What is Your Cath Lab's CPR Survival Rate?

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I read with great interest an article on the variation in survival after cardiopulmonary arrest in cardiac catheterization laboratories in the United States, recently published by Tripathi et al.[1] This topic covered in part some of the issues raised in a past *CLD* Editor's Corner in 2014 when we talked about code blue, the name given to the team that responds to cardiac arrests, and how a "Code Blue" should be managed in the cath lab.[2] Fortunately, a cardiac arrest in the cath lab is a rare event. However, I recall that when a code was called to our lab, there was some initial chaos that occurred with many of the code team members and other interested bystanders crowding the room, shouting orders or readbacks, and unsure of who was in charge. I thought that the article on the variation of outcomes of cardiopulmonary resuscitation (CPR) in the cath lab was on point and that we could learn more, reflect, and improve our performance for this critical event.

CPR in the Cath Lab Setting

We should begin this discussion recognizing several key differences between code blue in the cath lab and code blue in the hospital and community (Table 1).[3] The cath lab is a unique environment that is fully equipped to manage cardiac emergencies with highly trained personnel in attendance. Before putting these differences into perspective, let's review what Tripathi et al reported.

Tripathi et al[1] looked at the risk-adjusted survival rates (RASR) of patients who had CPR in the cath lab between January 2013 and December 2017. Data from 4787 patients from 231 hospitals came from interactive case report forms in the national American Heart Association (AHA) toolbox called IQVIA, a database housed at the University of Pennsylvania and working as the data analysis center. In this large cohort of patients, the medium RASR was 36%, ranging from 20% to 52%. The difference in survival between two randomly chosen hospitals varied by 71%. As one might have anticipated, the more experienced the lab, the better their outcomes. That is, hospitals with greater annual volumes and numbers of cardiac arrests in the cath lab had higher RASR scores.

The study by Tripathi et al[1] serves to stimulate our thinking about what produces better survival for patients experiencing this rare and unfortunate occurrence. It was interesting that among the hospital characteristics, hospital size, urban or rural location, and geographic location did not influence the outcomes (RASR), whereas the volume of in-hospital, in-lab cardiac arrests and total procedural volumes was associated with a lower mortality and higher survival rate at discharge. The annual rate of in-hospital cardiac cath lab cardiac arrests was 6% per year and the overall RASR for all hospitals was 36%, ranging from 24% to 46%. The survival by tertiles (ie, patients grouped in thirds for the lowest, middle, and highest RASR) was 20%, 36%, and 52%. The immediate hospital RASR was 53%, 65%, and 76% for the three tertiles and 24-hour survival was 37%, 53%, and 67%.

Table 1. Comparison of out-of-hospital cardiac arrest, in-hospital cardiac arrest, and in-hospital cath lab arrest.

Cardiac Arrest Setting	Out of Hospital	In-Hospital	In Cath Lab
Clinical context: cause of arrest	Cardiac > respiratory	Cardiac or respiratory, with respiratory causes more common	Cardiac > respiratory, with acute coronary syndromes in most cases
Timing to initiation of basic life support	Variable	Often immediate	Immediate
Timing to initiation of advanced life support drugs	≥20 min	5-10 min	Immediate
Nonshockable cardiac rhythm	80%	80%	60%
Resources available	Manual CPR AED On arrival of EMS, drugs and advanced airway support	Manual CPR External defibrillator ACLS drugs Advanced airway Possible access to mechanical circulatory support, revascularization, pacing	Mechanical CPR External defibrillator ACLS drugs Advanced airway Immediate access to mechanical circulatory support, revascularization, and pacing
Rescuers	Bystanders and EMS	Physicians and nurses with variable expertise	Interventional cardiologists and specialized cardiac teams

Population mean age is 66 years for all groups. CPR, cardiopulmonary resuscitation; AED, automatic external defibrillator; EMS, emergency medical services; ACLS, advanced cardiac life support

Reprinted with permission from Tomey MI. In-laboratory cardiac arrest: a distinct event deserving dedicated study. *JACC Cardiovasc Interv.* 2022 Dec 26; 15(24): 2472-2474. doi: 10.1016/j.jcin.2022.10.053

Shockable Versus Nonshockable Rhythm During Code Blue

Patients having a shockable in-hospital cardiac rhythm (ventricular tachycardia [VT]/ventricular fibrillation [VF]) during their arrest were more likely to survive than those with nonshockable rhythms. The RASR between shockable and nonshockable rhythms was 55% versus 28%. The 2 most common nonshockable rhythms having the worst RASR were pulseless electrical activity (PEA) and asystole. Even in a well-controlled setting such as the cath lab, only one-third of patients will survive to discharge after an arrest.

Variables of Cardiac Cath Lab Cardiac Arrest Survival

We can only speculate that the higher volume hospitals have more experience and may provide higher quality CPR, chest compressions, prompt initiation of acute cardiac support, and greater use of advanced mechanical support than other hospitals. However, these factors are not captured in the guideline resuscitation database and remain under study.

It is also likely that the procedure types may portend worse outcomes depending on whether the cardiac arrest occurs during the diagnostic angiography, noncomplex coronary intervention, or complex coronary or structural heart intervention, and whether the procedures were in patients with initially compromised cardiovascular status. Much of this information was not available in this study. The quality of chest compressions, postresuscitation measurements, and postdischarge care were not reported. Patient characteristics and clinical/procedural factors associated with cardiac arrest in the cath lab certainly differ among hospitals. Finally, we cannot apply the findings to cardiac arrest in other outpatient or inpatient hospital settings.

Table 2. Managing Cardiac Arrest in the Cath Lab.

1. Identifying patients at an increased risk for cardiac arrest in the cardiac catheterization laboratory (CCL)
   a. ST elevation myocardial infarction (STEMI)
   b. Cardiogenic shock (SCAI shock stages C, D, and E)
   c. High-risk percutaneous coronary intervention (PCI)
   d. Transcatheter aortic valve replacement (TAVR)
   e. PCI complications such as class III perforation, severe no-reflow, left main dissection, and coronary air embolism
   f. Severe left ventricular (LV)/right ventricular (RV)/biventricular systolic dysfunction
   g. History of cardiac arrest outside the CCL

2. Preventative planning in patients at a high risk for cardiac arrest
   a. Early notification to anesthesia; perfusion; cardiac surgery if there is a high likelihood of cardiac arrest requiring extracorporeal membrane oxygenation (ECMO).
   b. Apply defibrillator pads to high-risk patients
   c. Activate mechanical circulatory support (MCS)/ECMO in patients who are prearrest/rapidly declining.
   d. If possible, delay intubation in patients with severe hypotension and tachycardia until vascular access/MCS is in place, as these patients may arrest during induction.

3. Tips for the management of refractory in-lab cardiac arrest
   a. Start immediate high-quality CPR, defibrillation, and administer ACLS drugs per advanced guidelines. Monitor arterial access sheath pressure (90-100 mmHg) during chest compressions.
   b. Consider mechanical compression devices (MCDs). Facilitates fatigue-free CPR following guideline-recommended frequency, depth, and recoil parameters and frees staff to perform other tasks and reduce their exposure to radiation, injury, and communicable infection.
   c. Ensure the interventional cardiologist delegates responsibility of running the code blue to another team member so that he or she can focus on interventional aspects of the procedure.
   d. Call for help from another interventional cardiologist, if available. Notify cardiac surgery for extensive coronary or aortic dissection and refractory perforation.
   e. ECMO, if available, is the preferred device for refractory cardiac arrest and should be considered earlier (within 10–20 minutes) rather than later (after 30 minutes) after the start of CPR. [Note: The 2019 American Heart Association (AHA) Focused Update on ACLS states that there is insufficient evidence to recommend the routine use of ECMO during CPR (ECPR) for patients with cardiac arrest.]

Excerpted from J Bagai and CM Gasperetti. Management of cardiac arrest in the cardiac catheterization laboratory. Society for Cardiovascular Angiography and Interventions (SCAI). SCAI tip of the month. July 29, 2020. https://scai.org/management-cardiac-arrest-cardiac-catheterization-laboratory

Human Factors

Conducting a code blue in the cath lab can vary among hospitals depending on the hospital type (eg, no on-site surgery), staff composition and experience, and leadership of the cath lab nurses and physicians. Differences in code success also involves the type of assistance brought to a code (eg, anesthesiologist versus nurse practitioner [NP] or technologist) the level of staffing, and whether the code occurs during weekend or off hours.

Does Who's in Charge of the Code Matter?

Like the intensive care unit (ICU) and emergency department, the cardiac catheterization lab is a self-sufficient critical care area. All equipment and drugs are available for complete cardiovascular support and in some labs, open-heart surgery can be performed. Most cath lab nurses are highly skilled at both routine cath patient care as well as critical care. Many have ICU backgrounds. The most likely patients who may experience cardiac arrest in the lab are those with high-risk clinical and anatomic conditions (eg, low ejection fraction with renal or pulmonary impairment undergoing a complex interventional procedure. Table 2 lists patients at high risk for cardiac arrest in the cath lab). Every cath lab has a crash cart, vasopressor and anti-arrhythmic drugs, intubation trays, and airway equipment. Rarely is anything else required from outside of the lab. A common experience among many cath labs for some patients with ST-elevation myocardial infarction (STEMI) and shock is that the interventional procedure seems to be an ongoing code blue without the 'code team' in the room.

Leading the Code

How a code is conducted has an impact on a successful outcome. The cath lab attending physician is responsible for the patient. As the captain of the ship, the operator oversees and directs the care of the patient. Whether the patient is experiencing VT/VF or hypotension from tamponade, cardiogenic shock, or bleeding or anaphylaxis, the attending cath lab physician calls the shots. However, CPR guidelines[4] state that a code blue team leader should be responsible for nothing else besides the resuscitation efforts. The cardiologist performing an emergency percutaneous coronary intervention (PCI) on a patient in full arrest may not be able to monitor and assess CPR needs for drugs or compressions.

On the other hand, most cardiologists do not want a 'code leader' unfamiliar with the workings of a cath lab to interfere with critical interventions such as additional vascular access, pericardial tap, or coronary stent completion. All now agree that joint decision-making between the cath lab attending and code blue physician leader is necessary. The request by the cath attending to have a code blue leader direct resuscitation effort is a key to a successful code. The attending physician may recognize that the best person to intubate his patient is an anesthesiologist or an experienced pulmonary or emergency department physician.

A cath patient who becomes unstable and deteriorates is a situation where the cath team may need more help. The quickest way to get this help is to call a code. In the lab, until anesthesia arrives, the patient's ventilatory needs can temporarily be managed with bag mask ventilation. Hemodynamic support can be initiated during advanced cardiac life support (ACLS) medication administration. Defibrillation is performed as indicated in our ACLS arrhythmia algorithms. As the code time arrives, the lab can employ respiratory therapy technologists to support the airway and ventilator management, freeing them to assist directly with any ongoing interventional procedures.

All labs should review their strengths and weaknesses to improve their functions during the rare but critical life-threatening situations that occur in our labs.

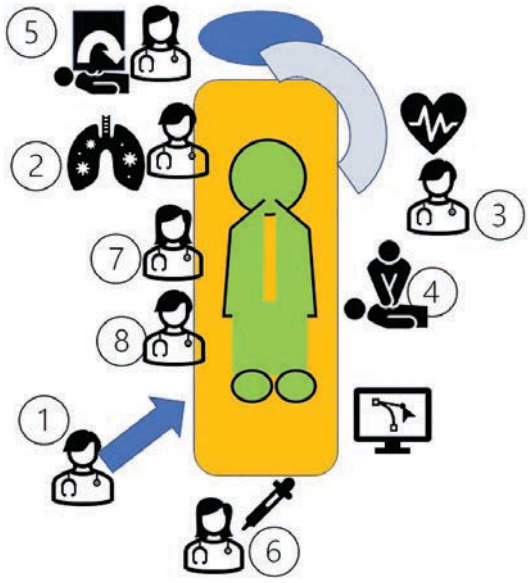

Figure 1. Code team and placements in the cardiac cath lab. 1. Emergency leader, 2. Airway and breathing, 3. Defibrillation and pacing, 4. Manual cardiopulmonary resuscitation (CPR), 5. Mechanical CPR, drugs, and timing, 6. Resource coordinator, 7. Operator, 8. Assistant.

Modified from Dunning J, Archbold A, de Bono JP et al. Joint British Societies' guideline on management of cardiac arrest in the cardiac catheter laboratory. http://dx.doi.org/10.1136/heartjnl-2021-320588, August 1, 2022.

Communication is the Key

When a code is called in the cath lab, the alarm brings not only the code blue team but many other people wanting to help (and some just to see what's happening). When the code team arrives in the lab, the attending physician should recap the problem, ask for someone to help with airway management or intubation, and continue to direct the code. If the attending physician cannot attend to all aspects of the ACLS protocol, he or she should designate a code leader to conduct the resuscitation, then return to the management of the interventional procedure.

Communication at all levels is critical to smooth operations. The designated code team leader must be identified and announced to the cath lab team as they continue to work with the patient still undergoing the procedure. Cath lab and code team members should strive to be clear on requested orders, read-back statements, and acknowledgements. Communications should be clear, calmly spoken, and part of the routine for the lab and particularly for CPR events.

The Bottom Line

The variation of survival after an arrest in the cath lab has many different factors (Table 2) that may or may not be active in your hospital. Nonetheless, all successful codes require good in-lab communication, a designated leader, and sufficient, trained support personnel and equipment. The survival rates among cath lab cardiac arrest patients reflects the variability of your hospital's resources, staffing, and experience of the code blue and cath lab teams. All labs should review their strengths and weaknesses to improve their functions during the rare but critical life-threatening situations that occur in our labs.■

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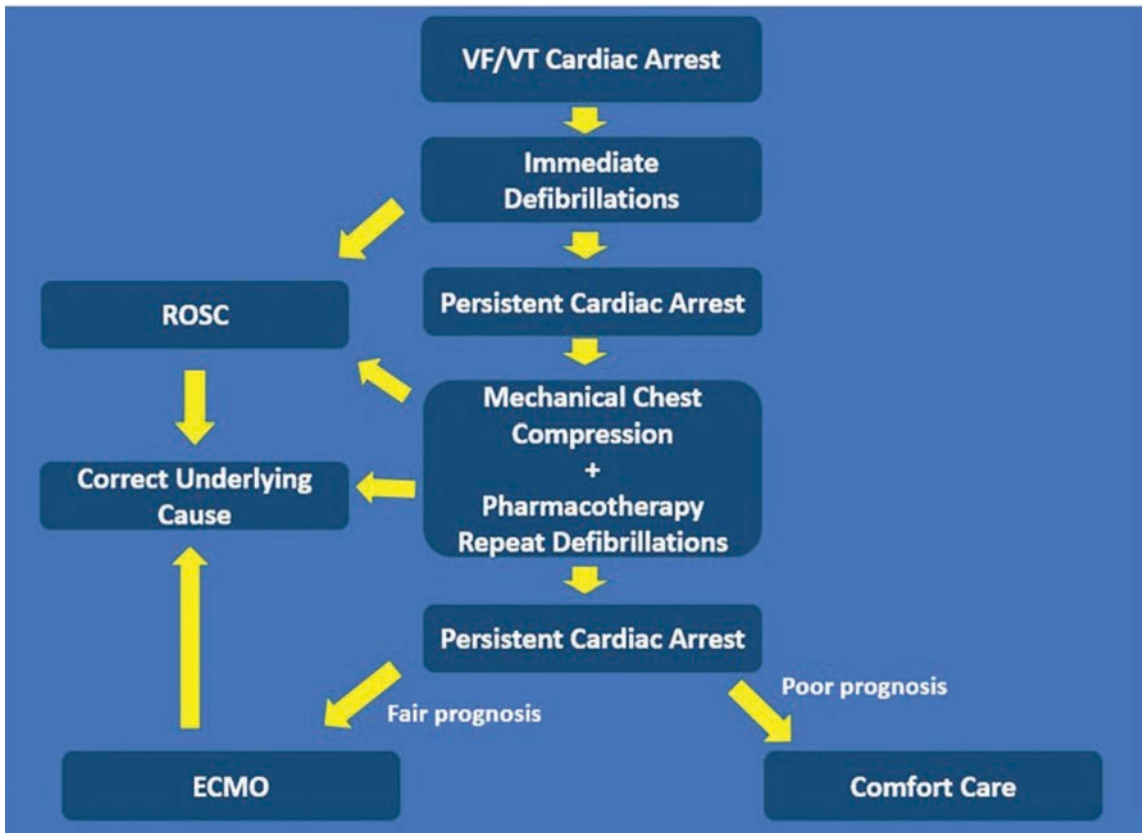

Figure 2. Suggested protocol for managing cardiac arrest in the cath lab. This is an open access article licensed under the terms of the Creative Commons Attribution-Non-Commercial 4.0 International Public License (CC BY-NC 4.0) (https://creativecommons.org/licenses/by-nc/4.0/legalcode).

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