An EBP Approach to Managing Post Cardiac Arrest Interdisciplinary Care

Mary Kay Bader RN, MSN, CCNS, CCRN, CNRN, SCRN, FNCS, FAHA
Neurocritical Care CNS – Providence Mission Hospital
Teresa Wavra RN, MSN,CCRN
Cardiac CNS – Providence Mission Hospital
Tauseef Qureshi MD
Medical Director Critical Care/Pulmonary Critical Care Intensivist Providence Mission Hospital
Jon Cline MD
Emergency Department Physician – Providence Mission Hospital
Marne Andersen RN, MSN, CCRN
Nurse Manager Critical Care Services - Providence Mission Hospital

Background

Joint Commission & AHA/ECC

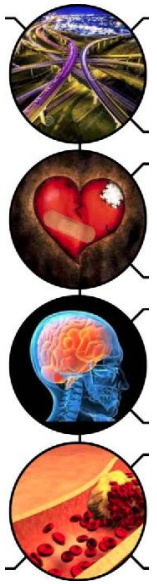
AHA/ECC meets with JC related to Post Cardiac Arrest Syndrome and Post Resuscitation Care

JC: Issued New Performance Standards 1-1-2022

Post Cardiac Arrest Syndrome

Definition: proposed by Nolan et al (2008)- PCAS was defined as a unique and complex combination of pathophysiological processes including four key components

- Systemic Ischemia-Reperfusion Injury
- Myocardial Dysfunction
- Hypoxic Brain Injury
- Underlying Etiology of Cardiac Arrest



Source: Nolan JP, Neumar RW, Adrie C, et al (2008). Post-cardiac arrest syndrome: Epidemiology, pathophysiology, treatment, and prognostication: A scientific statement from the ILCOR; AHAECC, CCVSA; CPR, CCC, & Council of Stroke (Part 1). (2008).Circulation 118:2452-2483. Figure from: Bro-Jeppesen, J. (2019). Post cardiac arrest syndrome : Pathophysiological and prognostic aspects of systemic inflammation and endothelial dysfunction. Doctoral Dissertation.

Background: Scope of the Problem
Joint Commission Resuscitation Standards for Hospitals

Effective January 1, 2022, new and revised requirements related to resuscitation care will be applicable to Joint Commission-accredited hospitals and critical access hospitals (CAHs). The requirements aim to strengthen resuscitation and post-resuscitation care processes in hospitals and CAHs by bringing the standards in closer alignment with contemporary guidelines and evidence.[1]

[1] The Joint Commission. R3 Report: Resuscitation Standards for Hospitals. Issue 29: June 18, 2021.

Standard PC.02.01.20: The hospital implements processes for post-resuscitation care.

EP 1: The hospital develops and follows policies, procedures, or protocols based on current scientific literature for interdisciplinary post–cardiac arrest care. Comprehensive post–cardiac arrest care is necessary to address the systemic effects of the ischemia-reperfusion injury following cardiac arrest. Growing evidence suggests that it is critical for both patient survival and optimal neurological outcome. Yet, significant variations in implementation have been observed across hospitals. JC & AHA strongly recommended the implementation of comprehensive, structured, and multidisciplinary protocols of care to optimize survival and neurological outcome.

EP 2: The hospital develops and follows policies, procedures, or protocols based on current scientific literature to determine the neurological prognosis for patients who remain comatose after cardiac arrest. Because any single method of neuroprognostication has an intrinsic error rate, current guidelines recommend that multiple testing modalities be incorporated into organizations' routine procedures and protocols to improve decision-making accuracy.

Background: Scope of the Problem
Joint Commission Resuscitation Standards for Hospitals

Standard PI.01.01.01: The hospital collects data to monitor its performance.

EP 10: The hospital collects data on the following:
1. The number and location of cardiac arrests (for example, ambulatory area, telemetry unit, critical care unit)
2. The outcomes of resuscitation (for example, return of spontaneous circulation (ROSC), survival to discharge)
3. Transfer to a higher level of care

Standard PI.03.01.01: The hospital compiles and analyzes data.

EP 22: An interdisciplinary committee reviews cases and data to identify and suggest practice and system improvements in resuscitation performance.
1. Review arrests in non-monitored or non-critical care units for any early warning signs of clinical deterioration present prior to arrest
2. Timeliness of staff's response to a cardiac arrest & Rates the quality of cardiopulmonary resuscitation (CPR)
3. Post–cardiac arrest care processes & Outcomes following cardiac arrest

[1] The Joint Commission. R3 Report: Resuscitation Standards for Hospitals. Issue 29: June 18, 2021.

Issue/Background Summary

The Joint Commission has issued a performance standard requiring hospitals to develops and follows policies, procedures, or protocols based on current scientific literature for interdisciplinary post–cardiac arrest care aimed at identifying, treating, and mitigating acute pathophysiological processes after cardiac arrest and includes evaluation for targeted temperature management and other aspects of critical care management as well as addressing neuro prognostication.

Purpose/Aim

1. Establish a multidisciplinary team of physicians, nurses, and ancillary staff to collaborate using an EBP model to review current literature (PICO/References/Evidence tables) and propose target goals, assessment/diagnostics, and interventions for inclusion in a hospital-based Post Cardiac Arrest Care Protocol.
2. Establish performance metrics related to cardiac arrest and post cardiac arrest care to evaluate team performance

Methods/Approach

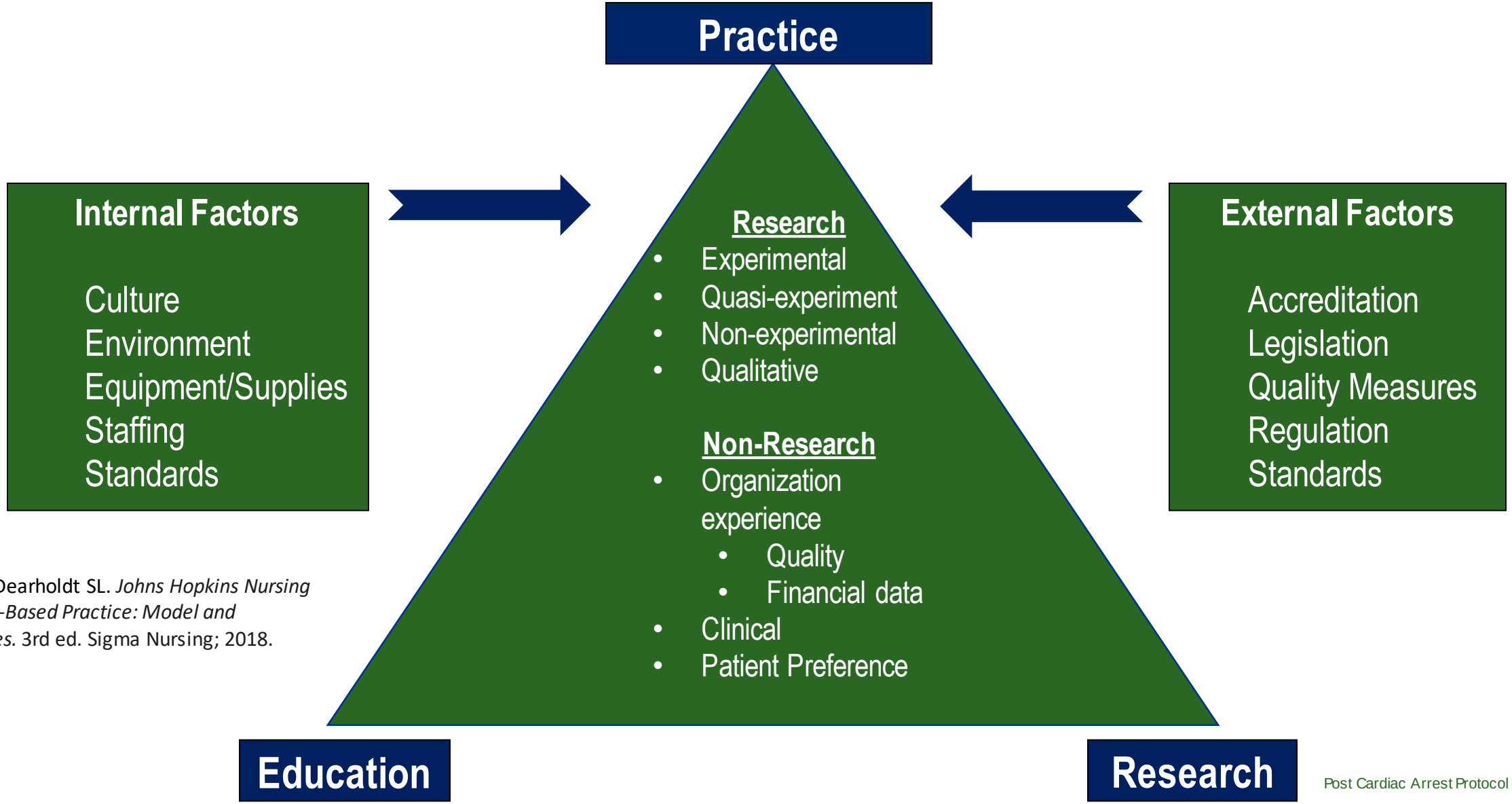
Mission Hospital Strategies and Plan

MH Resuscitation Committee Chairs meet to discuss strategies

Multidisciplinary Care Post Cardiac Arrest Protocol Project

- Design:
  - Use an evidence-based approach to establishing care priorities during/after cardiac arrest
- Sample:
  - Leaders of Initiative: Clinical Nurse Specialists in Critical Care
  - Multidisciplinary Leads: ICU CNSs, ED Physician, Critical Care Intensivist, Nurse Manager ICU
  - Active engagement of Team Members: Specialty MDs/NPs/Staff RNs/Ancillary Services
- Setting/Intervention: Virtual Meetings (2 Large Team & 1-2 Small Team for each Topic)
  - Use Johns Hopkins EBP Model Approach
  - Develop Problem Statement: PICO Questions rt areas of Post Arrest Care
  - Review evidence: Literature review by RN members/presentation to team
  - Translate evidence-MH Multidisciplinary Post Cardiac Arrest Care Protocol
- Analysis: Measure performance metrics as defined by JC (Resuscitation Committee)

Methods/Approach
Johns Hopkins Nursing Evidence-Based Practice Model



Dang D, Dearholdt SL. *Johns Hopkins Nursing Evidence-Based Practice: Model and Guidelines.* 3rd ed. Sigma Nursing; 2018.

P
Practice Question

- ✓ Step 1: Recruit interprofessional team
- ✓ Step 2: Define the problem
- ✓ Step 3: Develop and refine the EBP question(s)
- ✓ Step 4: Identify stakeholders
- ✓ Step 5: Determine responsibility for project leadership
- ✓ Step 6: Schedule team meetings

E
Evidence

- ✓ Step 7: Conduct an internal and external search for evidence
- ▪ Step 8: Appraise level of evidence and place summary into evidence tables
- ▪ Step 10: Develop recommendations for change based on evidence synthesis

T
Translation

- ▪ Step 11: Place interventions into care protocol.
- ▪ Step 12: Implement: Committee approval
- ▪ Step 13: Educate Team Members
- ▪ Step 14: Evaluate outcomes Quality Metrics by RNs
- ▪ Step 15: Report outcomes to committee

P:	**Patient, Population, or Problem**
I:	**Intervention or Exposure**
C:	**Comparison or Control**
O:	**Outcomes**

Dang D, Dearholdt SL. *Johns Hopkins Nursing Evidence-Based Practice: Model and Guidelines.* 3rd ed. Sigma Nursing; 2018.

Major Section Topics

References from AHA/NCS

Review Articles

Agree on Recommendations

MD Comprehensive PCA Protocol

Committee Approval

Education

Evaluation

Methods/Approach Team Based Initiative
Combination of Large Group/Small Team Meetings

Meeting Plan

- EBP Review Class February 28 830-930am (Recorded and available on SharePoint site)
- Large Group Kick Off Meeting March 2 730-830am with additional 1 hour for RNs discussion
- Small Group meetings between March 3-March 31: Each Team will schedule 1-2 meetings
  - Meeting 1: Review of the articles by RN members present their findings to the small team
  - Meeting 2 (if needed): Recommendations to take forward to the 2nd large group meeting will occur
- 2nd Large Group Meeting April 8 12-2pm
  - Recommendations from small teams presented for insertion into comprehensive protocol

Selection of Team Members

- Physician Specialty Leaders in ED, Cardiology, Neurology/Neuro Critical Care, and Pulmonary Critical Care
- Nurse Leaders: APNs (CNSs/NPs)/RRT/Critical Care/Cath Lab/Cardiac Services/ Palliative Care
- Specialty Leaders: Pharmacy, Nutritional Care and Respiratory
- Nurses: Staff Nurses from ED/CICU/SICU/Cath Lab - Clinical Ladder Opportunity EBP and Personal Growth
- Executive Sponsors: CNO/Executive Directors Cardiac and Emergency/Critical care

Small Teams

Post Cardiac Arrest Protocol and Bundles of Care

- Initial Stabilization
- Initiation of TTM
- Diagnostic Workup
- PCI: Early or Delayed

- Coronary Intervention: PCI
- ICU Management CV
  - MAP/BP
  - Echocardiography
  - Hemodynamics
  - Fluid Management
- Circulatory Assist Devices

- Mechanical Ventilation
- PaO2/PaCO2/SaO2
- Sedation

- Neuro Assess/Monitor
- Cerebral Edema Mgt
- Seizure Management
- Neuro Prognostication

- Hematological/GI
- Infection/DVT
- CRRT
- TTM

- Shared Decision Making
- Transitions in Care

Literature Review: PICO Questions

Section/Team	PICO Question(s)	# Articles Reviewed
Immediate Stabilization Priorities Bundles of Care	1. In patients (≥ 18 years of age) with post cardiac arrest syndrome, does establishing a comprehensive standard hospital-based protocol with bundles of care compared to standard practice improve clinical outcome at 30 days/6 months or longer?	28
Critical Care Management ➢ Cardiac ➢ General Critical Care	**Hemodynamics, Monitoring and Mechanical Circulatory Support:** 1. In patients (≥ 18 years of age) with post cardiac arrest syndrome, does establishing a mean arterial blood pressure (MAP) minimum threshold of 80 mm Hg or MAP_{opt} and/or SBP 120-140/DPB 80-100 mm Hg compared to a MAP<80 improve neurologic outcomes clinical outcome at 30 days/6 months or longer? 2. In patients (≥ 18 years of age) post cardiac arrest, does the use of echocardiography to evaluate right and left ventricular function, cardiac output and inferior vena cava size to guide hemodynamic management, compared to no echocardiography, improve outcomes at 30 days/6 months or longer? 3. In patients (≥ 18 years of age) with post cardiac arrest, does the use of a invasive hemodynamic monitor compared to no hemodynamic monitoring tools improve any outcome and clinical outcome at 30 days/6 months or longer? 4. In patients (≥ 18 years of age) with post cardiac arrest, does liberal vs restrictive fluid resuscitation improve any outcome clinical outcome at 30 days/6 months or longer? 5. In patients (≥ 18 years of age) post cardiac arrest, does early PCI versus late PCI improve outcome at 30 days/6 months or longer? 6. In patients (≥ 18 years of age) post cardiac arrest with drug refractory hypotension, does the use of circulatory devices (IABP, Impella, ECMO) compared to medication management improve cardiac performance and clinical outcome at 30 days/6 months or longer? **General Critical Care:** 1. In patients (≥ 18 years of age) post cardiac arrest, is there an optimal Hgb target, compared to no Hgb target, associated with favorable outcome at 30 days/6 months or longer? 2. In patients (≥ 18 years of age) post cardiac arrest, does DVT prophylaxis, compared to no prophylaxis, improved outcomes at 30 days/6 months or longer? 3. In patients (≥ 18 years of age) post cardiac arrest syndrome, does early enteral nutrition, compared to late enteral nutrition, improve outcome at 30 days/6 months or longer? 4. In patients (≥ 18 years of age) post cardiac arrest, do the early use of prophylactic antibiotics, compared to no prophylaxis, improved outcomes at 30 days/6 months or longer? 5. In patients (≥ 18 years of age) post cardiac arrest syndrome, does continuous renal replacement therapy, compared to no CRRT, improve outcome at 30 days/6 months or longer? 6. In adult patients (Age> 18 years of age) who remain comatose after return of spontaneous circulation, does TTM below 33-36 degrees C versus normothermia improve neurologic outcomes at 3/6 months?	14 2 2 4 14 4 3 2 4 2 4 10

Literature Review

Section/Team	PICO Question(s)	# Articles Reviewed
Critical Care Management: Pulmonary/Sedation	1. In patients (≥ 18 years of age) post cardiac arrest, is one strategy of mechanical ventilation, compared to any other strategy of mechanical ventilation associated with favorable neurologic outcome at 30 days/6 months or longer? 2. In patients (≥ 18 years of age) post cardiac arrest, is normoxia compared with hypoxia or hyperoxia, associated with favorable neurologic outcome at 30 days/6 months or longer? 3. In patients (≥ 18 years of age) post cardiac arrest, is hypercapnia, compared with normocapnia or hypocapnia, associated with favorable neurologic outcome at 30 days/6 months or longer? 4. In patients (≥ 18 years of age) post cardiac arrest, are certain approaches to sedation, analgesia, and neuromuscular blockade, compared to no medications, associated with favorable neurologic outcome at 30 days/6 months or longer?	5 2 3 3
Neuro Critical Care Mgt ➢ Neuro Assessment/Monitor ➢ Cerebral Edema Mgt ➢ Seizure Monitoring & Mgt	1. In patients (≥ 18 years of age) post cardiac arrest, does regular structured comprehensive neuro assessment , compared to no neuro assessment improve diagnosis of treatable causes of cardiac arrest brain injury and/or measurement of response to neuroprotective interventions during the first 30 days? 2. In patients (≥ 18 years of age) post cardiac arrest, does non-invasive monitoring technology (e.g., infared pupillometry), compared to standard manual pupil light reflex assessment, improve diagnosis of treatable causes of cardiac arrest brain injury and/or measurement of response to neuroprotective interventions during the first 30 day? 3. In patients (≥ 18 years of age) post cardiac arrest, does the active management of cerebral edema/increased ICP compared to no management improve response to neuroprotective interventions during the first 30 days? 4. In adult patients who remain comatose after resuscitation from cardiac arrest, does one type of EEG (recording duration, electrode arrangement or analysis) compared to another type of eEG or no EEG improve the diagnosis of seizures or status epilepticus or assessment of seizure or SE treatment response during the first 30 days?	8 10 5 16
Neuro Prognosticaton	1. In patients (≥ 18 years of age) post cardiac arrest, does delayed neuro prognostication starting at 5 days post ROSC, compared to early neuro prognostication at 48 hours, impact outcome at 30 days/6 months or longer?	16
Shared Decision Making	1. In patients (≥ 18 years of age) post cardiac arrest, does shared decision making strategies with the patient's surrogate decision maker, compared to usual decision making, improve satisfaction amongst care providers, team members and surrogate decision makers?	10
Survivorship	1. In patients (≥ 18 years of age) post cardiac arrest, does providing a structured survivorship assessment and plan, compared to usual care improve outcomes at 12 months or longer?	2

Literature Review: Each Section Evidence Table

Evidence Table Post Cardiac Arrest Protocol

Issue: The Joint Commission has issued a performance standard requiring hospitals: EP 1: The hospital develops and follows policies, procedures, or protocols based on current scientific literature for interdisciplinary post–cardiac arrest care. Note 1: Post–cardiac arrest care is aimed at identifying, treating, and mitigating acute pathophysiological processes after cardiac arrest and includes evaluation for targeted temperature management and other aspects of critical care management.

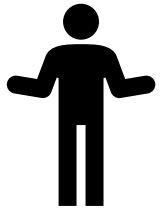
1. **PICO: In patients (≥ 18 years of age) with post cardiac arrest syndrome, does establishing a comprehensive standard hospital-based protocol with bundles of care compared to standard practice improve clinical outcome at 30 days/6 months or longer?**

Study	Level Quality	Sample Size	Major Findings	Comments
Research Articles				
Yeo JW, Ng Z, Goh Z, et al (2022). Impact of cardiac arrest centers on the survival of patients with nnontraumaic out-of-hospoital cardiac arrest: A systematic Review and meta-analysis. J Am Heart Assoc.11:e023806. DOI: 10.1161/JAHA.121.023806	III	147,943 54 studies	The results showed (1) significant improved survival to 30 days or discharge with good neurological outcome and (2) improved survival to 30 days or discharge for patients with OHCA who received care at a CAC (main analysis), regardless of how strictly CACs were defined (sensitivity analyses). Treatment effect of CACs may be significantly better for patients with shockable rhythm and without prehospital ROSC. High case volume and aggressive post resuscitation care have been shown to improve outcomes for OHCA, both of which are key features of CACs. CACs are specialized tertiary institutions, conceptually similar to level 1 trauma centers and are often high-volume or regionalized centers treating patients with OHCA with the capability to organize post resuscitation care, including 24/7 access to a cardiac catheterization laboratory for coronary angiography and percutaneous coronary intervention (PCI), TTM, extracorporeal membrane oxygenation, and neuroprognostication among other interventions. CACs provide a complex bundle of interventions.	Treatment of nontraumatic patients with OHCA at CACs was associated with significantly improved survival and neurological outcomes, and these findings persisted even when using varying definitions of CAC (eg, high-volume centers). • The treatment effect was more pronounced among patients with OHCA with shockable rhythm and those without prehospital return of spontaneous circulation.
Berger, D. A., Chen, N. W., Miller, J. B., Welch, R. D., Reynolds, J. C., Pribble, J. M., ... & CARES Surveillance Group. (2021). Substantial variation exists in post-cardiac arrest outcomes across Michigan hospitals. Resuscitation, 159, 97-104.	III	4,690	Statewide registry of Michigan hospitals. Used the Michigan Cardiac Arrest Registry to Enhance Survival (CARES) included 39 hospitals> 30 cases over 3 years. Outcomes of interest were survival to hospital discharge and survival with favorable neurologic outcome CPC 1 or 2 (CPC 1-2). Median survival to DC 31.3% and median survival to DC with CPC 1-2 was 25%. Identified a 12-fold variation in the use of TTM by hospitals and an eight-fold variation in use of left heart cath for all post arrest subjects. There was an approximately two-fold difference in adjusted survival rates (42.1% vs.18.1%) between the highest and lowest across hospitals. Moreover, the overall adjusted rate of survival with CPC 1-2 was 21.1%. Among 39 hospitals, three (7.7%) hospitals had significantly higher and four (10.3%) had significantly lower rates, with confidence intervals non-overlapping the CPC 1-2 adjusted survival rate of 21.1%. There was an approximately three-fold variation in rates of survival with CPC 1-2. Multivariable analysis demonstrates that LHC was positively associated with in-hospital survival and favorable CPC 1- 2 whereas the initiation of TTM was negatively associated with in-hospital survival.	Marked variation in overall survival to discharge and survival to discharge with CPC 1-2, when adjusted for subject and arrest characteristics. We also identified a substantial variation in key elements of post arrest care (TTM and LHC) by hospital. Variation in use of and target temperature of TTM. Variation in neuro prognostication. Substantial variations in practice.

Translation Evidence to Protocol/Practice Immediate Stabilization: 1st 120 minutes

Priorities: Immediate Post Resuscitation Care following ROSC

- Post arrest care focuses on mitigating injury to the brain.
- Possible contributors to this goal include optimization of cerebral perfusion pressure, management of oxygen and carbon dioxide levels, control of core body temperature, and detection and treatment of seizures
- Cardiac arrest results in a heterogenous injury – multiorgan dysfunction and shock
  - This is not "only" about the heart" - other organs – like the brain



- Multidisciplinary team with expertise in cardiac arrest care is necessary!
- A comprehensive structured, multidisciplinary system of care must be implemented in the same way every time!

Establish Target Goals

- Oxygenation/Ventilation: SpO2: Sp02 92-98%; PaCO2 35-45 mm Hg, PaO2 >80 mm Hg
- BP: SBP > 100 mm Hg and/or MAP > 80 mm Hg
- ECG: 12 Lead within 10 minutes
- TTM Candidates: TTM initiated within 60 minutes of ROSC
- PCI Candidate: PCI decision as soon as stabilized

Quick Airway-Breathing-Circulation-Rhythm Check

Nolan JP, Sandoni C, bottiger BW, et al. (2021): European Resuscitation Council and European Society of Intensive Care medicine guidelines 2021: post resuscitation care. Intensive Care Med 47:369-421; Panchal, A. R., Bartos, J. A., Cabañas, J. G., Donnino, M. W., Drennan, I. R., Hirsch, K. G., ... & O'Neil, B. J. (2020). Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation, 142(16_Suppl_2), S366-S468. Burstein B and Jentzer J. (2020). Comprehensive Cardiac Care after Cardiac Arrest. Crit Care Clin 36:771-786.Jentzer J and Callaway C. (2019). Cardiopulmonary Resuscitation and Critical Care After Cardiac Arrest. In book: Cardiac Intensive Care David Brown Ed. Pages 558-579. DOI: 10.1016/B978-0-323-52993-8.00051-5. Storm C, Leithner C, Krannich A, Suarez J, and Stevens RD. (2019). Impact of Structured pathways for Post Cardiac Arrest Care: A systematic review and meta-analysis. Crit Care Med 47: e710-716. Akin M, Sieweke JT, Zauner F, et al (2018). Mortality in Patients with Out-of-hospital cardiac arrest undergoing a standardized protocol including therapeutic hypothermia and routine coronary angiography. Experience from HACORE Registry. Amer College of Cardiol Intv 11:1811-1820.

Translation Evidence to Protocol/Practice - TTM

Target Temperature Management

- TTM at 33 °C had a favorable neurologic status as measured by Cerebral Performance Category (CPC) Score as compared to TTM at 36 °C (Johnson et al., 2020).
- Protocol compliance has decreased since adoption of TTM at 36 °C (Johnson et al., 2020).
- Non-compliance with achieving TTM at 36 °C is associated with poorer clinical outcomes (Bray et al., 2017).
- TTM at 33 °C in patients with non-shockable rhythm had more favorable outcome at 90 days (Lascarrou et al., 2019)
- TTM at 33 °C was associated with better survival than TTM at 36 °C for patients with the most severe post–cardiac arrest illness and TTM at 36 °C was associated with better survival in patients with mild- to moderate-severity illness (Callway et al., 2020)

- In patients with coma after out-of-hospital cardiac arrest, targeted hypothermia did not lead to a lower incidence of death by 6 months than targeted normothermia (Dankiewicz et al., 2021)
- Targeted temperature management at 33–34°C was associated with a significantly higher rate of a good neurologic outcome in the moderate-severity postcardiac arrest syndrome group, but not in the low- or high-severity group (Nishikimi et al., 2021).

Recommendations

- Consider TTM @ 33 °C for comatose patient post cardiac arrest, unless unable to tolerate cooling then consider TTM @ 36 °C
- Consider use of a risk stratification to guide selection of the optimal TTM strategy.

Translation Evidence to Protocol/Practice -Cardiac

Coronary Angiogram

- Coronary artery stenosis was found in 42.7% of TTM-treated non-ST elevated OHCA patients with Coronary angiogram within 24hrs, but there was no clear neurological benefit of immediate versus early coronary angiogram (Kim et al., 2019).
- Revascularization in patients with life-threatening ventricular arrhythmias and in survivors of cardiac arrest is associated with arrhythmia reduction and decrease mortality (Lawton et al., 2022).
- Guidelines does make recommendation for emergent versus early PCI (Panchal et al., 2020).
- Early access to PCI was associated with a 10-15% increase in 30-day survival rate compared to no PCI or late PCI in patients post cardiac arrest with STEMI and NSTEMI (Yannopoulo et al., 2019).
- There is no difference between immediate and delayed coronary angiogram in patients with NSTEMI who survive cardiac arrest (Barbarawi et al., 2019).
- There is no difference in overall survival at 90 days in immediate versus delay angiography in patient with successful resuscitation after out- of hospital arrest and no signs of STEMI (Lemkes et al., 2019).
- In patients who survive out of hospital cardiac arrest **without** ST-Segment elevation there is no difference in 30-day mortality, neurologic status or rate of PCI in early versus none early coronary intervention (Verma et al., 2020).
- If ≥ 3 of the following features are present post cardiac arrest survival is < 40% and ≥ 6 features are present survival is ≤ 10 % (Time-to-ROSC > 30 minutes, age > 85, and non-shockable presenting rhythm, unwitnessed arrest, no bystander CPR, ongoing CPR, pH < 7.2, Lactate > 7 mmol/L, end stage renal disease, and noncardiac cause of arrest. Time-to-ROSC > 30 minutes, age > 85, and non-shockable presenting rhythm are the 3 strongest risk factors (Harhas et al., 2021)

Recommendations

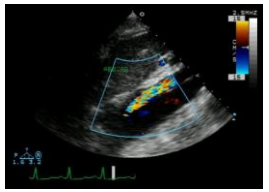
- Delaying coronary angiogram in patients WITHOUT ST segment elevation who survived out of hospital arrest is reasonable.
- Delaying or forgoing invasive procedure in patient with 6 or more unfavorable features listed above is reasonable.

Mean Arterial Pressure

- Relationship between MAP > 90mm Hg and good neurologic outcome was similar regardless of location of arrest, initial rhythm, or administration of vasopressor agent (Roberts et al., 2019).
- MAP and neurological outcome after CA may be dependent. (MAP>90 for no previous history or HTN vs >110 with previous history of HTN (Roberts et al., 2019).
- Early goal directed hemodynamic optimization strategy of maintaining a MAP 85-100 mm Hg in the first 36 hours post cardiac arrest was safe, improve cerebral perfusion and oxygenation during the critical delayed hypoperfusion phase but did not improve the neurological outcome at 180 days (Ameloot et al., 2019).
- Individualized MAP targets may be needed to take into consideration the physiologic difference between patients rather than a "one-size-fits-all". (i.e., patients with a history of hypertension may need a higher MAP goals (Ameloot et al., 2019; Sekon et al., 2019).
- MAP targeted between 80-100 mm Hg during the first 36 hours of ICU stay in post-CA patients with shock after AMI was associated with a significant reduction of myocardial injury (Ameloot et al., 2020).
- High-normal MAP level was recently shown to decrease troponin release as a marker of myocardial injury and optimal MAP may vary according to the patient's physiology (Jozwiak et al., 2020)
- MAP range between 76-86 mm Hg and SVO2 between 67% and 72% were associated with maximum survival and a MAP between 87-101 mm Hg and SVO2 between 70 and 75% were associated with optimal cerebral saturation (Amelot et al., 2015).
- Low-normal (65-75 mmHg) vs. high-normal MAP (80-100 mm Hg) did not affect markers of neurological and myocardial injury, electroencephalography (EEG) and cerebral oxygenation (Jakkula et al., 2018)
- In comatose survivors of OHCA with an initial shockable rhythm, MAP thresholds < 75 mmHg are associated with increased rates of severe neurological dysfunction(Russo et al., 2018)
- Hypotension occurring during the first six hours after cardiac arrest is an independent predictor of poor one-year neurologic outcome. High vasopressor load was not associated with poor outcome and further randomized trials are needed to define optimal MAP targets in OHCA patients (Laurikkala et al., 2016).

Recommendation: target MAP > 80 mmHg in post cardiac arrest patients.

Translation Evidence to Protocol/Practice -Cardiac



Fluid Management: Balanced crystalloid versus 0.9% saline

- No significant difference in mortality
  - Exception: Balanced solutions decreased mortality in sepsis and non traumatic brain injury
- Balanced Crystalloid
  - Decrease in Renal Replacement Therapy free days
  - Longer free days of organ support
  - Less fluctuation in serum electrolytes

Recommendation

- Either balanced or 0.9% saline can be used for fluid resuscitation
- Exception: Consider using balanced solution when the patient underlying etiology is sepsis or non-traumatic brain injury.

(Xue et al., 2019; Martin et al, 2019; Hammond et al., 2020; Liu et al., 2019)

Echocardiography

- Serial TTEs prove to be beneficial in OHCA patients to guide treatment and follow up outcomes in order to gauge long term mortality (Jentzer et al., 2018)
- Echocardiography can be used to manage the response to fluid resuscitation in critically ill patients who are at risk for heart failure or tissue hypoperfusion (Porter et al., 2015).
- Post resuscitation myocardial dysfunction (PRMD) can develop in about one-third of patients post cardiac arrest (Cha et al., 2018).

Recommendations

- Consider serial Echocardiogram to guide treatment and to gauge long term mortality in patients post cardiac arrest.

Mechanical Circulatory Support (MCS)

- Early initiation of LV support with peripheral ventricular assist device (PVAD), was associated with improved hospital and 6-month survival in patients with OHCA and post cardiac arrest cardiogenic shock complicating AMI (Chatzis et al., 2021).
- Early initiation peripheral ventricular assist device (PVAD), especially prior to PCI, was also associated with a greater functional recovery of the left ventricle (Chatzis et al., 2021).
- The IABP use for adult patients who achieved ROSC after non-traumatic out-of-hospital arrest was not associated with improved 1-month survival with favorable neurological outcome compared with the non-IABP use (Kishimori et al., 2019).
- Steady increase in use of mechanical circulatory support (MCS) including Intra-aortic balloon pump (IABP), peripheral ventricular assist device (PVAD), extracorporeal membrane oxygenation (ECMO) since January of 2008 and survival to discharge was significantly higher in patients who were selected to receive MCS (Patel et al., 2018).
- Patients receiving MCS for refractory OHCA presented promising survival rates with a favorable neurological outcome at hospital discharge (Mork et al., 2021).

Recommendation

- Consider use of mechanical circulatory assist devices in patients post cardiac arrest with refractory hypoperfusion.

Invasive Hemodynamic Monitoring

- In patients with cardiogenic shock invasive hemodynamic monitoring with pulmonary artery (PA) catheters is associated with a reduction in in-hospital mortality (Osman et al., 2021)
- Emerging data suggest that PAC use is associated with improved survival in patients with Cardiogenic shock support by mechanical assist devices (Saxena et al., 2020).
- PA catheters can be used for diagnosis, prognosis and to guide, optimize and wean therapies in patients with cardiogenic shock with or without mechanical circulatory assist devices (Saxena et al., 2020).

Recommendation

- Consider inserting Pulmonary Artery Catheter in patients who present with cardiogenic to monitor effectiveness, optimize device settings, guide timing and weaning of mechanical circulatory assist devices.
- Provide appropriate training.

Mork, A. R., Stengaard, C., Linde L., Moller J. E., Jensen, L. O., Schmidt, H., Riber, L. P., Andreasen, J. B., Thomassen, S. A., Lagensen, H., Freemant, P. M., Christensen, S., Greisen, J. R., Tang, M., Moller-Sorensen, P. H., Holmvang, L., Gregers, E., Kjaergaard, J., Hassanger, C., Eiskjaer, H., & Terkelsen, C. J. (2021). Mechanical circulatory support for refractory out-of-hospital cardiac arrest: A Danish nationwide multicenter study. Critical Care, 25:174. https://doi.org/10.1186/s13054-021-03606-5

Translation Evidence to Protocol/Practice
Pulmonary & General Critical Care

Pulmonary/Ventilator Management:

- Lower VT after OHCA is independently associated with favorable neurocognitive outcome & more ventilator-free days
- Conservative Oxygen therapy
- PaO2> 60 mm Hg and avoid hypoxia
- PaCO2 35-45 mm Hg
- SpO2 92-98%

Sedation

- Short acting sedatives/sedation agents are ideal
- Intermittent Neuromuscular blockers are idea

Renal Replacement Therapy

- RRT started on the day of cardiac arrest, the patients had a higher likelihood of death vs. waiting 2-3 days after CA to initiate RRT (Winther-Jensen et al., 2018)
- Survival and neurological status at discharge were not significantly different in patients requiring RRT within the first 72 hours due to severe AKI, compared with those who did not need RRT (Ghoshal et al., 2019).
- Post-arrest AKI has an early onset, occurs in more than 50% of CA patients, and it is associated with increased mortality.

Recommendation

- Current data does not support specific recommendations for RRT
- RRT should be initiated based on the patient clinical condition and underlying etiology

Prophylactic Antibiotics

- Antibiotic prophylaxis following cardiac arrest is not associated with a change in key clinical outcomes (Couper et al., 2019)
- Early elevation of serum procalcitonin at 24–48 h from ICU admission strongly correlate with the severity of PCAS and are significantly associated with long-term patient prognosis (Engel et al., 2013).

Recommendations:

- Current data does not support the use of prophylactic antibiotics in patients following cardiac arrest.

Early Nutrition(within 48 hour) in patients undergoing TTM

- No significant association between early enteral (within 2 days) and 30-day mortality (Joo et al., 2019)
- There was a mortality reduction in patients with Low BMI <18.5
- Early nutrition is associated with better 3-month neurological outcomes (Martin et al., 2020)
- Low dose enteral feeding during therapeutic hypothermia and increase the dose after rewarming (Singer et al., 2019)

Recommendation:

- Early Enteral Access during TTM
- Initiate feeding and escalate dose during rewarming phase of TTM

Hemoglobin Concentration

- Patient with higher mean hemoglobin concentration (11.5 versus 10.7 g/dL) in the first 48 hours and 7 days after hypoxic ischemic brain injury had a higher odds of a favorable outcome at hospital discharge (Wormsbecker et al., 2017)
- Hemoglobin concentration after ROSC are associated with neurologic outcomes at hospital discharge (Kim et al., 2018).
- Hemoglobin level ≥ 10 g/dl is associated with survival with good neurologic outcomes at hospital discharge (Albaeni et al., 2016)
- None of the study discussed adverse events of transfusion

Recommendation

- Consider increase Hemoglobin in patients post cardiac arrest based on underlying etiology.

DVT prophylaxis

- Pharmacologic thromboprophylaxis has proven to significantly reduce VTE in ICU patients (Ejax et al., 2018)
- Minimal literature regarding SQ DVT prophylaxis in patient undergoing TTM.

Recommendation

- Follow current hospital protocols for DVT prophylaxis in patient who are not undergoing TTM
- In patient undergoing TTM at 33 degree
  - No SQ injections during cooling process.

Translation Evidence to Protocol/Practice - Neuro Assess/Monitor

Critical Care Management Phase: EBL Recommendations

Neuro Assessment/ Monitoring & Management of Cerebral Edema

- Neurologic Exam should be performed in all patients admitted to ICUs;
  - Includes assessment of consciousness and cognition, brainstem function, and motor function;
- Sedation should be managed to maximize the clinical detection of neurological dysfunction, except in patients with reduced intracranial compliance in whom withdrawal of sedation may be deleterious;
- Additional tests, including neurophysiological and neuroradiological investigations, should be guided by the NE
- Invasive and noninvasive neuromonitoring provides insights into cerebral physiology, allowing an individualized approach to patient care.

ian R, Maciel CB, Bailu R, Greer D, and Gilmore EJ. (2021). Neuromonitoring after Cardiac Arrest: Can Twenty-First Century Medicine Peronalize Post Cardiac Arrest Care. Neurol clin 39:273-292. Cardim D, Griesdale DE, Ainslie PN, Robba C, Calvielio L, Czosnyka M, Smielewski P, Sekhon MS. A comparison of non-invasive versus invasive measures icranial pressure in hypoxic ischaemic brain injury after cardiac arrest. *Resuscitation*. 2019;137:221-228. doi: 10.1016/j.resuscitation.2019.01.002. Oddo M, Bracard S, Cariou A, Chanques G, Citerio G, Clerckx B, Godeau B, Godier A, Horn J, Jaber S, et al. Update in Neurocritical Care: a summary of the 2018 Paris international conference of the French y of Intensive Care. *Ann Intensive Care*. 2019;9:47. doi: 10.1186/s13613-019-0523-x. Sharshar T, Citerio G, Andrews PJ, Chieregato A, Latronico N, Menon DK, Puybasset L, Sandroni C, Stevens RD. Neurological examination of critically ill patients: a pragmatic approach: report of an ESICM expert panel. sive Care Med. 2014;40:484-493. doi: 10.1007/s00134-014-3214-x

Target Goals:

- Neurologic status monitored/changes detected.
- Strategies to reduce cerebral edema/ICP implemented.
- Seizures detected/interventions to reduce seizures initiated.

Neuro Assessment and Monitoring – Clinical Exam

- Assessment/Monitoring: Ongoing clinical assessment/documentation of level of consciousness with arousability/awareness assessment, Glasgow Coma Score (GCS), Pupillometry, selective cranial nerves, and motor response (Geocadin et al 2019, Berg et al AHA 2020, Panchal et al AHA 2020) as indicated per condition/treatment.
- Note any seizure activity

Geocadin RG, Callaway CW, Fink EL, Golan E, Greer DM, Ko NU, Lang E, Licht DJ, Marino BS, McNair ND, et al; on behalf of the American Heart Association Emergency Cardiovascular Care Committee. Standards for studies of neurological prognostication in comatose survivors of cardiac arrest: a scientific statement from the American Heart Association. *Circulation*. 2019;140:e517-e542. doi: 10.1161/cir.0000000000000702. Berg KM, Nolan JP, on behalf of the Adult Advanced Life Support Collaborators. (2020).Adult Advanced life Support: 2020 International consensus on Cardiopulmonary Resuscitation and Emergenmcy Cardiovascular Care Science with Treatment Recommendations. *Circulation*. 2020;142(suppl 1):S92–S139. DOI: 10.1161/CIR.0000000000000893Panchal AR, Baros JA, Cabanas JG, Donnino MW, Drennan IR, Hirsch KG, et al 2020. Part 3: Adult Basic and Advanced life Suppt: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2020;142 (supple 2): S366–S468. DOI: 10.1161/CIR.0000000000000916

Non-invasive monitors may include:

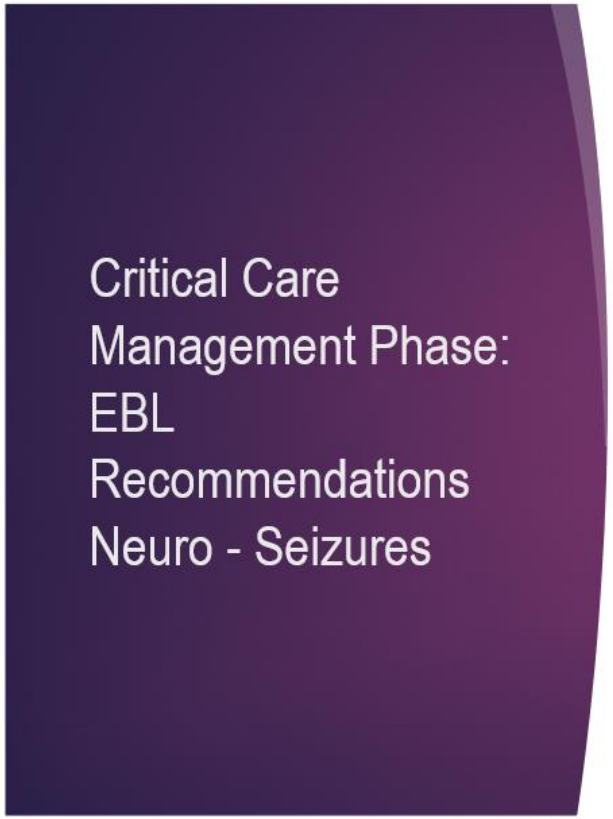
- Pupillometry: NPI (Abnormal NPI < 3 or 0.7 difference between eyes)
- Near infared spectroscopy (NIRS): Abnormal < 50%
- EEG (see Seizure management section)
- Transcranial Dopplers (TCDs): Abnormal - loss of flow in arteries

Invasive Monitoring may include Intracranial Pressure (ICP) devices

Interventions/Management

- Notify provider with changes in neuro exam or abnormal result from neuro monitoring
- Head of Bed at 30-45 degrees
- Administer medications (AEDs, Mannitol) per provider order

Translation Evidence to Protocol/Practice –Seizure and EEG



- Electroencephalographic (EEG) patterns on the ictal-interictal spectrum develop in approximately 1 in 3 comatose post-arrest patients and are associated with worse outcomes
  - EEG changes dynamically hours – days after CA (Solanki 2019)
  - Data from Solanki et al 2019 support a potential utility of valproate and levetiracetam for treatment of epileptiform EEG activity in selected comatose postarrest patients
- Seizures occur 15-33% post CA treated with TTM (Beekman
  - Depletion of ATP/insufficient energy reserves as in PCA-seizures worsen the injury
  - Seizures lasting longer than 5 minutes – continue despite 1st and 2nd line treatment results in refractor status epilepticus (Convulsive or Non-Convulsive SE)
  - If not recognized (EEG) and treated results in poor neurologic outcomes
- EEG monitoring integral to detect seizure activity as well as clinical exam
- Treating epileptiform EEG activity/SE/NCSE may reduce secondary injury

Assessment/Monitoring

- Assess for any signs/symptoms of seizure activity and notify provider
- EEG monitoring ordered by provider:
  - Apply Rapid Response EEG following ROSC in comatose PCA patients. EEG technician will change EEG to full montage as soon as available
  - Maintain electrodes, notify EEG tech if electrodes require repositioning, and alert provider of any issues related to EEG, if needed.

Interventions/Management

- Administer anticonvulsant medications as ordered by provider
- Check skin condition on scalp (EEG electrode location)

Beekman R, Maciel CB, Balu R, Greer D, and Gilmore EJ. (2021). Neuromonitoring after Cardiac Arrest: Can Twenty-First Century Medicine Personalize Post Cardiac Arrest Care. Neurol clin 39:273-292. Figure Page 278. Solanki P, Coppler PJ, Kvalay JT, Baldwin MA, Callaway CW, Elmer J. Association of antiepileptic drugs with resolution of epileptiform activity after cardiac arrest. *Resuscitation*. 2019;142:82-90. doi: 10.1016/j.resuscitation.2019.07.007

Translation Evidence to Protocol/Practice - Neuro Prognostication

Neuro Prognostication EBL

- Neuroprognostication should not commence until 72 hours after ROSC and/or return to normothermia and elimination of major confounders such as sedation/NMB
- Must use a multimodal approach
  - Clinical Exam is paramount!
  - SSEP: (bilateral absent N20 wave poor prognostic indicator)
  - EEG (highly malignant pattern poor prognostic indicator)
  - Biomarkers: Neuron-Specific Enolase (NSE): (33 to 120 µg/L within 72 hours after ROSC predicted poor neurological outcome)
  - Imaging: CT and MRI (gray matter–to–white matter ratio GWR and/or diffusion-weighted brain MRI for predicting neurological outcome)

koff MH, Singletary EM, Soar, Jasmeet, et al. (2021). 2021 ILCOR and Emergency Cardiovascular Care Science with Treatment Recommendations: Summary from the SLS, ALS, NLS, Education, implementation, and Teams:; First Aid Task Force; and the COVID-19 working group. 169:229-311.Perkins GD, Callaway C, Haywood K, et al. (2021): Cardiac Arrest 2: Brain Injury after cardiac arrest. The Lancet 398:1269-8. https://doi.org/10.1016/ S0140-6736(21)00953- Sandroni C, Cronberg T, and Sekhon M (2021). Brain injury after Cardiac Arrest: pathophysiology, treatment and prognosis. Int Care Med 47:1393-1414. Sandroni C, D'Arrigo S, Cacciola S, Hoedemaekers CWE, Kamps MJA, Oddo M, Taccone FS, Di Rocco A, Meijer FJA, Westhall E, et al. (2020). Prediction of poor neurological outcome in comatose survivors of iac arrest: a systematic review. *Intensive Care Med*. 46:1803- 1851. doi: 10.1007/s00134-020-06198-e Panchal AR, Bartos JA, Cabañas JG, Donnino MW, Drennan IR, Hirsch KG, et al (2020). Part 3: Adult Basic and Advanced life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 142 (suppl 2): S366–S468. DOI: 161/CIR.0000000000000916 Berg KM, Nolan JP, on behalf of the Adult Advanced Life Support Collaborators. (2020).Adult Advanced life Support: 2020 International consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Circulation*. 142(suppl 1):S92–S139. DOI: 10.1161/CIR.0000000000000893 Geocadin RG, Callaway CW, Fink EL, Golan treer DM, Ko NU, Lang E, Licht DJ, Marino BS, McNair ND, et al((2019). On behalf of the American Heart Association Emergency Cardiovascular Care Committee. Standards for studies of neurological prognostication in comatose survivors of cardiac arrest: a scientific statement from the American Heart Association. *Circulation* 140:e517-e542. doi: 10.1161/cir.0000000000000702

Target Goal:

- Neuroprognostication assessment of comatose PCA patient at 5 days Post ROSC (rewarmed after TTM to 37 degrees C) or 3 days in comatose PCA Patients (no TTM) is ideal, though individual prognostic testes may be obtained earlier than this (Panchal et al AHA 2020, p. S431).

Definitions/Assumptions:

- Definition of Coma: Unresponsiveness to internal and external stimuli with a complete absence of arousal (Geocadin 2019, p. e519).
- Neurological prognostication of unfavorable outcome is based on the absence or limitations of function of a particular injured area of the brain as determined by clinical assessment or diagnostic testing. (Geocadin 2019, p. e520).
- Neuroprognostication involves a multimodal approach and is not based on a single finding.
- Interdisciplinary team members epileptologist, neuro intensivist, and neurologist are essential members determining neuroprognostication of the PCA comatose patient.

- Definitions/Assumptions:
  - Cerebral Performance Score (CPC) includes 5 categories from 1(no or minor disability) to 5 (dead). CPC scores of 1-2 are defined as a good neurological outcome in Out-of-Hospital-Cardiac Arrest (OCHA) patients measured at hospital discharge, 1 month or later. CPC 3-5 relate to prediction of an unfavorable neurological outcome at hospital DC
    - CPC 1 No or minor disability
    - CPC 2 Moderate Disability
    - CPC 3 Severe Disability
    - CPC 4 Unconscious-Persistent Vegetative State
    - CPC 5 Dead
  - Interdisciplinary team members caring for comatose cardiac arrest survivors shall have regular and transparent multidisciplinary discussions with surrogates about the anticipated time course for and uncertainties around neuroprognostication (Panchal et al AHA 2020, p. S431).
  - Good communication includes providing surrogates with correct information and avoiding disproportionate care with severe/irreversible brain injury (Sandroni et al 2021).

Translation Evidence to Protocol/Practice Neuro Prognostication

- Clinical Assessment: Ongoing clinical assessment/documentation of level of consciousness with arousability/awareness assessment, Glasgow Coma Score (GCS), Pupillometry, selective cranial nerves, and motor response (Geocadin et al 2019, Berg et al 2020, Panchal et al AHA 2020).
  - Nursing assessment: Hourly or as indicated
  - Provider assessment: Daily
  - ***Clinical indicators or poor neurologic prognosis include:***
    - ***Coma (unarousable/no awareness)with loss of brainstem functions (without confounding variables), GCS 3***
    - ***No pupillary light reflex at 72 hours, Automated pupillometry with minimal or absent % change at 48 hours after ROSC/Pupillometer NPI value 0-2 at 48 hours***
    - ***Absent corneal reflex at 72 hours, loss of cough reflex/gag reflex as well as oculocephalic/oculovestibular reflexes***
    - ***Absence of spontaneous breathing, and heart rate variability (Oddo et al 2018, Oddo et al 2019, Geocadin et al 2019, Berg et al AHA 2020, Nolan et al 2021).***

Assessment of any motor phenomena/eye movement and/or myoclonic jerks that may represent seizure like activity is included in the assessment of the PCA patient with notification to the provider as indicated

Electroencephalography (EEG) monitoring shall commence as soon as feasible following ROSC.

- Rapid response EEG monitoring with headband as initial EEG monitor
- Full comprehensive montage EEG monitoring as soon as EEG technicians are available for ongoing EEG assessment up to a target of 120 hours post ROSC.
- Epileptologist/Neuro Intensivist and/or Neurologist monitors EEG activity/directs appropriate medication administration and other actions.
- ***Potential indicators of poor neurological outcome include presence of status epilepticus, burst suppression at 72 hours after ROSC without confounding variables, and/or highly malignant patters (periodic discharges in combination with suppression)***

Blood Biomarkers for Prognostication

- Neuron-Specific Enolase (NSE) levels may be measured at 24, 48, and 72-hours post ROSC in PCA patients
- Specific levels are reviewed by neuro provider. Levels ranging from 33-120 ug/L within 72 hours after ROSC predicted poor neurological outcome from hospital discharge to 6 months (Berg et al 2020, p. S122; Nolan et al 2021).

Imaging: CT and MRI

- CT scan of brain without contrast within 2 hours of ROSC.
  - Grey-Matter-to-White matter Ratio: Average, basal ganglia, putamen/corpus callosum, simplified, caudate nucleus/posterior limb of the internal capsule/ cerebrum all had 100% specificity when completed within two hours of ROSC when set values less than about 1.2 (Berg et al AHA 2020).
- MRI of brain: diffused weighted imaging between 48 hours and 7 days (Sandroni et al 2020).
  - High signal density within 6 hours to 5 days of ROSC on MRI was associated with poor neurological outcomes (Berg et al AHA 2020).

Collaborative dialogue between the attending providers (pulmonary critical care intensivists, trauma surgeons, neurosurgeons, cardiologists, emergency medicine, and hospitalists) and providers determining neuroprognostication is imperative (Sandroni et al 2021).

Evaluation of all studies are reviewed by interdisciplinary team

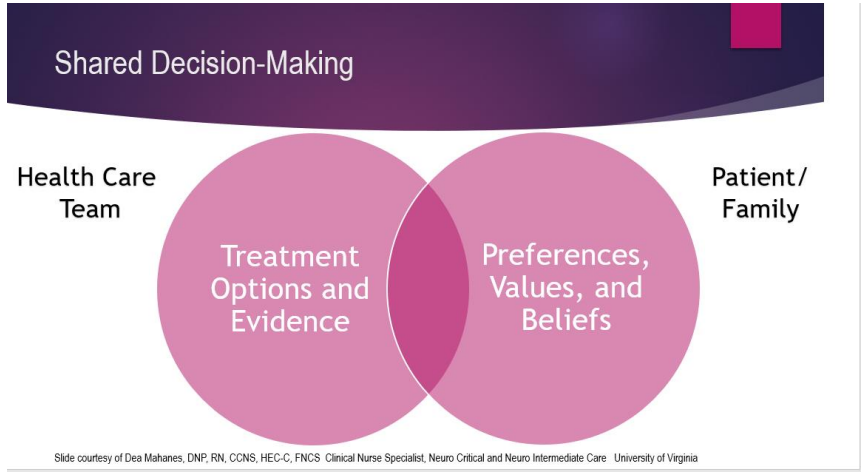
Epileptologist/Neuro Intensivist are the providers to determine neuroprognostication in PCA patients with ROSC.

Ongoing communication and information sharing with patient's surrogate decision maker(s) is an essential component of neuroprognostication

Translation Evidence to Protocol/Practice Shared Decision Making and Survivorship

Mentzelopoulos SD, Couper K, Vand de Voorde P, et al. (2021). European Resuscitation Council Guidelines 2021: Ethics of Resuscitation and end of life decisions. Resuscitation 161:408-432.

- **Safeguard Autonomy:** Use advance care planning that incorporates shared decision making to improve consistency between patient wishes and treatment. Offer advance care planning to all patients at increased risk of cardiac arrest or poor outcome in the event of cardiac arrest.
- **Improve Communication:**
- Use evidence-based interventions with surrogate decision makers
- Combine structured end-of-life discussions with video decision aids for shared decision making about end-of-life hospital transfer from nursing homes in systems where this technology is available.
- Integrate patient/family support elements in discussions (clear/concise information; include pt goals/values/treatment preferences; empathic statements assuring non-abandonment, symptom control, and decision-making support; provide spiritual support; explain protocolized treatment plans of team)
- **Decide when to start and when to stop CPR (includes family presence during CPR)**
- When making decisions about CPR, clinicians should explore and understand the value that a patient places on specific outcomes



Survivorship: Great Heterogeneity in Survivors of Cardiac Arrest

- Address cause of arrest and implement strategies to reduce risk
- Physical, cognitive, and emotional effects of surviving cardiac arrest may linger for months or years
- Focus assessment and interventions on at-risk body systems and their impairments
- Develop strategies to promote well-being: Affective & Existential and return to normal functions

Results – Translation to Practice

Bundle Elements: ROSC TO 120 minutes	Interventions	Parameter Goals
Oxygenation & Ventilation	Assess Airway-Breathing GCS 3-8: Intubation & Mechanical Ventilation GCS 9-15: Supplemental O2 delivery based on SpO2	Sa02 92-98% PaCO2 35-45 mm Hg Tidal Volume 4-8 ml/kg
Cardiac and Hemodynamic Optimization	Assess HR/ BP/ fluid responsiveness/ cardiac echo Provide fluids/vasopressor Assess ECG & manage arrhythmias	SBP>100 mm Hg/MAP>80 mm Hg ECG-Continuous / Stat Echo 12 Lead ECG done within 10 min
Consults	Pulmonary Critical Care Hospitalist Cardiology Neurology/Neurocritical Care	Within 30 minutes Within 60 minutes Within 30 minutes for STEMI Within 6 hours
Metabolic derangements	Glycemic control: Assess serum glucose/insulin treat Assess ABG: manage acidosis Assess Laboratory Values: CBC/BMP/Mag/Ca/Coagulation	Blood Glucose 80-180 mg/dL pH and Lactate Electrolytes
TTM In patients with GCS 3-8	Begin TTM in the ED: Obtain labs Initiate Propofol/Fentanyl/NMB Insert Temp probe(Bladder vs Esophageal) Iced saline & Cooling with device to 33/36	Time to target temperature: 2-4 h RASS BSAS Electrolyte values
Early Cardiac Intervention	STEMI protocol for rapid access to Cath Lab	Early revascularization
Neurologic Care Seizure Care	Neuro exam and Pupillometer Assess immediate ROSC Headband EEG Monitor placed in GCS 3-8	Clinical Exam at ROSC Pupil dynamics: NPI & CV @ ROSC EEG by 30 minutes
Family & Caregivers	Shared decision-making Supportive multidisciplinary team	Initial meeting with Provider and Family

Results – Translation to Practice

BEDSIDE CHECKLIST 1ST 120 MINUTES

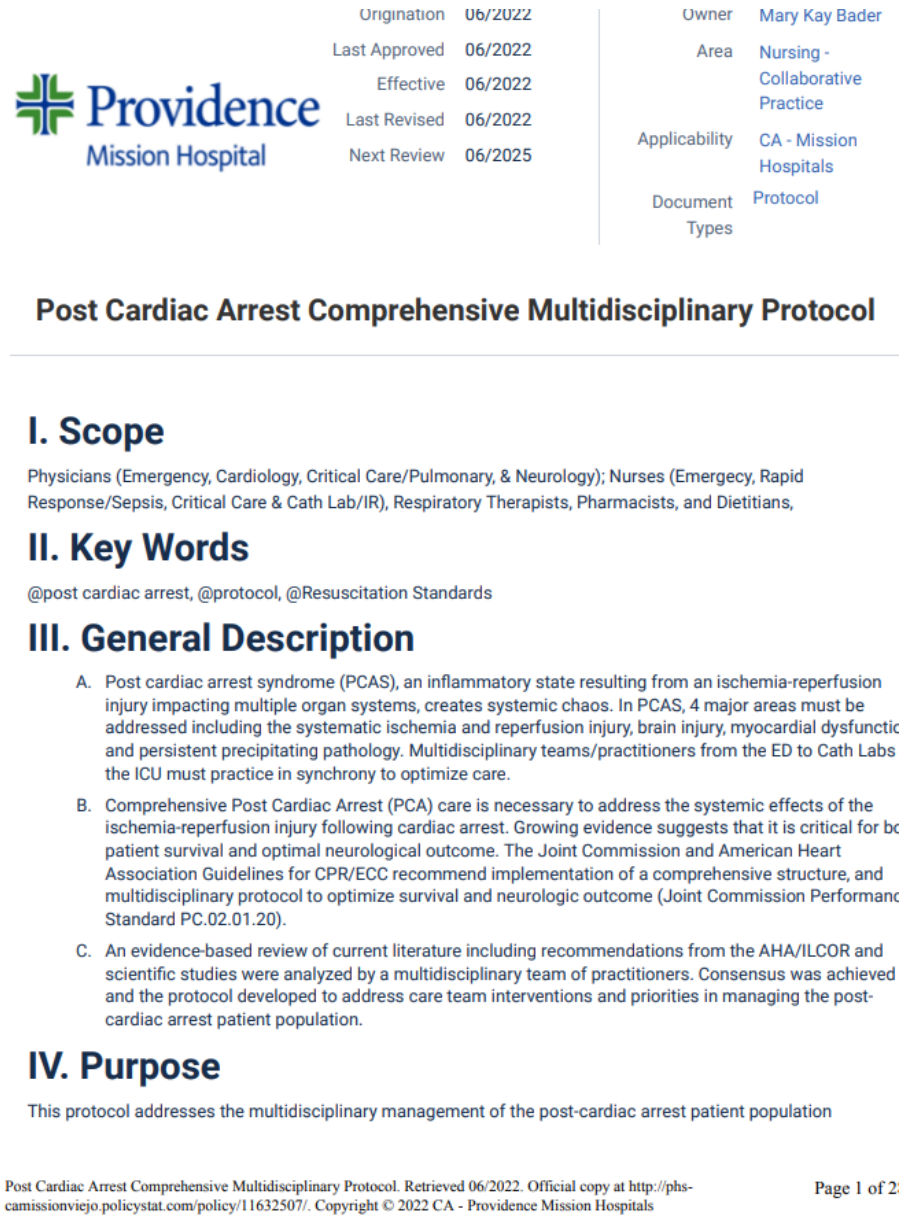
Item	Where to Get Product/Service	Notes/Comments
□ ABG/Labs □ Chest X-ray Post Intubation	RN/RT (ED 1521/Lead 1599) to draw Call ED Radiology Tech	
□ 12 Lead ECG within 10 min □ MAP goals: See other side	ED Tech	
□ Neuro Assess and Pupillometry by 30m	ED Supply Room/ED 1 Document– Pupillometer under Headache Assessment	
□ Determine Plan of Care Post ROSC □ Central Line/Arterial Insertion for TTM □ TTM Candidate- Induction □ Foley Temp Probe catheter inserted □ Meds on board-Sedation/Analgesia □ Pads/Machine/Cold Iced Saline □ IV Push Norcuron/Paralytic @initiation □ PCI: Candidate	ED MD/Intensivist Critical Care Cart Temp Foley – Critical Care Cart ED Pyxis : Propofol/Fentanyl CICU-Call extension 4836 Pyxis: Cath lab team will arrive for transport	**Time TTM Started: _____**
□ Stat Echo	Weekends/Off Hours – call HCC	
□ CT scan of brain completed	Before ICU admit or PCI	
□ Apply Ceribell EEG within 30 min	ED Supply Room Headband ED Med Room for Device Document under Seizure	

Results – Translation to Practice

Bundle Elements: ICU Phase	Interventions	Parameters
Oxygenation & Ventilation	Assess Airway-Breathing GCS 3-8: Intubation & Mechanical Ventilation GCS 9-15: Supplemental O2 delivery based on SpO2	Sa02 92-98% PaCO2 35-45 mm Hg Tidal Volume 4-8 ml/kg
Cardiac and Hemodynamic Optimization	Assess fluid responsiveness/provide fluids Assess cardiac hemodynamics, serial cardiac echo & manage arrhythmias Cardiac Medications: Vasopressor/Vasoactive/Inotrope Cardiac Assist Devices to support CV system	SBP/DBP/MAP >80 mm Hg ECG SV/SVV CO/CI/LVSWI/RVSWI/ IABP/LVAD/ECMO parameters
TTM Maintenance & Rewarm (GCS 3-8)	Maintenance at Target Temp x 24 hours Propofol/Fentanyl/Shivering assessment and interventions Maintenance of electrolytes Rewarm slowly (0.25 degrees/hour) Avoid hyperthermia x 72 hours post hypothermia	Time at target: 24 hours RASS/BIS: 0 to -5 (0 to -2)/ 40-60 BSAS 0 Electrolyte values WNL Rewarm rate @0.25d/hr T 37C Maintain 37 x 72 hours
Cardiac Workup	Per Cardiology	
Neurologic Care	Neuro exam and Pupillometer Hourly Control ICP	Clinical Exam: GCS/LOC/Motor Pupil dynamics: NPI & CV
Seizure Surveillance Mgt (GCS 3-8)	EEG monitoring and Medications	EEG continuous
Metabolic derangements	Glycemic control: Assess serum glucose/insulin treat Assess ABG: manage acidosis Assess electrolytes and replace per protocol	Blood Glucose 80-180 mg/dL pH and Lactate 7.35-7.45 Electrolytes WNL
Neuro Prognostication Survivorship	Multi-modal: Clinical Exam; NSE levels @ 24, 48, & 72 h; EEG; and CT/MRI 72 hours post TTM 37d Assessments by Disciplines (Rehab)	Neurointensivist/Epileptologist Neurologist and Physiatrist Rehab Team: PT/OT/ST/Psych/Neuropsych
Family & Caregivers	Shared decision-making Supportive multidisciplinary team	Regular structured meetings team and family

Results

- **170 Articles reviewed in small teams with consensus achieved**
- **Consensus statements placed into Policy Stat Post Cardiac Arrest Protocol**
  - Approval by Medical Staff Committees
- **Development of Bundles of Care reference sheets for staff**
- **Resuscitation Committee monitoring Cardiac Arrest outcome measures**



Providence Mission Hospital

Origination	06/2022
Last Approved	06/2022
Effective	06/2022
Last Revised	06/2022
Next Review	06/2025
Owner	Mary Kay Bader
Area	Nursing - Collaborative Practice
Applicability	CA - Mission Hospitals
Document Types	Protocol

Post Cardiac Arrest Comprehensive Multidisciplinary Protocol

I. Scope

Physicians (Emergency, Cardiology, Critical Care/Pulmonary, & Neurology); Nurses (Emergecy, Rapid Response/Sepsis, Critical Care & Cath Lab/IR), Respiratory Therapists, Pharmacists, and Dietitians,

II. Key Words

@post cardiac arrest, @protocol, @Resuscitation Standards

III. General Description

A. Post cardiac arrest syndrome (PCAS), an inflammatory state resulting from an ischemia-reperfusion injury impacting multiple organ systems, creates systemic chaos. In PCAS, 4 major areas must be addressed including the systematic ischemia and reperfusion injury, brain injury, myocardial dysfunctic and persistent precipitating pathology. Multidisciplinary teams/practitioners from the ED to Cath Labs the ICU must practice in synchrony to optimize care.

B. Comprehensive Post Cardiac Arrest (PCA) care is necessary to address the systemic effects of the ischemia-reperfusion injury following cardiac arrest. Growing evidence suggests that it is critical for bc patient survival and optimal neurological outcome. The Joint Commission and American Heart Association Guidelines for CPR/ECC recommend implementation of a comprehensive structure, and multidisciplinary protocol to optimize survival and neurologic outcome (Joint Commission Performanc Standard PC.02.01.20).

C. An evidence-based review of current literature including recommendations from the AHA/ILCOR and scientific studies were analyzed by a multidisciplinary team of practitioners. Consensus was achieved and the protocol developed to address care team interventions and priorities in managing the post-cardiac arrest patient population.

IV. Purpose

This protocol addresses the multidisciplinary management of the post-cardiac arrest patient population

Post Cardiac Arrest Comprehensive Multidisciplinary Protocol. Retrieved 06/2022. Official copy at http://phs-camissionviejo.policystat.com/policy/11632507/. Copyright © 2022 CA - Providence Mission Hospitals

Page 1 of 2

Performance Metrics

- The Number And Location Of Cardiac Arrests
- Outcomes Of Resuscitation (Return Of Spontaneous Circulation or Survival To Discharge)
- Transfer To A Higher Level Of Care
- Review Arrests In Non-monitored Or Non-critical Care Units For Any Early Warning Signs Of Clinical Deterioration Present Prior To Arrest
- Timeliness Of Staff's Response To A Cardiac Arrest & Rates The Quality Of Cardiopulmonary Resuscitation (CPR)
- Post–cardiac Arrest Care Processes & Outcomes Following Cardiac Arrest

Source: Joint Commission. 2021. Resuscitation Standards for Hospitals. R3 Report: Requirement, Rationale, Reference. Issue 29, June 18, 2021.

Indicators	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Number of Codes	44	24	25	26
PATIENT VARIABLES				
Location of Codes				
1. ED	8	2	2	5
2. IICU AND CICU	4 + 8=12	15	16	14
3. SICU	10	2	0	2
4. DSU	0	1	2	0
5. Cardiac/Telemetry	4	1	2	0
6. PCSU/Stroke Unit	1	0	0	0
7. 3 east surgical	0	0	0	0
8. 3 west medical	1	0	1	0
9. Labor/Delivery/post-partum	0	0	0	0
10. Radiology	4	1	0	0
11. Cath Lab	3	2	1	1
12. OR/PACU/Outpatient	0	0	0	0
13. ARU	0	0	1	0
14. TSN/CDU	0	0	0	1
15. Tele Sepsis	1	0	0	1
16. MHLB: ICU	0	0	0	0
ACLS Interventions at time of event				
1. None				
2. IV access	44	24	25	26
3. IV medications	28	20	18	17
4. Intubation	18	17	8	16
5. Mechanical Ventilation	18	17	8	16
6. Implantable Defib/Cardioverter	0	0	0	

Indicators	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Initial Rhythm				
1. Ventricular fibrillation	2	2	2	1
2. Ventricular tachycardia	1	2	2 with P	2
3. PEA	29	19	16	14
4. Bradycardia			0	0
5. Asystole	7	1	1	8
6. Perfusing Rhythm	4 + 1 UNK		4	1
Event Times: From collapse/onset to				
1. CPR started	42 Imm	24 imm	19 imm	25 imm
2. 1st Defib shock	12 min	3 min	4 imm	3 imm
3. Airway achieved	6 min	5 min	2 min	6 min
4. 1st dose of epi	1 min	2 min	2 min	1.2 min
CPR stopped				
1. ROSC (return of circulation)	38	19	12+4int	19+1int
2. Futile				
3. Death	6	5	9	6
4. DNAR				
Length of Arrest	16.1 min	19.6 min	16.5 min	18 min
HOSPITAL/SYSTEM VARIABLES				
Documentation of observed codes	Y N U	Y N U	Y N U	Y N U
1. Crash cart stocked	30 14	19 5	24 1	22 4
2. Code clearly announced	30 14	19 5	24 1	22 4
3. Medications available	30 14	19 5	24 1	22 4
4. Adequate # responders	30 14	19 5	24 1	22 4
Team responders present/timely				
1. Physician	30 14	19 5	24 1	22 4
2. Pharmacist	28 2 12	19 5	24 1	22 4
3. Critical care/ED nurse	30 14	19 5	24 1	22 4
4. Respiratory therapist	30 14	19 5	24 1	22 4
Team leader clearly identified	30 14	19 5	24 1	22 4
Orders given clearly	30 14	19 5	24 1	22 4

Indicators	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
OUTCOME VARIABLES				
In-Hospital Event		1 inpt		
1. Hospital Discharge	12	1	2	6
a. Average GOS	3.9	3	5	3.8
b. LOS	17.7	38	27.5	19
c. Destination				
1) Home				
2) SNIF				
3) ARU				
4) Other hospital				
2. In-Hospital Death	31	17	23	19
a. At Code Blue	15		16	6
b. Within 24 hours of code	16		9	8+
c. ROSC > 24 hours	9.4		54	4
1) Mean LOS				8
3. If died, principal cause of death				
a. CAD				
b. Cancer				
c. Trauma				
d. Stroke				
e. Other				
Debriefing after Cardiac Arrest	78 %	87%	84%	90%
ET CO2 monitoring used	47 %	83%	52%	57%

Indicators	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Age				
1. 18 to < 25 years	0	0	0	0
2. 25 to < 35 years	3	6same pt	0	0
3. 35 to < 45 years	2	1	3	0
4. 45 to < 55 years	3	1	1	4
5. 55 to < 65 years	15	5	8	6
6. 65 to < 75 years	6	3	8	8
7. 75 to < 85 years	11	4	1	4
8. 85 and older	5	4	4	5
Gender				
1. Male	29	19	15	17
2. Female	15	5	10	9
Witnessed Arrest				
1. Yes	43	24	24	25
2. No	1	0	1	1
Monitored prior to arrest				
1. Yes	41	24	18	25
2. No	3	0	7	1
EVENT VARIABLES				
Resuscitation attempted?	Y N U	Y N U	Y N U	Y N U
1. Chest compressions	38 4	24	19 6	25 1
2. Defibrillation	7 37	7	5	5 21
3. Airway	44	24	25	26
4. None				
a. Found dead				
b. Considered futile				
c. DNAR				
Initial Resuscitation Condition	Y N U	Y N U	Y N U	Y N U
1. Conscious	2 42	0 24	6 20	26
2. Breathing	2 42	0 24	2 23	26
3. Pulse	4 38	0 24	6 19	1 25

Indicators	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Equipment/supplies available/function	Y N U	Y N U	Y N U	Y N U
1. Monitor	30 14	19 5	24 1	22 4
2. Defibrillator	30 14	19 5	24 1	22 4
3. Airway tray	30 14	19 5	24 1	22 4
Resuscitation Management within AHA Guidelines	44	24	25	26
IF NO, % cases				
1. Establishment of airway difficult or unable to maintain airway				
2. Unable to obtain IV access				
3. Drug inappropriate for rhythm				
4. Drug dose incorrect				
5. Drug route of admin incorrect				
6. Defibrillation use inappropriate for rhythm				
7. Defibrillation joules incorrect				
8. Other				
Was resuscitation record documentation complete?	Yes No	Y N	Y N	Y N
1. Section I	42 2	21 3	24 1	26
2. Section II	29 15	20 4	24 1	22 4
3. Section III	39 3	22 2	24 1	25 1
4. Section IV	40 4	23 1	24 1	26
5. Section V	42 2	23 1	24 1	25 1

Issue Identified	Actions taken to resolve issue
Cases Reviewed: Failure to Rescue – Codes outside of ICU/ED Case 1: 79 yo admitted to Cartel - arrested 50 minutes after arrival. Pt with recent H/O hip fracture, DIC, COPD and dry gangrene of bilat hands/feet. Also, H/O CHF, pacemaker. Admitted with worsening encephalopathy, GIB, acute renal insufficiency. Pt seen by RRT at 1600 for neuro change, requiring ABG/CXR-added to rounds. MRI from previous noc, negative for acute CVA. Seen again at 1630 for coarse breath sounds requiring suction. Noc RRT proactively rounded at 2100 and increased oxygen. RRT called 2300 for hypotension, increased alt loc. IVF being given when pt became unresponsive with agonal reps-code blue called.ROSC, to SICU, comfort care later-expired,. Areas for improvement: inappropriate floor placement? Also, pt in and out of AFib all day, recent DIC, with neuro changes noted,. No repeat CT done-unsure if neuro changes were new or not. Discussed with both RRTs on case. Forwarded to Kelly, clinical coordinator, for follow up with primary RN. Case 2: 61 yo male admitted to Cartel 9 hours prior to code from ED. Pt with H/O morbid obesity, OSA, PAF, DM, recurrent nonhealing wounds/osteomyelitis. Admitted with recurrent foot infection with home wound vac. Pt went into respiratory distress, CPR done for 1-2minutes although no proof of loss of pulse. Intubated, SICU. Imaging neg for PE Case 3: 78 yo male admitted to 3 West (Day 4) Pt with H/O stageIV panc CA. Admitted with syncope, dehydration, and arrest at home with bystander CPR. On 3W, pt had episode of resp distress, witnessed by daughter, which turned into code blue. Intubated,ROSC, to SICU. Cause: aspiration. Area for improvement: 0740 BP 84/53, without note indicating that MD was notified, or any intervention done. Case 4: 67 yo female sent from ED to MRI (admit Cartel) - H/O HTN, DM. Admitted with syncopal event and ARF. Pt left ER at 2204 to go to Cartel. Pt was taken to MRI and left. Found unresponsive in MRI hallway, code blue, ROSC, to SICU. Hg found to be 5.8, without E/O bleeding. Code hemorrhage called. Pt coded again and expired. Area for improvement: pt was ordered to be on telemetry and was left unattended in MRI, without RN or monitor Case 5: 30 yo male admitted to Cartel and arrested 15 hours after admit from ED. H/O polysubstance abuse, bipolar disorder, schizoaffective disorder, GAD, suicidal ideation. Admitted after seizure-like activity and welbutrin overdose. RN notified MD that pt looked bad; CXR and ABG ordered by MD; RT and RRT called and present when pt had asystolic arrest, ROSC, CICU. Pt coded again, VFib, ROSC, changed to comfort care, expired. AM WBC increased from 8.4 to 15.2. Pt was a coroner's case. No area for improvement identified.	1) RRT and RT had been called multiple times. CC had been in room throughout shift to assist bedside RN. Patient should have been DSU? MD declined repeat head CT. No ICU beds, No DSU beds—was on contingency. 2) NO AREA for improvement 3) Forwarded to nurse manager, Mindy, for follow up RN educ. Otherwise, no area for improvement identified. Will discuss in resuscitation meeting. AM BP was not called to MD- NM educated RN. 4) This has already been escalated and led to the evolution of the transport nurse. Will discuss in resuscitation committee. 5) No area for improvement identified. Need to look at guidelines for QTc monitoring for OD and tele tech knowledge. Also need to work on workflow for RN/TT being aware for orders for ECG and QTc monitoring. Reviewed with nurse manager

Implication for practice

Implementing recommendations from a regulatory body in healthcare that calls out **an evidence-based and interdisciplinary** approach requires establishing a plan that includes:

1. Identify key stakeholders and front-line staff: Meet with Team Leads prior to 1st meeting
2. Using an EBP model to approach issue
   - PICO Question(s)
   - Pull articles/assign to team members
   - Evidence table set up
3. Establish critical time-line and expectations
4. Organize large team/small team-work prior to 1st meeting
5. Translate consensus to Clinical Protocol
6. Measure ongoing Performance

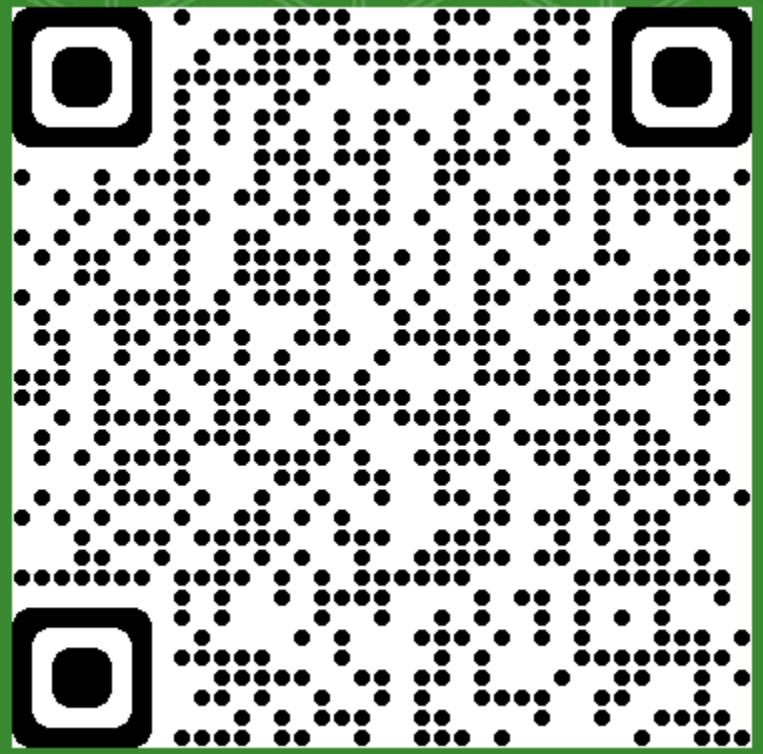
Conclusion

Translation of Evidence-Based Literature to Practice using an EBP Framework brings the multiple disciplines together.

The team's ability to read and summarize the science, present it to the multidisciplinary team, engage in dialogue and come to consensus on target goals and interventions provides a strong foundation for practice.

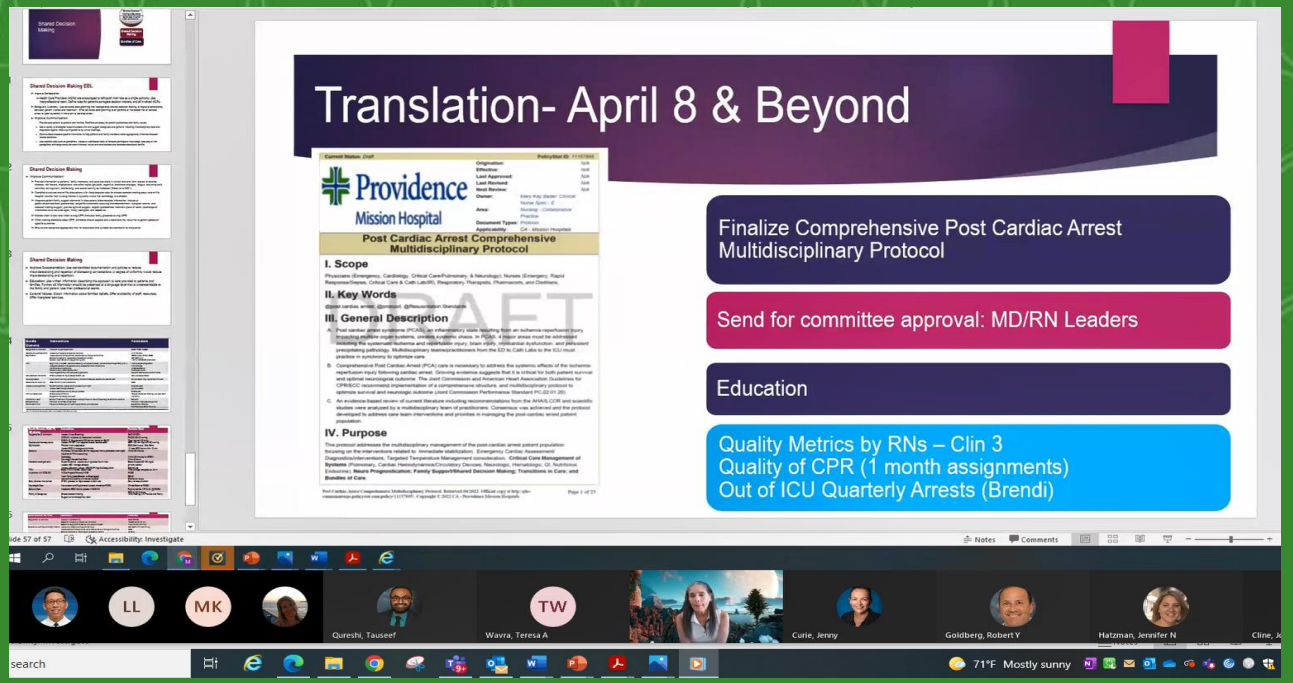
Presenting the translation of the evidence to non-members of the EBP team was enhanced by having physician/nurse champions present the protocol and achieved buy-in and adoption to practice.

References listed in Policy Stat Protocol



Acknowledgements

- Mary Kay Bader
  - Neuro/Critical Care CNS/Co-chair Resuscitation Committee
- Teresa Wavra
  - Cardiac CNS
- Dr Tauseef Qureshi
  - Medical Director Critical Care
- Dr Jon Cline
  - ED Physician/ Co-chair Resuscitation Committee
- Marne Andersen
  - CICU Manager/ Co-chair Resuscitation Committee



Questions?

Mary Kay Bader RN MSN CCNS

- Providence Mission Hospital
- Neuro/Critical Care CNS
- Marykay.Bader@stjoe.org

Teresa Wavra RN MSN CNS

- Providence Mission Hospital
- Cardiac CNS
- Teresa.Wavra@stjoe.org

Marne Andersen RN MSN

- Providence Mission Hospital
- Nurse Manager ICUs
- Marne.Andersen@stjoe.org

Tauseef Qureshi MD

- Providence Mission Hospital
- Pulmonary/Neuro Intensivist & Medical Director of Critical Care
- Tauseef.Qureshi@stjoe.org

Jon Cline MD

- Providence Mission Hospital
- ED Physician
- Jon.Cline@stjoe.org