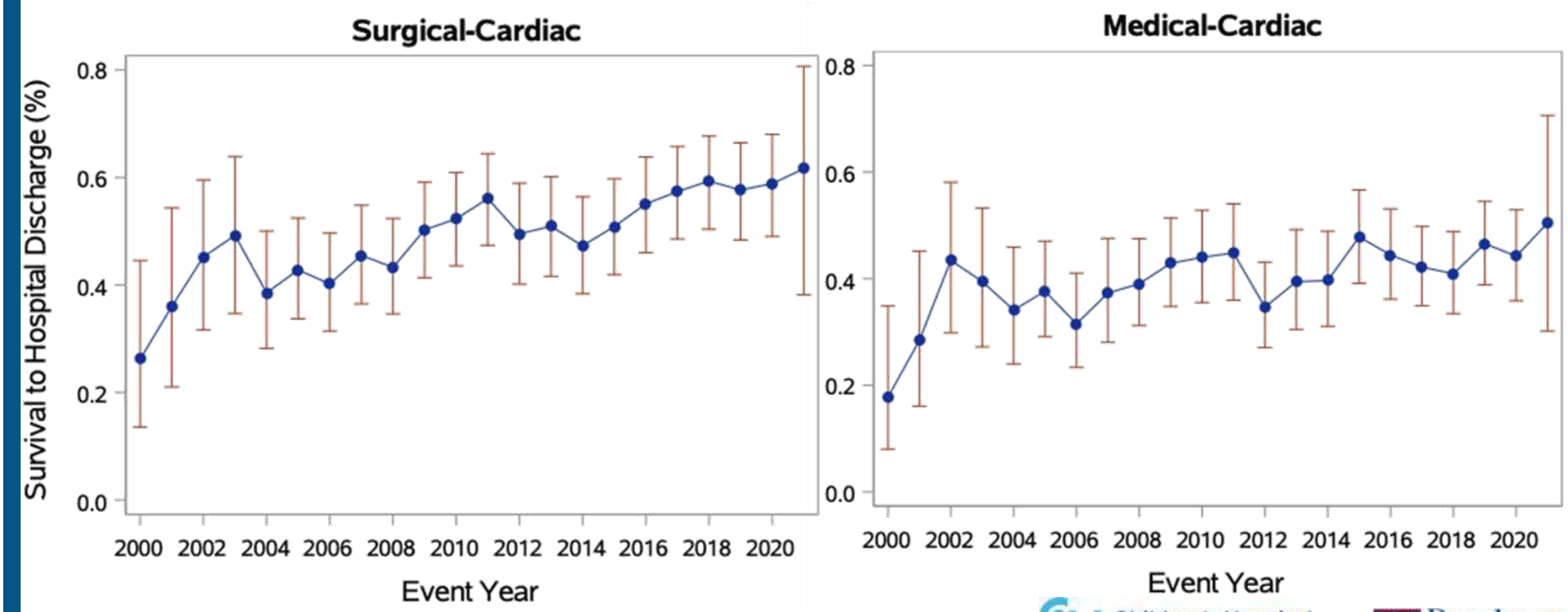
Cardiac arrest in the cardiac population

SURVIVAL FOR IHCA BASED ON POPULATION, AS REPORTED TO AHA GWTG



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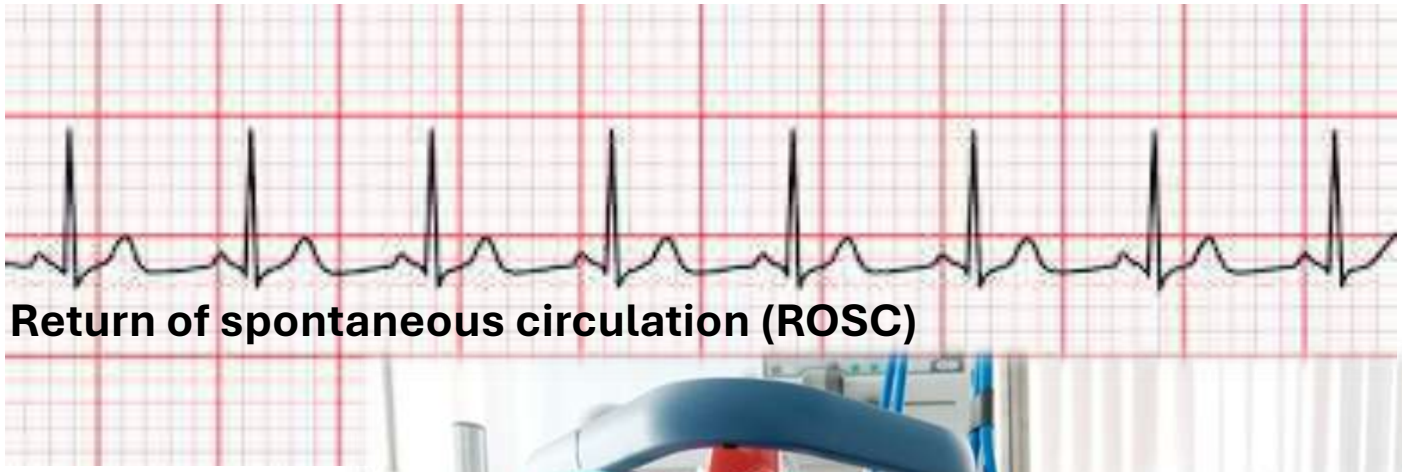
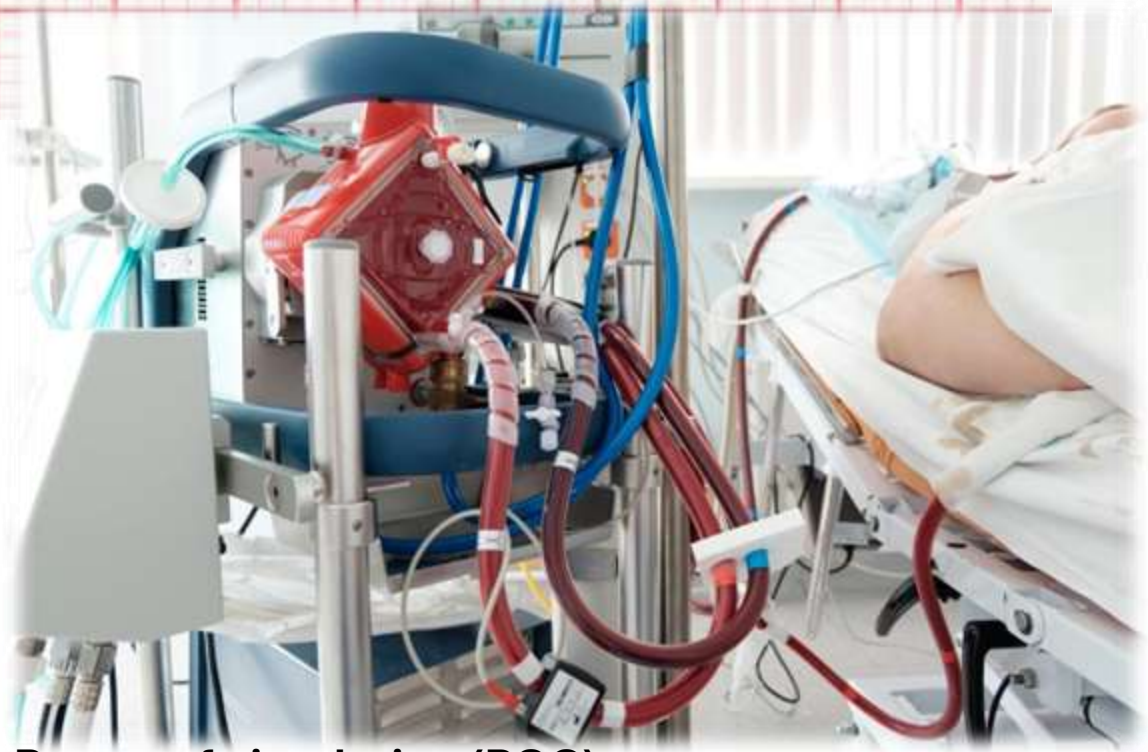
Return of circulation… now what?



Return of spontaneous circulation (ROSC)



Return of circulation (ROC)

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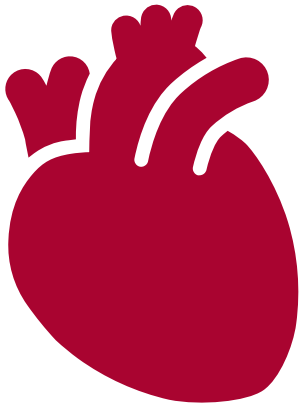
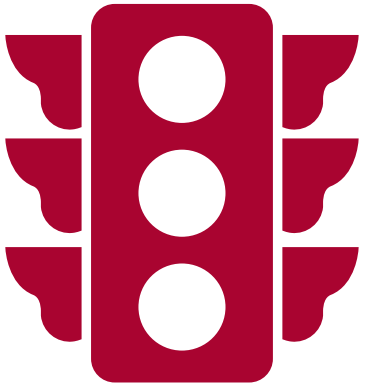
Another battle begins… Post cardiac arrest syndrome

POST CARDIAC ARREST SYNDROME (PCAS)

Brain Injury	Myocardial Dysfunction	Ischemic-Reperfusion Response	Persistent Pathology





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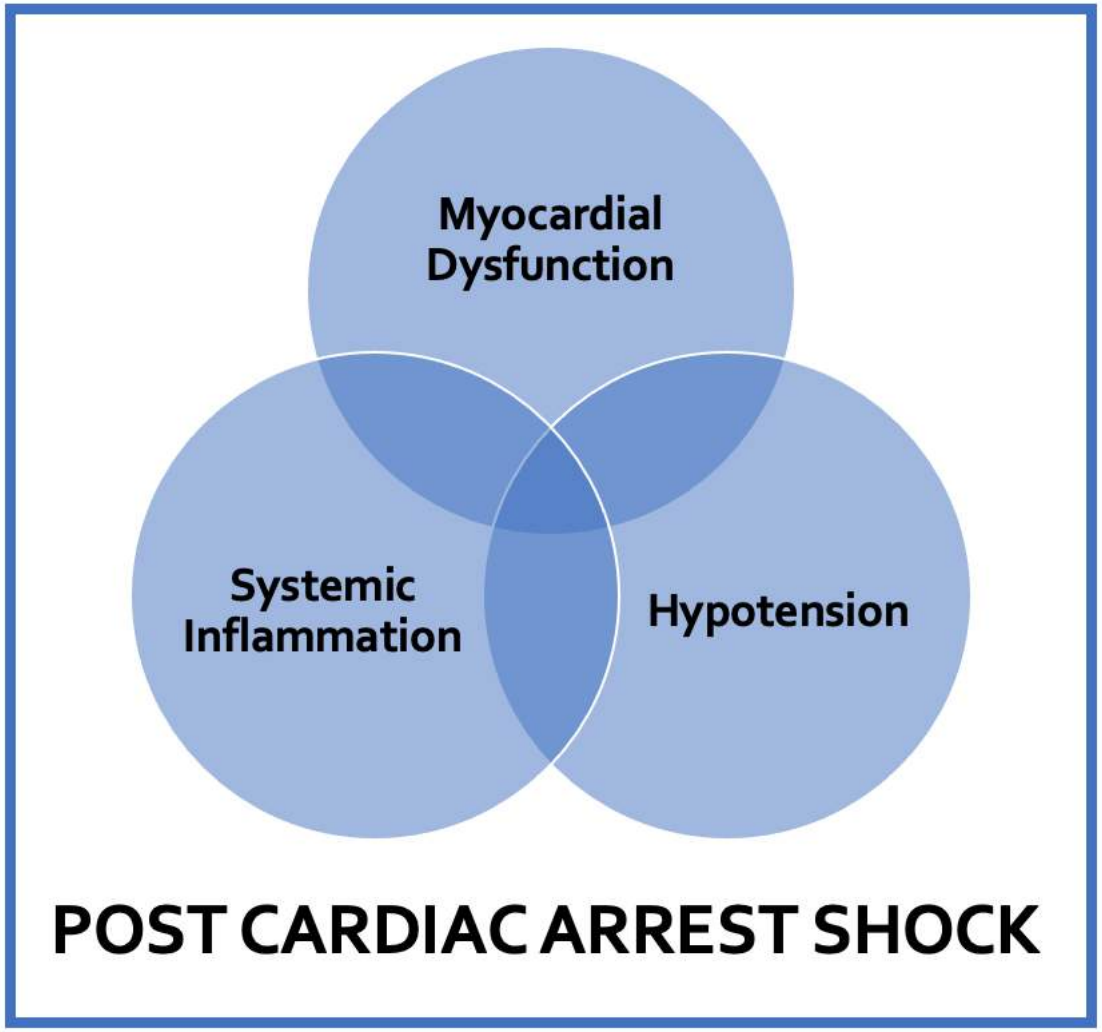
Topjian AA (Circulation 2019)

Background on PCAS



Brain & Organ Injury

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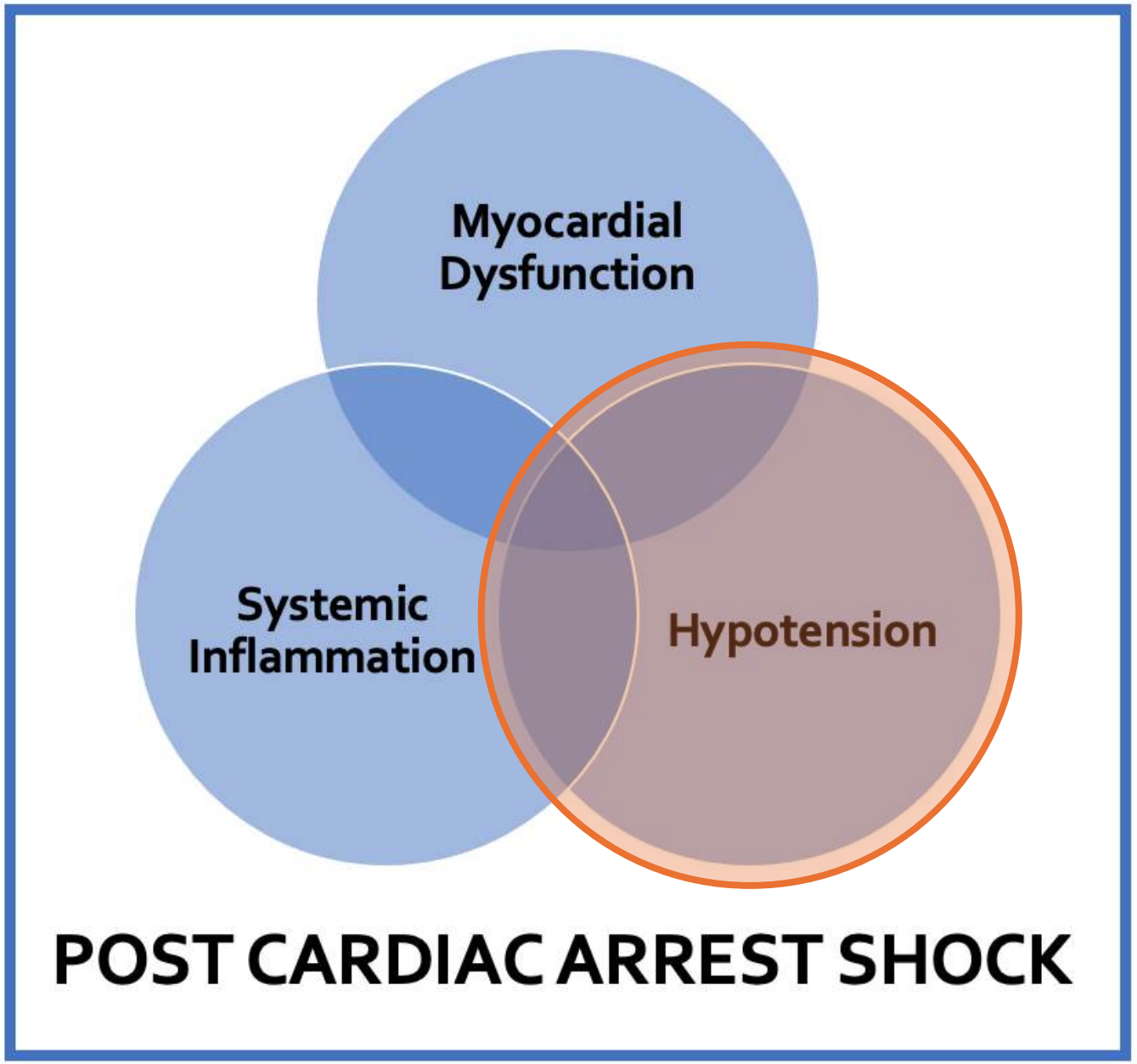
Myocardial Dysfunction
Systemic Inflammation
Hypotension
POST CARDIAC ARREST SHOCK

Post-Cardiac Arrest Hypotension

- Hypotension after cardiac arrest is frequent (25-55%)
- Hypotension within 6 hours after cardiac arrest is associated with **mortality** and **worse neurologic outcomes**

HYPOTENSION = SBP <5% for AGE

POST ARREST HYPOTENSION IS ASSOCIATED WITH MORTALITY AND LIKLEY MODIFIABLE

- Threshold for hypotension should be HIGHER
  - SBP <10% and DBP <50% early after arrest was associated with mortality

Topjian AA (CCM 2014), Topjian AA (JAMA Peds 2017), Topjian AA (Resuscitation 2019), Laverriere E (PCCM 2020), Topjian AA (CCM 2014), Liu R (CCM 2024), Gardner MM (CCM 2024)

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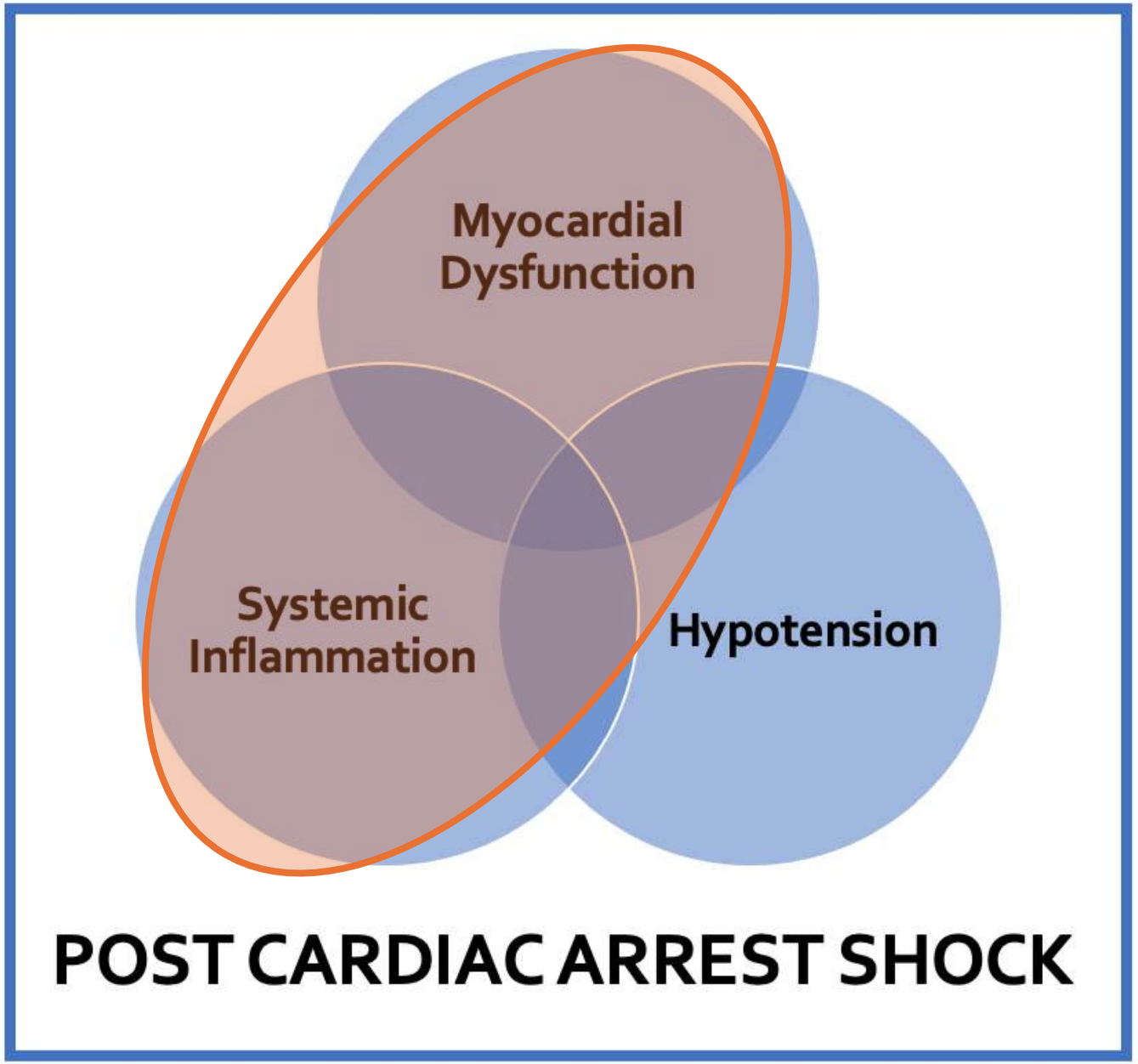


Post-Arrest Systemic Inflammation

- Sepsis-like syndrome with elevated levels of IL-6, TNF-α and cytokines in adults
  - Limited pediatric studies:
    - sRAGE, IL-6, and granzyme B were associated with mortality in ARDS
    - Ciliary neurotrophic factor and IL-17 associated with 6-month neurologic outcome
- Inflammation may also manifest as fever
  - Despite mixed results from trials, targeted temperature management is likely beneficial (36°C, if not 33°C)

DO WE NEED BETTER EVIDENCE TO IDENTIFY & TREAT SYSTEMIC INFLAMMATION?

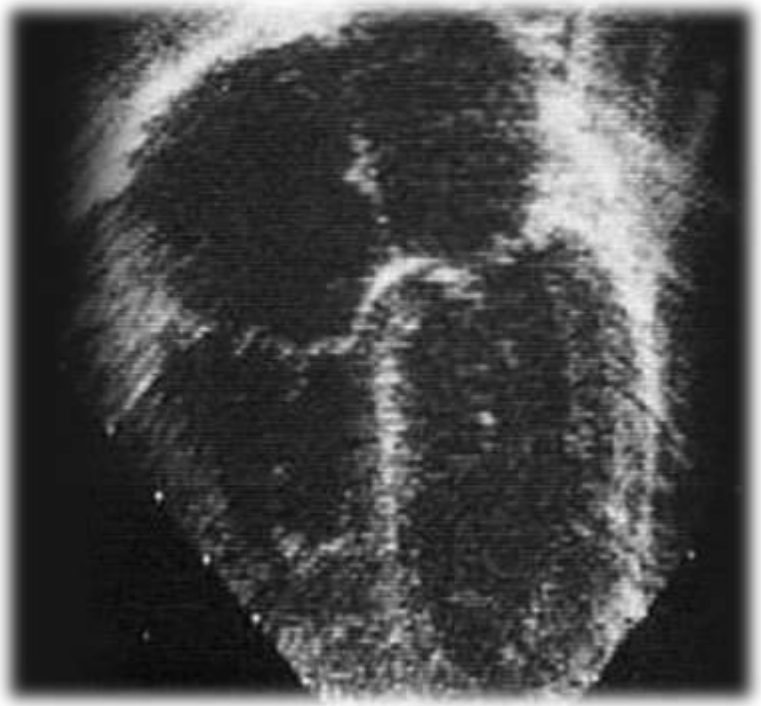
Adrie C (Circulation 2002)
Perberdy MA (Resuscitation 2016)
Moler FW (NEJM, 2015)

Adrie C (Current Opin Crit Care 2004)
Kernan K (Resuscitation 2021)
Moler FW (NEJM, 2017)

Bro-Jeppesen J (Resuscitation 2017)
Gardner MM (Resuscitation, 2022)
Harhay MO (NEJM Evidence, 2022)

Myocardial Dysfunction

- Laurent *et al*. first described myocardial dysfunction in adult OHCA
- Two small pediatric studies:
  - Lower ejection fraction and circumferential fiber shortening associated with mortality
- Largest retrospective study (n=124) found impaired function present in 37% of patients
  - Worse function was associated with mortality



DO WE CONSISTENTLY AND SUFFICIENTLY ASSESS MYOCARDIAL DYSFUNCTION?

Laurent I (JACC, 2002)
Conlon T (PCCM, 2015)

Cecchia P (Resuscitation, 2002)
Gardner (Resuscitation, 2024)

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My dream for post-cardiac arrest care…

- After suffering a cardiac arrest, a child should receive personalized treatment to minimize secondary organ injury
  - Based on their degree of inflammation, myocardial dysfunction, etc.
  - More work is needed to understand these processes

Undifferentiated Children with PCAS

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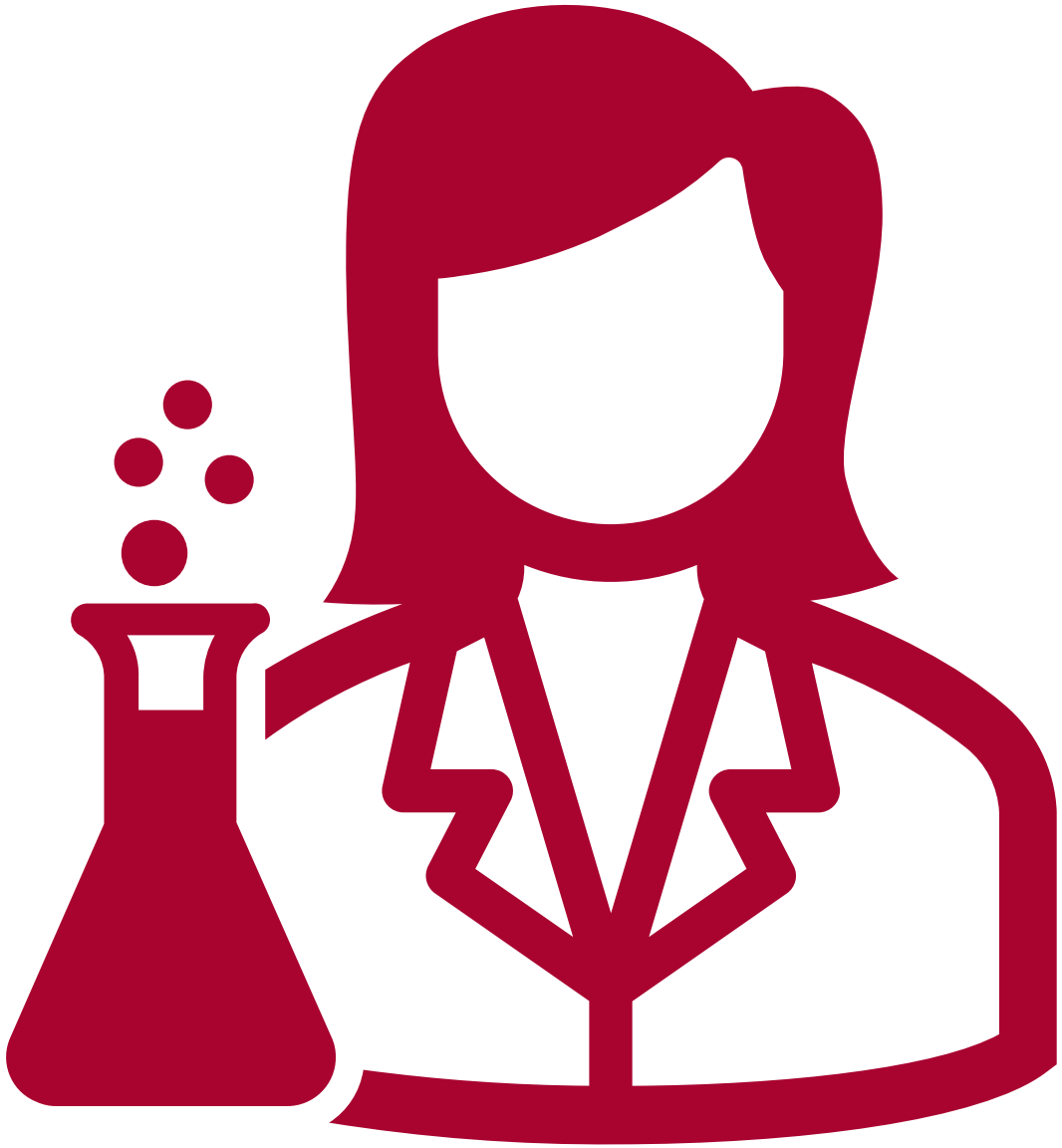

You just talked a lot of science…

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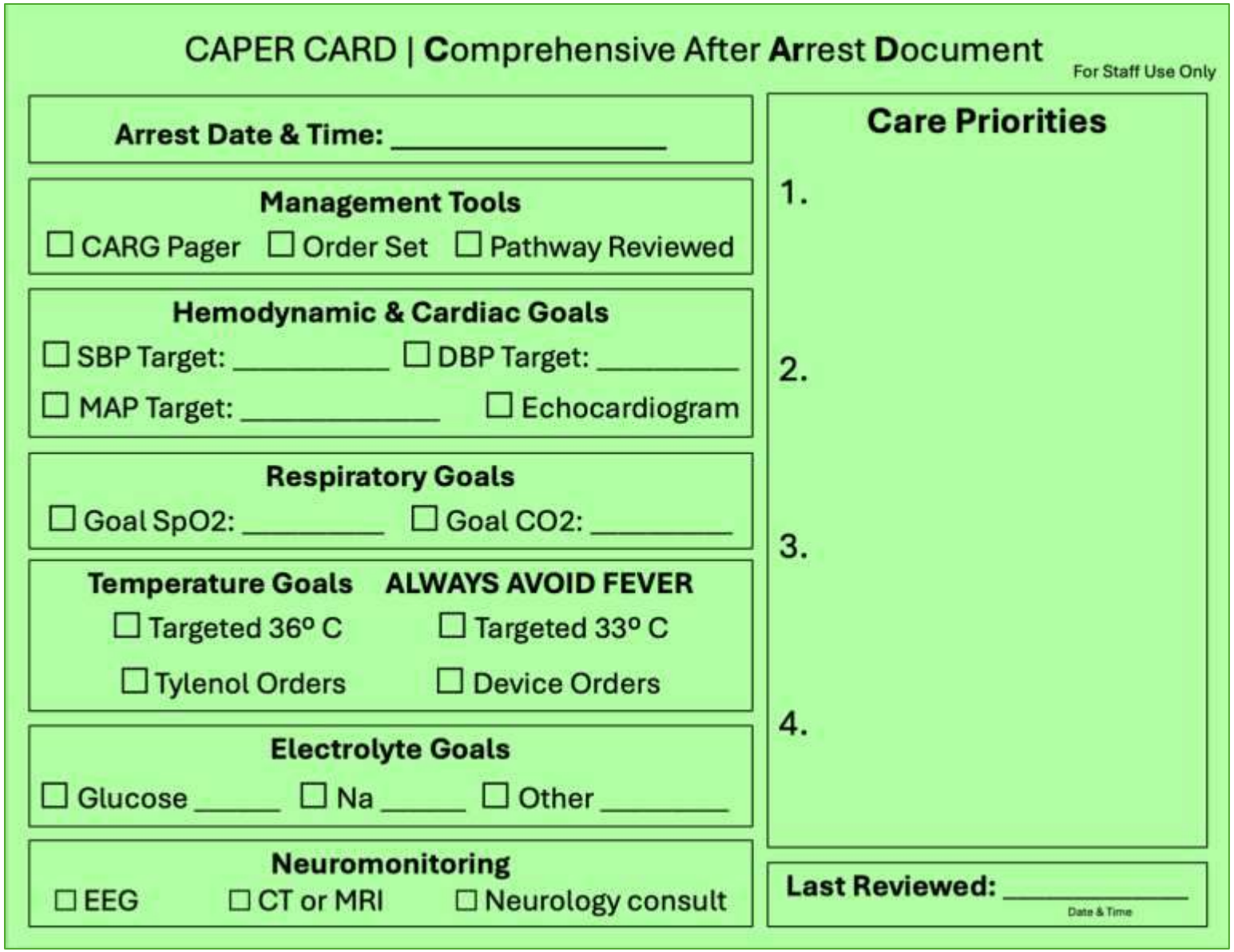
Moving the science to the bedside…

- Implemented a bedside tool (Fall 2025)
  - Initiated within 12 hours of arrest
- Establish understanding among team members for priorities and targets
- Allows for teaching and common language



CAPER CARD | **C**omprehensive After **A**rrest **D**ocument

For Staff Use Only

Arrest Date & Time: _____

Management Tools

☐ CARG Pager ☐ Order Set ☐ Pathway Reviewed

Hemodynamic & Cardiac Goals

☐ SBP Target: _____ ☐ DBP Target: _____

☐ MAP Target: _____ ☐ Echocardiogram

Respiratory Goals

☐ Goal SpO2: _____ ☐ Goal CO2: _____

Temperature Goals **ALWAYS AVOID FEVER**

☐ Targeted 36° C ☐ Targeted 33° C

☐ Tylenol Orders ☐ Device Orders

Electrolyte Goals

☐ Glucose _____ ☐ Na _____ ☐ Other _____

Neuromonitoring

☐ EEG ☐ CT or MRI ☐ Neurology consult

Care Priorities

1.

2.

3.

4.

Last Reviewed: _____

Date & Time

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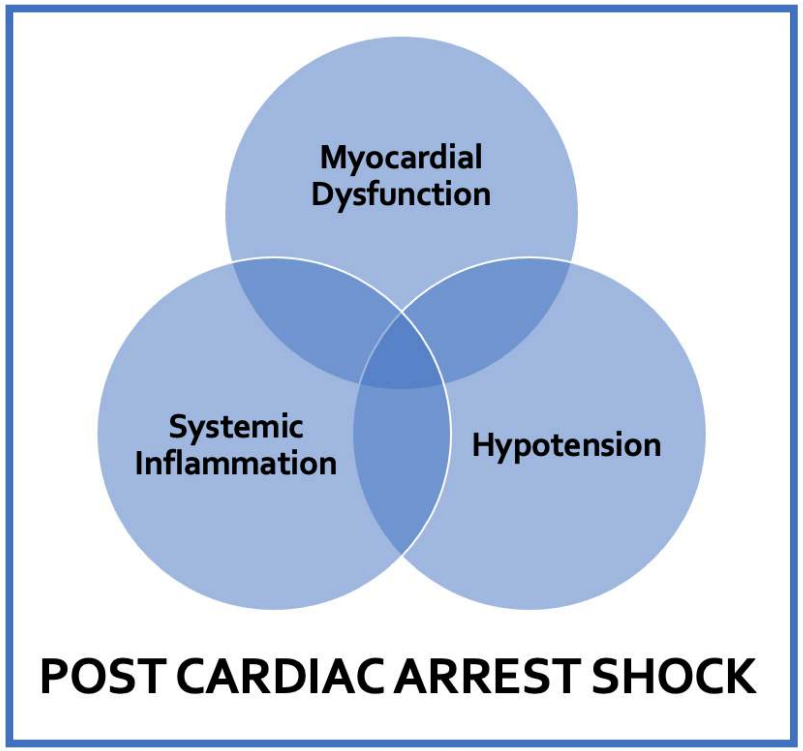
Future Directions



Minimize Brain & Organ Injury

IMPROVE POST-CARDIAC ARREST OUTCOMES

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The best CPR… is no CPR

JAMA Pediatrics | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Preventing Cardiac Arrest in the Pediatric Cardiac Intensive Care Unit Through Multicenter Collaboration

JAMA Network Open

Original Investigation | Critical Care Medicine

Sustained Performance of Cardiac Arrest Prevention in Pediatric Cardiac Intensive Care Units

But when CPR starts… get the circulation back

- Improving science for:
  - High-quality, physiology-directed CPR
  - Epinephrine dosing
  - Utilization of extracorporeal support (E-CPR)

2020 AMERICAN HEART ASSOCIATION GUIDELINES FOR CARDIOPULMONARY RESUSCITATION AND EMERGENCY CARDIOVASCULAR CARE

Part 4: Pediatric Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care

Mueller D (JAMA Open, 2024)
Alten J (JAMA, 2022)
Topjian AA (Circulation, 2020)

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Rescue after Resuscitation

- Children with heart disease are more at risk for cardiac arrest
- After cardiac arrest, the second resuscitation begins:
  - Limit fever and hypotension
  - Assess for myocardial dysfunction
  - Consider systemic inflammation
- Prevention and short arrest duration are crucial

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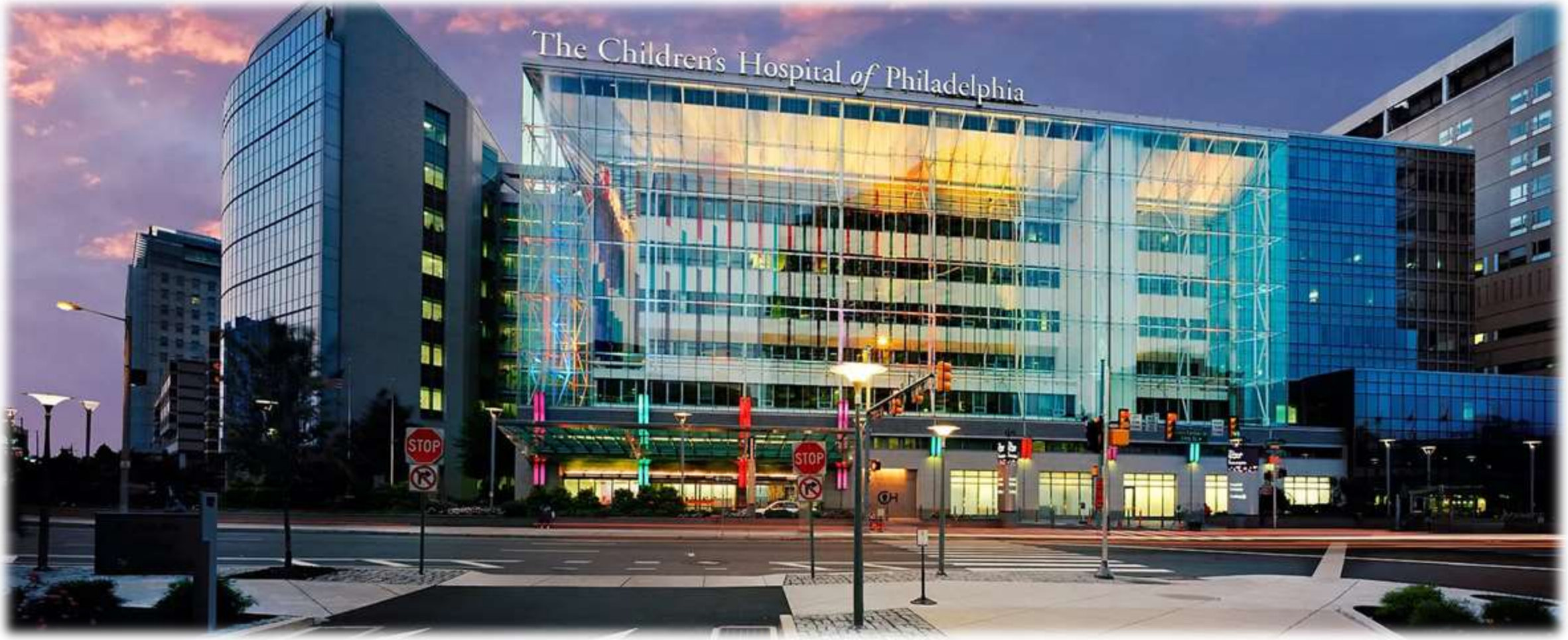
Thank You!



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