



60th Annual Meeting

Sparkle Shine Celebrate!

Pulse Check: Reviewing the Management of the Cardiac Arrest Patient – What They Don't Teach You in ACLS

Jazmyne Jackson, Pharm.D.
Patrick Funderburk, Pharm.D., BCEMP
Memorial Healthcare System

August 9, 2026

1



60th Annual Meeting

Sparkle Shine Celebrate!

Disclosure

I, **Patrick Funderburk**, do not have a vested interest in or affiliation with any corporate organization offering financial support or grant monies for this continuing education activity, or any affiliation with an organization whose philosophy could potentially bias my presentation (within the last 12 months).

I, **Jazmyne Jackson**, do not have a vested interest in or affiliation with any corporate organization offering financial support or grant monies for this continuing education activity, or any affiliation with an organization whose philosophy could potentially bias my presentation (within the last 12 months).

2



60th Annual Meeting

Sparkle Shine Celebrate!

Pharmacist Objectives

1. Evaluate evidence for emerging therapies for refractory ventricular dysthymias include dual sequence defibrillation, vector change, beta blockers, and stellate ganglion block
1. Describe how underlying etiologies (e.g., hypothermia, hyperkalemia, severe acidosis, toxicologic causes, pregnancy, pulmonary embolism) impact medication selection or dosing outside standard ACLS algorithms
1. Design strategies for optimizing pharmacy workflow during cardiac arrest events, including medication preparation, cognitive aids, and minimizing delays for non-standard medications
1. Apply evidence for the use of alternative cardiac arrest escalation medications and tools to a patient case.

3



60th Annual Meeting

Sparkle Shine Celebrate!

Technician Objectives

1. Identify critical medications necessary in cardiac arrest management
1. Design strategies for optimizing pharmacy workflow during cardiac arrest events, including medication preparation, cognitive aids, and minimizing delays for non-standard medications

4



60th Annual Meeting

Sparkle Shine Celebrate!

Chapter 1: Details of the Basics

5



60th Annual Meeting

Sparkle Shine Celebrate!

What is high quality CPR to you?

Preparation

Appropriate Compressions

Early Defibrillation

Minimized Interruptions

Evidence Based Medicine

Closed Loop Communication

6

FSHP

60th Annual Meeting

Sparkle Shine Celebrate!

Phases of Cardiac Arrest

Electrical	Circulatory	Metabolic
<5 min - Shockable rhythm ~75%	5-12 minutes - Focus to restore blood flow to heart	>12 minutes - Build up of toxins

7

FSHP

60th Annual Meeting

Sparkle Shine Celebrate!

The Journey to Today

Vasoactive studies on mongrel dogs

1960s

Need for guidelines

1966

JAMA Standards of Care

1974

Multiple iterations of guidelines with little change

1980-2000s

AHA ACLS Guideline and Executive Summary

2020s

Most recent guideline update

2025

JAMA. 1966;198:372-379
 JAMA. 1974;227(suppl):852-860

8

FSHP

60th Annual Meeting

Sparkle Shine Celebrate!

Redding and Pearson (1963)

TABLE 1. Drug protocol for pretreatment and resuscitation

	Group A	Group B	Group C
No. Dogs	11	10	10
Pretreatment	Phenoxybenzamine	Propranolol	None
Resuscitation	Isoproterenol	Phenylephrine	Epinephrine

Anesthesiology 24:203 1963

9

FSHP

60th Annual Meeting

Sparkle Shine Celebrate!

Redding and Pearson (1963)

TABLE 2. Experimental observations

	Group A	Group B	Group C
No.	11	10	10
Resuscitated	3*	10	10
Mean time to circulatory arrest, min:sec (SE)	12:01 (1:10)	12:17 (0:54)	10:13 (0:28)
Mean time to restoration of spontaneous circulation, min:sec (SE)	2:14 (0:28)*	1:29 (0:19)	1:04 (0:18)
Mean diastolic pressure upon resumption of spontaneous circulation, mm Hg (SE)	10 (1)*	38 (4)	40 (7)

* Significantly different ($p < 0.05$) from groups B and C.
 * Significantly different ($p < 0.05$) from group C.

Anesthesiology 24:203 1963

10

FSHP

60th Annual Meeting

Sparkle Shine Celebrate!

Reading and Pearson (1963)

- Artificial ventilation
- Effective closed chest cardiac massage
- Vasoactive agents that were not pure beta agonists

11

FSHP

60th Annual Meeting

Sparkle Shine Celebrate!

Good for the heart, not for the brain?

- Alpha-2 adrenoceptors
 - Platelet aggregation
- Microvascular Ischemia
 - Is 1 mg still the right dose?
 - Using same dose as animal models from 1960s

Neth Heart J (2019) 27, 341-342

12

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Epinephrine

- Epinephrine increases rates of ROSC in non-shockable rhythms
- High use of epinephrine is correlated to worse neurological outcomes and refractory shockable rhythms
- We do not know what the most optimal dose is

13

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Other medications with utility in crashing patient!

14

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Chapter 2: Specific Etiologies

15

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Refractory Ventricular Arrhythmias

16

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Epidemiology

- EMS provides initial treatment to 83.4 individuals with OHCA per 100,000 annually
- Risk factors
 - Hypertension (*pre-existing*)
 - Prior MI
 - STEMI changes (*at presentation*)
 - Chronic Obstructive Pulmonary Disease

J Am Coll Cardiol. 2018;72(14):e91-e220.

17

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

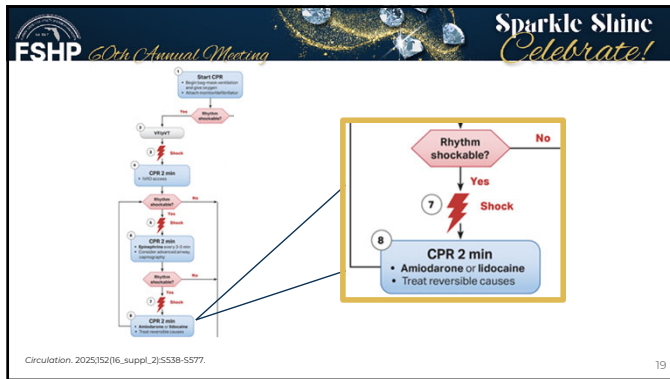
Ventricular Fibrillation (VF)

Recurrent	Refractory	Pragmatic Refractory
Return of VF after confirmed successful earlier defibrillation	VF that is <i>not</i> terminated with any of the initial 3 shocks	VF that is visible at rhythm check 2 minutes after a <i>third</i> defibrillation +/- confirmation of unsuccessful defibrillators at any of the previous 3 defibrillation shocks

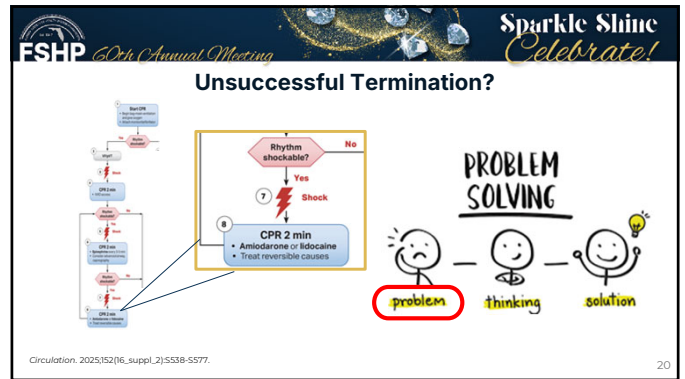
Referred to as "persisting VF" in ALS 2025 Guidelines

J Am Heart Assoc. 2025;14(21):e044130.

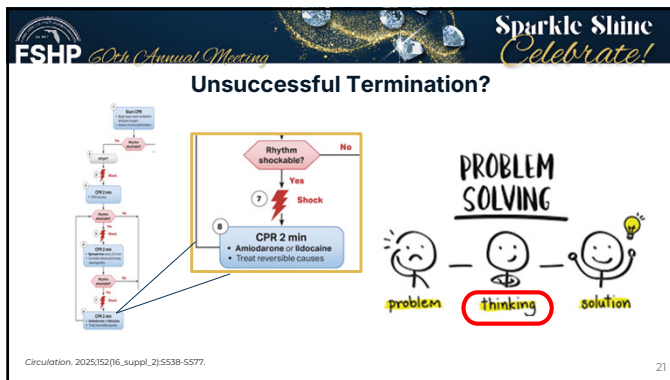
18



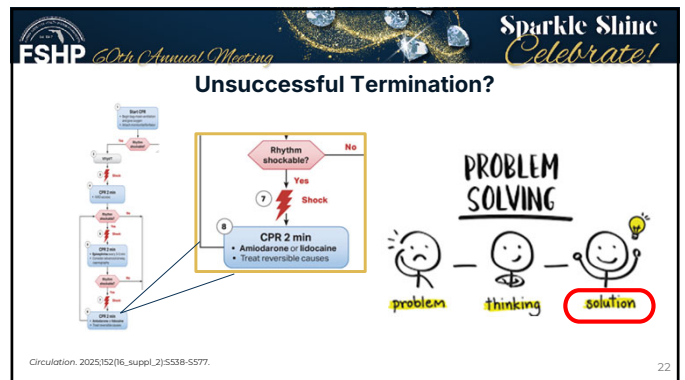
19



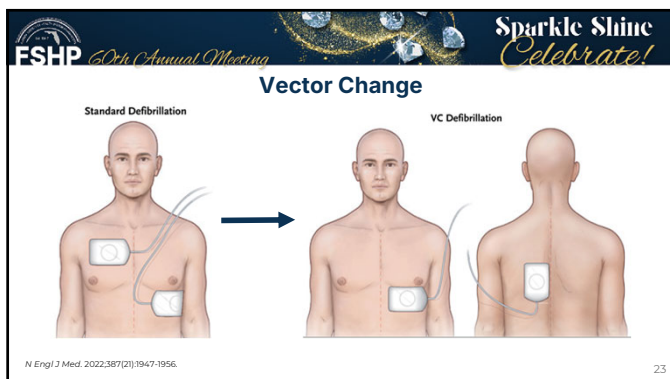
20



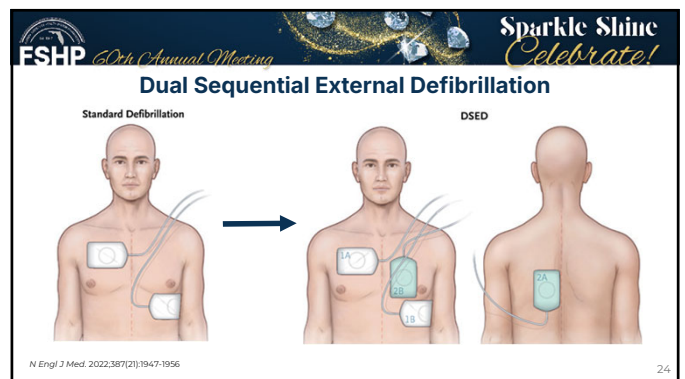
21



22



23



24



FSHP

60th Annual Meeting



Sparkle Shine
Celebrate!

Theories

01

Threshold Theory

02

Vector Theory

25

Recommendations for Vector Change and Double Sequential Defibrillation		
COR	LOE	Recommendations
2b	B-R	1. The usefulness of vector change for adults in cardiac arrest with persisting VF/pVT after ≥ 3 consecutive shocks has not been established.
2b	B-R	2. The usefulness of double sequential defibrillation for adults in cardiac arrest with persisting VF/pVT after ≥ 3 consecutive shocks has not been established.

26



ESHP 60th Annual Meeting



Sparkle Shine
Celebrate!

Clinical Considerations

- Delay in continuation of CPR
- Technique competency
- Device integrity



27

27

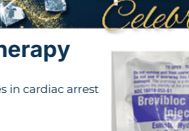


6th Annual Meeting

Beta-Blockade Therapy

Sparkle Shine
Celebrate!

- Accumulation of endogenous and exogenous catecholamines in cardiac arrest
 - $\uparrow$ MVO_2 demand = $\uparrow$ risk of ischemia + $\uparrow$ VFib threshold
 - Use in electrical storm
- Esmolol (*Brevibloc*®)
 - Load: 500 mcg/kg, followed by 50 mcg/kg/min continuous infusion
 - Onset: $\leq$ 2 minutes
- Gottlieb and colleagues: Beta-blockade may be associated with improved outcomes, including ROSC, survival to admission, survival to discharge, and survival with favorable neurological outcomes



28



FSHP 60th Annual Meeting

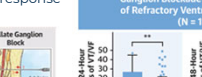


Stellate Ganglion Block

Spark Shine
Celebrate!

- Interrupts and mitigates excessive sympathetic response
- Anesthetic options utilized
 - Lidocaine
 - Bupivacaine
 - Ropivacaine
- Left vs. Right GSB
 - Decrease in HR
 - QT prolongation

D 2-Center Experience With Stellate Ganglion Block for the Treatment of Refractory Ventricular Arrhythmia (N = 117)



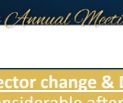


JACC Clin Electrophysiol. 2024;10(4):750-758. | Sci Rep. 2024;14(1):24779.

29



FSHP
60th Annual Meeting



**Sparkle Shine
Celebrate!**

In Summary...



Vector change & DSED: usefulness remains unestablished, but is considerable after 3 initial defibrillation attempts



Esmolol: considerable in prolonged cardiac arrest, acts as a “catecholamine washout”



Stellate Ganglion Block: has been associated with termination of refractory ventricular dysrhythmias

30

30

A decorative banner for the 60th Annual Meeting. On the left is the FSHP logo. In the center, a shooting star with a long, golden, sparkling tail streaks across a dark background. On the right, the text "Sparkle Shine Celebrate!" is written in a white, elegant script font.

31



ESHP
60th Annual Meeting



**Sparkle Shine
Celebrate!**

Swiss Staging System for Hypothermia

Stage	Symptoms	Suspected core temperature
I	Conscious and shivering	89.6 to 95°F (32 to 35°C)
II	Altered mental status, not shivering	82.4 to 89.6°F (28 to 32°C)
III	Unconscious, not shivering, vital signs present	75.2 to 82.4°F (24 to 28°C)
IV	No vital signs	< 75.2°F (< 24°C)

Am Fam Physician. 2019;100(11):680-686a

32

32

Phases of Hypoxic Injury

- 1 EARLY**
Absence of cerebral blood flow
- 2 IMMEDIATE**
Release of excitatory amino acids and glutamate activate cytotoxic cascades
- 3 LATE**
Breakdown of blood-brain barrier, exacerbation of cerebral edema, and neuronal death

33

Neuroprotective Effects Hypothermia

- Reduction in **brain metabolism**
- Attenuation of **neuroexcitotoxic cascade**
- Destruction of **reactive oxygen species**
- Inhibition of **apoptosis**

Hypothermia

The diagram illustrates the following pathways and interventions:

- Excitotoxicity** leads to **Ca²⁺ homeostasis imbalance** (Ca²⁺ influx, Ca²⁺-mediated signaling cascades).
- This leads to **Mitochondrial metabolism disorder** (ROS, ATP production, oxidative stress levels are increased).
- This leads to **Misfolded proteins** (ER stress, autophagy and apoptosis are induced).
- This leads to **NAD⁺ depletion in excitotoxicity** (cellular homeostasis is disrupted).

Hypothermia (indicated by a large red X) is shown to intervene and reduce the excitotoxic cascade.

34



ESHP
60th Annual Meeting



**Sparkle Shine
Celebrate!**

Management of Environmental Hypothermia

- Life-threatening environmental hypothermia: core temperature < 30°C (86 °F)
- Continue compressions
- Defibrillate vs. deferred defibrillation
 - ≥ 30 °C threshold
 - Risk of Injury
- Vasoactives
 - May consider holding epinephrine until core temperature is ≥ 30°C

35



ESHP

20th Annual Meeting

*Sparkle Shine
Celebrate!*

Rewarming Methods for the Hypothermic Patient



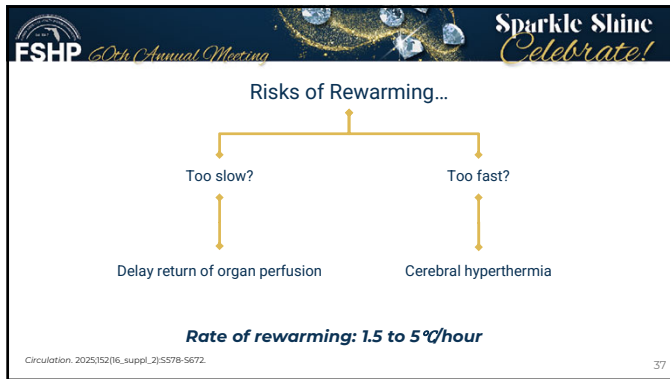




Circulation, 2025;152(16,suppl_2):S578-S672.

36

36



37



38

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Extracorporeal Life Support

Transfer Time: within 6 hours

- Extracorporeal Life Support (ECLS = gold standard)
 - Venous/Arterial (VA) Extracorporeal Membrane Oxygenation (ECMO) - preferred
 - Cardiopulmonary Bypass (CPB)
- Continue CPR until ECLS is established

Circulation. 2025;152(16_suppl_2):5578-5672.

39

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Indications for Extracorporeal Life Support

ECLS is indicated in a **HYPOTHERMIC** patient (core temperature <30°C [86°F]) with:

HEMODYNAMIC INSTABILITY
HYPOTENSION <90 mmHg AND/OR VENTRICULAR ARRHYTHMIA

OR

HYPOTHERMIC CARDIAC ARREST
AN ESTIMATED PROBABILITY OF SURVIVAL BY HOPE SCORE ≥10%
<https://hypothermiascore.org/>
Accidental hypothermia patients with no signs of life can have good outcomes.

DO NOT EXCLUDE PATIENTS WITH

Extracorporeal rewarming is appropriate for patients with any of these features.

Hypothermic cardiac arrest is different than normothermic cardiac arrest! In hypothermic cardiac arrest, do not use criteria for ECPR that apply to normothermic patients.

ASAIO J. 2025;71(11):B65-874.

40

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Medication Management

- Prior to cannulation, continue standard ACLS measures...
 - Epinephrine
 - Defibrillation (guide wire insertion = electrocution risk - caution!)
 - Reasonable to defer defibrillation following guide wire insertion until established support
- Once ECMO has been established...
 - Hold** further epinephrine boluses
 - Hypertension risk following circulation via VA ECMO support
 - Wean vasopressor and inotrope infusions

ASAIO J. 2021;67(3):221-228.

41

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

In Summary...

- Hypothermia has neuroprotective effects
- Continue compressions; defibrillation and/or epinephrine may be deferred
- If eligible, ECLS should not be delayed (ECMO > CPB)
- Hypothermic cardiac arrest ECMO criteria ≠ standard criteria

42

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Acidosis/Toxidromes

43

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Hyperkalemia - Calcium Chloride

A

B

Kaplan-Meier time to ROSC

Crit Care Med. 2024;52(10):1499-1508 | Resuscitation. 2023 Oct;91:109933. | Critical Care Medicine 52(2):p e67-e78

44

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Hyperkalemia - Sodium Bicarbonate

- Sodium bicarbonate**
 - Hyperkalemia:** 50 mEq IV bolus
 - Na⁺ channel blocker overdose:** 50 to 150 mEq IV bolus, followed by continuous infusion

Kaplan-Meier time to ROSC

Circulation. 2023;148(6):e149-e184. | Critical Care Medicine 52(2):p e67-e78

45

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Hyperkalemia - Insulin

- Hyperkalemia:** regular insulin 10 units IV bolus
 - Case study – Report of high-dose insulin (1 unit/kg IV)
- Calcium channel blocker or Beta-blocker overdose:** High Dose Insulin infusion

High-Dose Insulin for Hyperkalemic Cardiac Arrest

Mohammed A. Shikhooun, MD,¹ Loai A. Abdulhadi, MD,²
 Wael M. Yafes, MD,³ Moataz R. Saleh, MD,⁴ Sue Anne Corsentino, MS, ACNP-BC,⁵
 and Enrique J. Pantin, MD^{6*}

Ann J Ther. 2023;30(5):e426-e432. | Circulation. 2023;148(6):e149-e184. | Clin Toxicol (Phila). 2011;49(4):277-283.

46

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Lipid Sink Theory

- Dose: 1.5 mL/kg bolus, max bolus dose: 100 mL
- Indications
 - Local Anesthetic Systemic Toxicity (LAST)
 - Bupivacaine – high potency at cardiac Na⁺ channels
 - Tricyclic Antidepressants
 - Calcium Channel Blockers
 - Bupropion, Lamotrigine, Quetiapine

3 Perianesth Nurs. 2015;30(4):308-320. | Ann Intensive Care. 2025;15(1):181.

47

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Pulmonary Embolism

48




Massive High Risk PE Management

- Clinical Manifestations

Angina	Dyspnea	Diaphoresis
HD instability (SBP < 90)	Acute RV failure	PEA/Asystole
- First line reperfusion therapy: systemic thrombolysis (alteplase or tenecteplase)
 - American College of Chest Physicians (CHEST)
 - European Society of Cardiology (ESC)
 - National Pulmonary Embolism Response Team (PERT)

49



FSHP

60th Annual Meeting



**Sparkle Shine
Celebrate!**

Massive High Risk PE Management

	Tenecteplase (TNK)	Alteplase (tPA)
Massive, high-risk PE	< 60 kg: 30 mg ≥ 60 to < 70 kg: 35 mg ≥ 70 kg to < 80 kg: 40 mg ≥ 80 kg to < 90 kg: 45 mg ≥ 90 kg: 50 mg	100 mg infused over 2 hours
PE associated with Cardiac Arrest		50 mg bolus, may repeat 50 mg bolus if ROSC not achieved (total 100 mg)
FDA Indication	X	✓

50

ESHP 60th Annual Meeting *Sparkle Shine Celebrate!*

How long should advanced cardiovascular life support measures be continued?

ESC **60 to 90 minutes** **CHEST**

Chest. 2019;156(6):1035-1036. | Eur Heart J. 2020;41(4):543-603.

51

51



FSHP

50th Annual Meeting



In Summary...

- Alteplase currently holds FDA indication for pulmonary embolism
- No recommendations made between TNK and tPA
- If indicated, eCPR should not be delayed
- You **must** commit to the bit! – Team is committing to additional CPR time

52

A decorative banner at the top of the slide. On the left is the FSHP logo (a stylized arch over the letters FSHP) and the text "60th Annual Meeting". On the right is the text "Sparkle Shine Celebrate!" in a cursive font, with a graphic of a shooting star or comet. Below this banner, the word "Pregnancy" is written in a large, white, sans-serif font on a dark blue background.

53



FSHP

2023 Annual Meeting



**Sparkle Shine
Celebrate!**

Epidemiology and Maternal Mortality

- Epidemiology
 - From 2017 to 2019, cardiac arrest occurred in ~1 in 9,000 in-hospital deliveries
 - Higher than previous estimates of incidence of cardiac arrest in ~1 in 12,000 deliveries
 - Maternal mortality rate in the U.S.: 23.8 deaths per 100,000 live births
- Who is at risk?
 - Black women – *3x more likely to experience pregnancy-related death*
 - Advanced maternal age (≥ 35 years old)
 - Underlying medical conditions

JAMA. 2023;329(14):1143. | J Racial Ethn Health Disparities. 2024;1(6):3658-3677.

54

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Managing Cardiac Arrest in Pregnancy

- Two patients
 - Mother and fetus
- Resuscitation priorities
 - Airway management
 - Left lateral uterine displacement (LUD)
 - Relieves aortocaval compression

Am J Obstet Gynecol. 2026;233(6):S272-S279.

55

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Obstetric Life Support

Maternal cardiac arrest
No pulse, no response

- Initiate obstetric life support
 - Start ventilation and chest compressions
 - Call for the maternal cardiac arrest and neonatal teams
 - Call for a resuscitative cesarean delivery
 - Remove fetal monitor

Continuous high-quality chest compressions and left uterine displacement until delivery

Resuscitation algorithm flowchart:

```

graph TD
    Start([Maternal cardiac arrest  
No pulse, no response]) --> Init[Initiate obstetric life support  
• Start ventilation and chest compressions  
• Call for the maternal cardiac arrest and neonatal teams  
• Call for a resuscitative cesarean delivery  
• Remove fetal monitor]
    Init --> Rhythm{Rhythm  
absent?}
    Rhythm -- Yes --> Shock[Resuscitative cesarean delivery  
• Shock  
• Cardiorespiratory resuscitation for 2 minutes  
• Intravenous/interosseous access  
• If refractory ventricular fibrillation/pulsless ventricular tachycardia, start epinephrine every 3-5 minutes  
• Consider advanced airway/capnography]
    Rhythm -- No --> AED[Apply/prepare electrical activity]
    AED --> CPR[Cardiorespiratory resuscitation for 2 minutes  
• Intravenous/interosseous access  
• Epinephrine every 3-5 minutes  
• Consider advanced airway/capnography]
    Shock --> Perf[Perform resuscitative cesarean delivery at 4 minutes if no return of spontaneous circulation]
    CPR --> Perf
    Perf --> Post[Start post-arrest care if there is a return of spontaneous circulation. Consider targeted temperature management.]
    Perf --> Post2[Start extracorporeal cardiorespiratory resuscitation if there is no return of spontaneous circulation after delivery.]
  
```

Am J Obstet Gynecol. 2026;233(6):S272-S279.

56

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Potential Etiologies of Maternal Cardiac Arrest (A-G Mnemonic)

Etiologies of Cardiac Arrest

- A Anesthetic complications
- B Bleeding
- C Cardiovascular
- D Drugs
- E Embolic (amniotic fluid or pulmonary embolism)
- F Fever
- G General causes (H's and T's)
- H Hypertension (eg, preeclampsia)

Circulation. 2025;152(16_suppl_2):S578-S579.

57

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Resuscitative Delivery

- Resuscitative Cesarean Delivery
 - "4-minute rule"
 - Optimizes both maternal and fetal outcomes
 - Language shift: fetal salvage + maternal resuscitation
 - Purpose: Pressure placed on the IVC can compromise venous return to the heart → reduce cardiac output, thus preventing effective circulation

Recommendations for Pregnant Patients in Cardiac Arrest		
COR	LOE	Recommendations
1	B-NR	1. Resuscitative delivery is indicated for a pregnant patient in cardiac arrest when fundal height is at or above the umbilicus and ROSC is not achieved with standard resuscitation.
1	B-NR	2. Preparation for resuscitative delivery for a pregnant patient in cardiac arrest should begin at the recognition of cardiac arrest, with the goal to complete delivery by 5 minutes.

Am J Obstet Gynecol. 2026;233(6):S272-S279.

58

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

In Summary...

- Two patients – shift to maternal resuscitation from fetal salvage
- Left lateral uterine displacement relieves aortocaval compression
- A-G Bundle: specific obstetric and peripartum causes of death

59

59

FSHP 60th Annual Meeting Sparkle Shine Celebrate!

Chapter 3: How to we improve?

60

60

A decorative banner for the 20th Annual Meeting. On the left is the FSHP logo. In the center, the text '20th Annual Meeting' is written in a gold script font. On the right, the text 'Sparkle Shine Celebrate!' is written in a large, bold, gold serif font. The background of the banner features a dark blue space theme with a gold comet streak, stars, and several grey, rock-like objects.

61



FSHP

60th Annual Meeting



Sparkle Shine
Celebrate!

Improving Outcomes - Cognitive Aids

- Used in all industries
 - Healthcare
 - Alarms
 - Mnemonics
 - Check lists
- Use of decision support tools in ACLS
 - In room display of algorithms
 - Utilization of software/applications
 - Embedded EHR Narrators

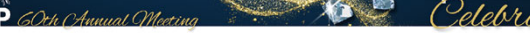
62

Improving Outcomes - Feedback Devices/Roles

- Simulation/Training
- Defibrillator Feedback
- Appropriate Coaches
- Ventilation
- High Quality Chest Compressions

Optimizing Oxygenated Perfusion

63



Improving Outcomes - Medication Procurement

- Resuscitation ADC
 - Dedicated machines in high resuscitation areas (ED/ICU)
- Code Bags (Pharmacy Code Response)
 - Carry one off medications that have less routine utility
- Process from Main Pharmacy
 - Dedicated Code Technician/Pharmacist Support Staff

64



60th Annual Meeting

Sparkle Shine
Celebrate!

How Do We Improve - Summary

- Cognitive aids may assist in protocol adherence but real world application needs to be evaluated
- Coaches and feedback devices should be routine
- Strategies should be implemented to decrease delays medication procurement

65

[illegible]

66



FSHP 60th Annual Meeting

Sparkle Shine
Celebrate!

**Pulse Check: Reviewing the Management
of the Cardiac Arrest Patient –
*What They Don't Teach You in ACLS***

Jazmyne Jackson, Pharm.D.
Patrick Funderburk, Pharm.D., BCEMP
Memorial Healthcare System

Thank you!



67