Implementation of Extracorporeal Cardiopulmonary Resuscitation (eCPR) Guidelines for the Hospitalized Adult: A Doctor of Nursing Practice Scholarly Project

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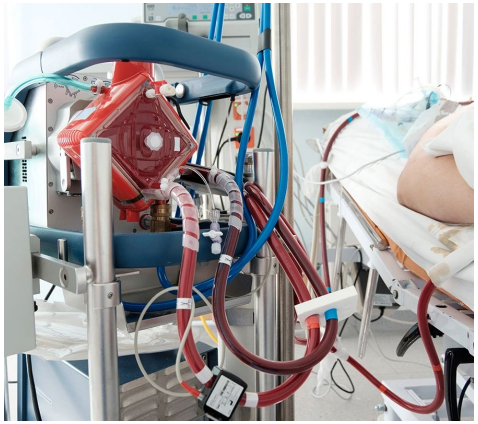
Disclaimer Statement

The views expressed herein are those of the authors and do not reflect the official policy or position of the US Army Medical Department, the US Army Office of the Surgeon General, the Department of the Army, the Department of Defense, or the US government.

Definitions

- **Extracorporeal Membrane Oxygenation (ECMO):** Mechanical circulatory device to provide Cardiac and or Pulmonary support by way of oxygenation and gas exchange of the patient's blood outside of the body and returning it back to the body via a centrifugal pump.
- **Extracorporeal Cardiopulmonary Resuscitation (eCPR):** The application of VA-ECMO during cardiopulmonary resuscitation to re-establish systemic perfusion by artificial means
- **Low Flow State:** State of systemic perfusion carried out by external cardiac massage or chest compressions during cardiopulmonary resuscitation that is considered inadequate to sustain life.



Background and Significance

- More than 436,000 deaths occur from Cardiac Arrest each year (*What Is Cardiac Arrest?*, n.d.).
  - Annual Economic Productivity Loss $10.2 Billion (Coute et al., 2021).
- Cardiac Arrest events deemed refractory to conventional efforts have a high-mortality
- Despite high-quality efforts in advanced resuscitation, survival to discharge of patients experiencing cardiac arrest is 25% (Anderson et al., 2019)

(Out-of-Hospital Chain of Survival, n.d.)

Background and Significance (cont.)

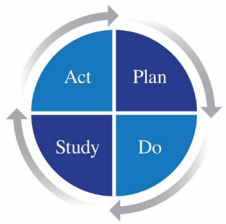
- In the last decade, the application of VA-ECMO or eCPR into the resuscitation efforts has become a promising alternative
- ECMO provides artificial systemic perfusion by a centrifugal pump and oxygenator to provide oxygenation and gas exchange
- Initiation of ECMO during CPR provides re-establishment of systemic perfusion while reversible causes are identified

Background and Significance (cont.)

- For eCPR to be effective, ECMO should be established as soon as possible
- Low flow states persisting greater than 22 minutes yields poor patient outcomes (Wengenmayer et al., 2017).
- ELSO Guidelines recommend initiation of eCPR within 10-20 minutes
- AHA updated Clinical Practice Guidelines on Advanced Resuscitation Recommends *"Use of ECPR for patients with cardiac arrest refractory to standard ACLS is reasonable in select patients when provided within an appropriately trained and equipped system of care."* (Perman et al., 2023)

EBPQI Framework: Iowa Model

- Step 1: Identify an issue
- Step 2: Form a question
- Step 3: Form a team
- Step 4: Assemble, appraise, and synthesize the evidence
- **Step 5: Design and pilot the practice change**
- **Step 6: Integrate and sustain the practice change**
- Step 7: Disseminate results



(Iowa Model Collaborative, 2017)

Step 1: Identify An Issue

- Local Problem
  - Level 1 Trauma Academic Medical Center in Southeastern United States
    - eCPR is performed and implemented but is used inconsistently and rarely instituted in a timely and effective manner
    - While eCPR is available and performed, there is a notable lack of awareness and knowledge regarding its use and accessibility
    - The institution lacks a standardized process for an otherwise complex procedure

Step 2: Form a Question

In the hospitalized adult who experiences cardiac arrest refractory to conventional cardiopulmonary resuscitation, what are the best practices for the development of an eCPR practice guideline to improve patient outcomes?

Step 3: Form a Team

- Primary DNP Team
  - DNP Chair
    - Dr. Beth Quatrara, DNP, APRN, CMSRN, ACNS-BC
  - Second Reader
    - Dr. Terri Yost, PhD, RN, FNP-BC
  - Practice Mentor(s)
    - Brian Clouse MSRC, RRT, CES-A, CES-P & Dustin Money, RRT-ACCS
- ECPR Subcommittee
  - Dr. Leora Yarboro, Cardiac Surgery, Dr. Jared Beller, MD, Cardiac Surgery, Dr. William Brady, ED/EMS Medical Director, Dr. Akram Zaaqoq, MD, Dr. Michael Mazeffi, MD Dr. Jonathan Curley TCV Intensivist, MD, Emily Schneiderman APP Manager, Michelle Dawson APP Fellowship Director, Lindsey Tyson, ECMO Specialist/Education, Matt Heinrick, MET Team Manager
- Resuscitation Committee
  - Dr. William Brady, EMS/ED Director, Rebekah Billings, Resuscitation Coordinator for Life Support Learning Center, Nelson Figueroa ED Administration, and Dina Hood, ED CNS

Step 4: Assemble, Appraise, & Synthesize the Evidence

- Databases:
  - PubMed, Web of Science (WOS), Excerpta Medica Database (Embase), and Cumulative Index of Nursing and Allied Health Literature (CINAHL)
- Search Terms: ECPR, ECMO CPR, Extracorporeal Membrane Oxygenation CPR, Resuscitation, Neurological Outcomes, CPG, Clinical Practice Guideline, Protocol and Policy
- Limitations:
  - Published between 2017 and 2024

Is there sufficient evidence?

Major Conclusions:

- eCPR is beneficial for the hospitalized adult who is in refractory cardiac arrest
- Necessity for standardization and organization for timely and efficient ECMO initiation
- Education and training are essential for effective eCPR

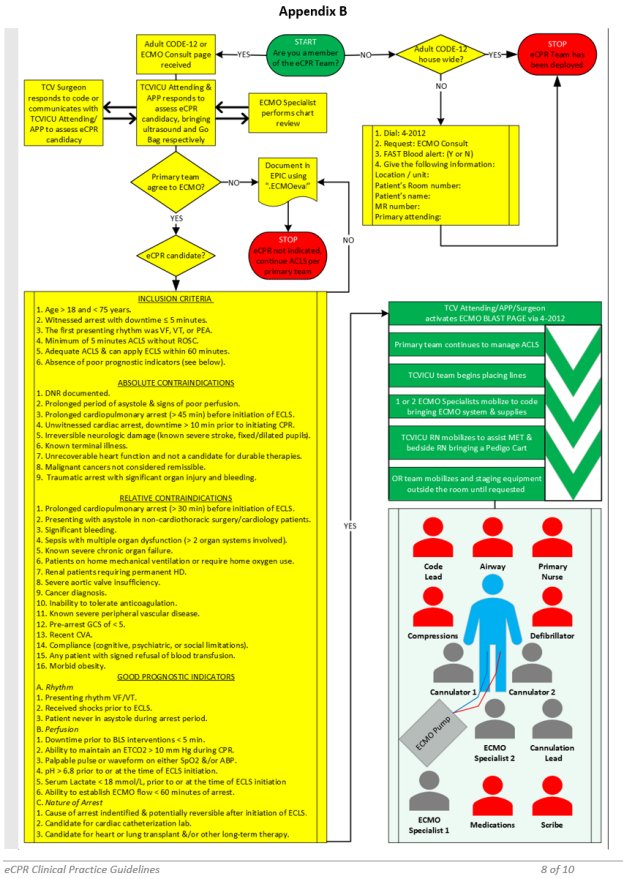
Step 5: Design and Pilot the Practice Change

Project Purpose

Catalyzing the implementation of eCPR practice guidelines for the hospitalized adult through a cross-functional team collaborative training initiative

Step 5: Design and Pilot the Practice Change (cont.)

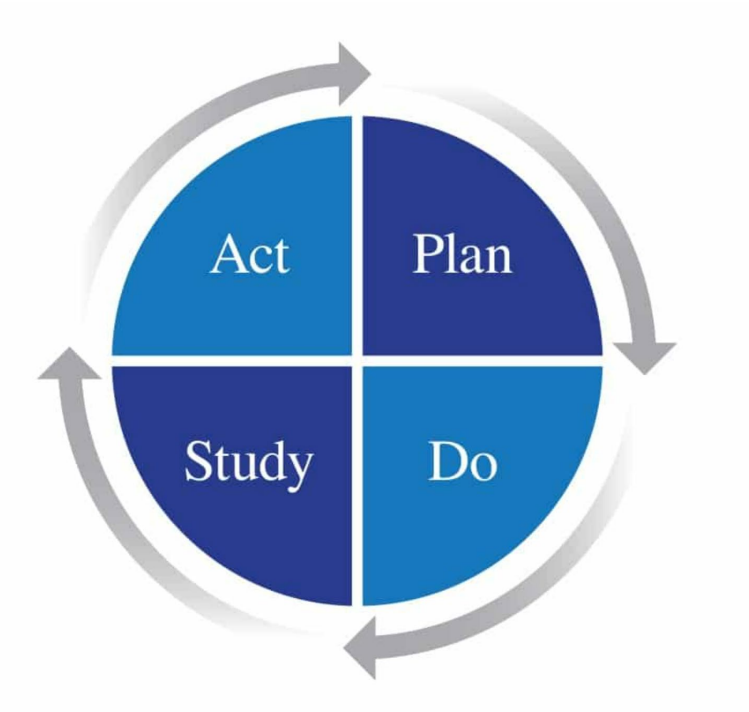
- What is the ECPR Practice Guideline?
  - A document that provides the background and rationale for the guidelines
  - Outlines ECPR Process
  - Inclusion/Exclusion
  - Education and data collection opportunities



Step 5: Design and Pilot the Practice Change (cont.)

- Methods:
  - Process improvement through creation of eCPR Guidelines, eCPR Response Bag, integration of Mechanical Chest Compressor, & Cannulation Mannequin
  - System-wide collaboration with institutional resuscitation committee for eCPR guideline recommendations & approval
  - Operationalization of the eCPR Guidelines through simulation-based training

Step 5: Design and Pilot the Practice Change (cont.)



Step 5: Design and Pilot the Practice Change (PDSA Cycle 1)

- Plan
  - Conduct simulation 1 with:
    - Participants fully aware of event with role card distribution
    - Maximal prompting & direction
    - ECPR Guidelines visible to participants
    - Resources available at bedside
- Do
  - Conduct Simulation during Mid Afternoon on CTICU Simulation Room
  - High Fidelity Mannequin, Simulation Equipment, ECPR Bag, Mechanical Chest Compressor Utilized
- Study
  - Structured participant debrief
  - Recorded video analysis
- Act
  - Schedule next tier simulation with increasing difficulty

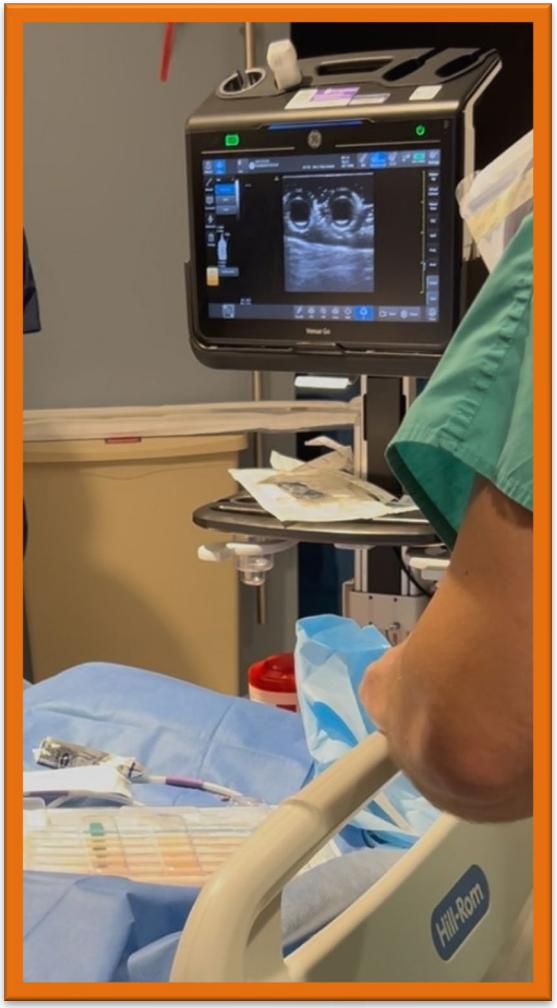
Step 5: Design and Pilot the Practice Change (PDSA Cycle 2)

- Plan
  - Conduct simulation 2 with:
    - **Partial participant awareness,**
    - **No prompting or direction**
    - **No guideline visible**
    - **Access to resources only upon request (ECPR Response Bag & Mechanical Chest Compressor)**
- Do
  - Conduct Simulation during Mid Afternoon on CTICU Simulation Room
  - High Fidelity Mannequin & Simulation Equipment
- Study
  - Structured participant debrief
  - Recorded video Analysis
- Act
  - Schedule next tier simulation with increasing difficulty

Step 5: Design and Pilot the Practice Change (PDSA Cycle 3)

- Plan
  - Conduct simulation 3 with:
    - **No participant awareness**
    - No prompting
    - No guideline visible
    - Access to resources only upon request (ECPR Response bag & Mechanical Chest Compressor)
- Do
  - Conduct Simulation **during early morning hours (end of night shift)** on CTICU Simulation Room
  - High Fidelity Mannequin & Simulation Equipment
- Study
  - Structured participant debrief
  - Recorded video analysis
- Act
  - **Schedule education and training**
  - **Sharing of results to resuscitation committee & Heart and Vascular team**

Step 5: Design and Pilot the Practice Change (cont.)



Step 5: Design and Pilot the Practice Change (cont.)

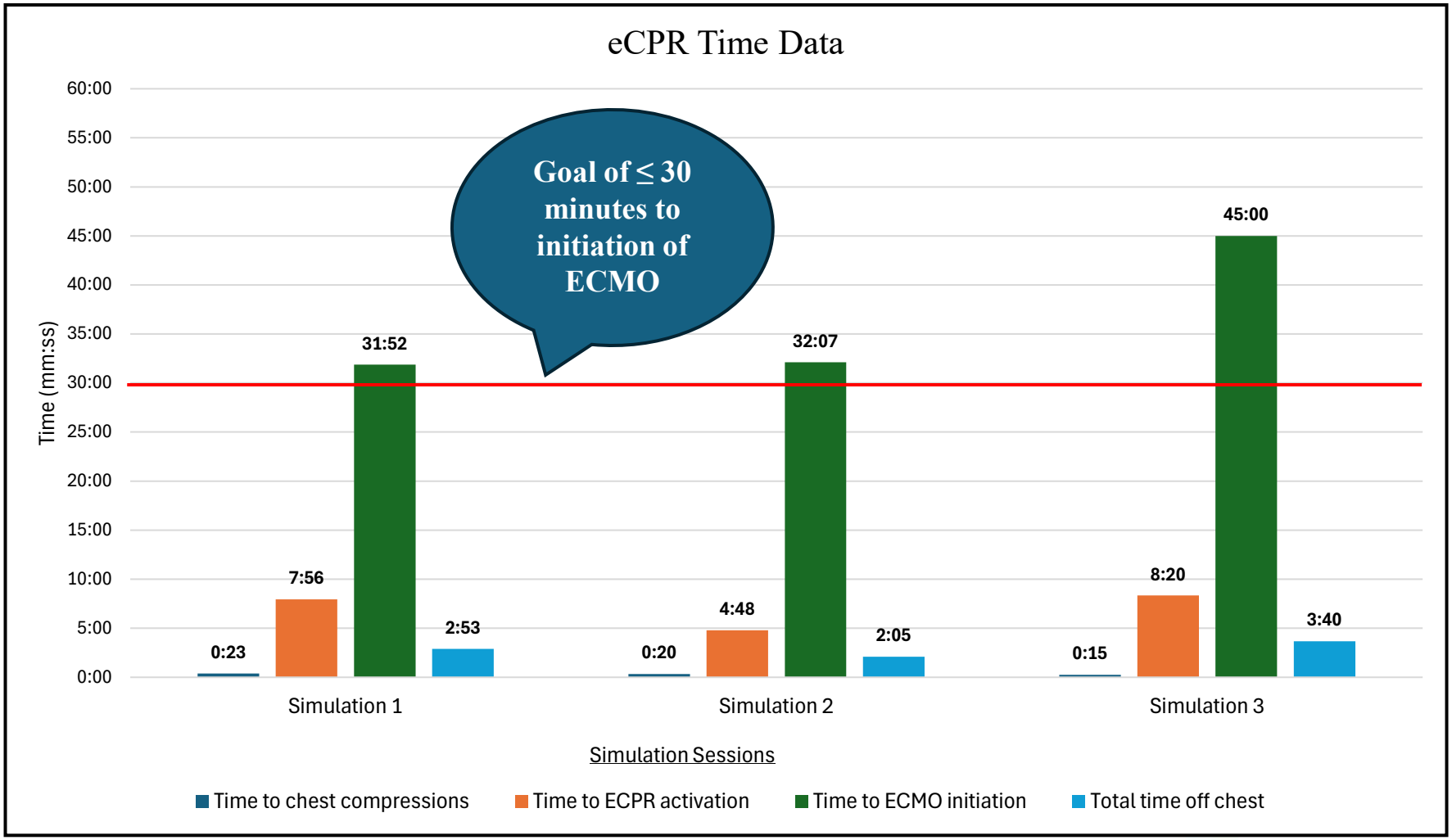
- Performance Measures
  - Yes/No format for:
    - Adherence to Closed-Loop Communication
    - Adherence to eCPR Candidate Selection
    - Use of eCPR Response Bag
    - Use of Mechanical Chest Compressor
- Time Measures
  - Time to:
    - Chest Compressions
    - eCPR activation
    - Initiation of ECMO
      - 30 Minutes or Less
    - Total Time off Chest

Results

eCPR Performance Metrics Across Simulations

Category	Simulation 1	Simulation 2	Simulation 3
Role Adherence	Yes	Yes	No
Closed-Loop Communication	No	Yes	No
Use of ECPR Bag	No	Yes	No
Use of Mechanical Chest Compressor	Yes	No	No
Adherer to eCPR Candidate Selection	Yes	Yes	No

Results



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Discussion

- Time to eCPR activation, role adherence, & use of the candidate selection algorithm are overall positive outcome metrics (66%)
- Improvement Needed:
  - The use of mechanical chest compressor, & eCPR response bag (33%)
- Additional training and simulation needed
  - Many of these areas for improvement could be confounded by the nature of a simulation event and not perceived as 'real'
  - Addressing underlying assumptions that will be further explored
- Demonstrates the initial phases and steps for the solidification of eCPR guidelines

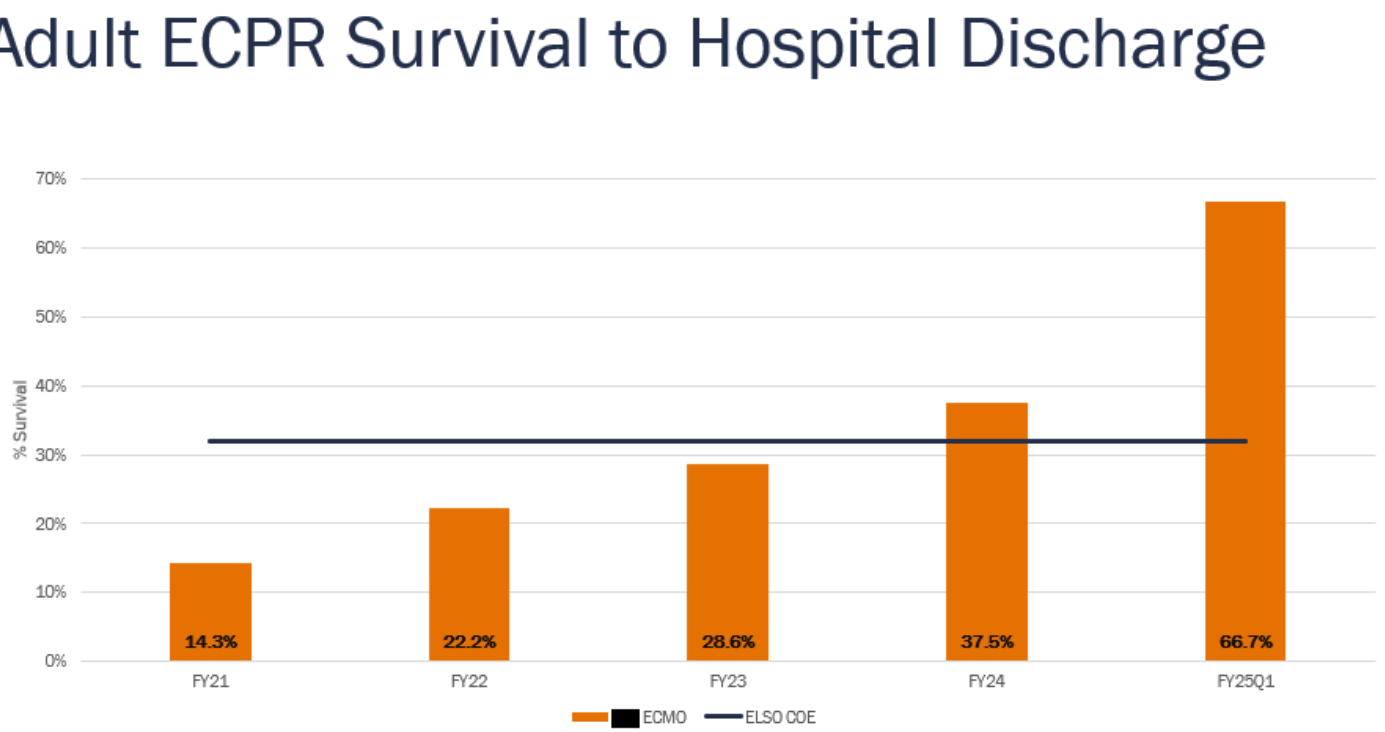
Discussion

Confounding factors worth noting:

- Session 3
  - Simulation fatigue with utilization of the same room
  - 3rd Simulation time of day and shift
  - Automaticity with respect to Cardiac Surgical Unit – Advanced Life Support (CSU-ALS)

Step 6: Sustainability

Project effect on ECPR selection & survival



Step 6: Sustainability

- ECMO Team
  - Provide continuity of the new ECPR practice guidelines
  - Constant supervision and refinement of the process
- CTICU Staff
  - RNs, APPs, and MDs
- Rapid Response Team
  - Provide continuity of the ECPR process

Step 7: Dissemination Plan

- Poster Presentation at the National Association of Clinical Nurse Specialists (NACNS) Annual Conference
- Poster Presentation at the Virginia Association of Clinical Nurse Specialist (VACNS) Annual Conference
- Submit manuscript to the American Society for Artificial Internal Organs (ASAIO) Journal

NACNS INNOVATE 2025 Annual Conference

Serving Patients, Families, VaCNS Virginia Association of Clinical Nurse Specialists Systems & Communities

ASAIO Journal

University of Virginia School of Nursing

Ethical Implications of ECPR

1. Utilitarianism:

- Balancing wider access to ECPR with potential increased mortality rates when criteria are less selective poses an ethical challenge.
- Prioritize ECPR treatment for patients who are most likely to have successful outcomes, maximizing overall benefits.
- Implementing stringent selection criteria means fewer patients receive ECPR, but those treated have higher survival chances.

2. Nonmaleficence:

- Emphasizes avoiding treatments that may cause more harm than good to patients.
- Exclude patients with terminal illnesses, significant comorbidities, or advanced age to prevent unnecessary harm
- Ensures only those who are likely to benefit receive ECPR, aligning with the duty to minimize harm.

3. Beneficence:

- Emphasizes the moral duty to act in the best interest of the patient, promoting their well-being.
- ECPR offers life-saving potential for patients in refractory cardiac arrest who are suitable candidates when conventional CPR is insufficient.
- Utilizing ECPR within capable health systems goes above and beyond standard care, enhancing survival rates and fulfilling the commitment to patient benefit.

Return on Investments

- Cost of Simulation Mannequin
  - Marketed High Fidelity Cannulation Mannequin ($20K-$50K)
  - 10% Ballistics & Penrose Drain (~$450)
- Cost of VA ECMO Management
  - **~$61,560/day**
  - Reduction in **morbidity** and **mortality** with respect to patients experiencing refractory cardiac arrest
- Provides an opportunity to address reputation risks as an ELSO Platinum Center of Excellence
- Potential to enhance staff retention through standardization of eCPR back by evidence-based practice

DNP Scholarly Project Team

- Dr. Beth Quatrara DNP, APRN, CMSRN, ACNS-BC
  - Associate Professor of Nursing, Acute Care CNS Specialty Lead, UVA School of Nursing
    - Faculty Advisor
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  - Associate Professor of Nursing, Family Nurse Practitioner Specialty Lead, UVA School of Nursing
    - 2nd Reader
- Brian Clouse MSRC, RRT, CES-A, CES-P
  - ECMO Services Manager, Heart & Vascular Center, UVA Health
    - Practice Mentor
- Dustin Money RRT-ACCS
  - Senior ECLS Specialist, Heart & Vascular Center, UVA Health
    - Practice Mentor
- Dr. Jared Beller, MD
  - UVA Heart & Vascular Center, Cardiothoracic Surgery

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Questions?

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