

# Actionable Patient Safety Solutions (APSS): **In-Hospital Cardiac Arrest**

## How to use this guide

This guide gives actions and resources for In-Hospital Cardiac Arrest. In it, you'll find:

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## Executive Summary

### The Problem

Up to 80% of patients will show symptoms of a potential cardiac arrest up to 24 hours prior ([Kim et al., 2015](#); [Schein et al., 1990](#); [Chon et al., 2013](#)) and yet early detection and intervention mechanisms are absent or insufficient.

### The Cost

It has been estimated that the incidence of in-hospital cardiac arrest hovers around 1 to 5 events per 1000 admissions ([Liu et al., 2011](#)). Studies show that having a rapid response team and an early clinical assessment is associated with a 15% reduction in mortality ([Rocha et al., 2018](#)) and a 52% decrease in in-hospital cardiac arrest occurrences ([Goncales et al., 2012](#)).

### The Solution

Many healthcare organizations have successfully implemented and sustained improvements and reduced death from in-hospital cardiac arrest. These organizations have focused on projects that included **standardizing workflows around cardiac arrests, integrating the family members into monitoring efforts, and improving recognition of early warning signs through staff education.**

This document provides a blueprint that outlines the actionable steps organizations should take to successfully reduce in-hospital cardiac arrests and summarizes the available evidence-based practice protocols. This document is revised annually and is always available free of charge on our website. Hospitals who make a formal commitment to improve in-hospital cardiac arrests and share their successes on the PSMF website have access to an additional level of consulting services.

## Leadership Checklist

On a monthly basis, or more frequently if a problem exists, the executive team should review the outcomes of patients with cardiopulmonary emergencies. Use this checklist as a guide to determine whether current evidence-based guidelines are being followed in your organization:

- Measure and report the number of arrest related deaths by the total number of admissions monthly. Note trends in areas with low rapid response intervention and high severe cardiac arrest incidence. Routinely reassess outcomes.
- If cardiac arrest rates indicate room for improvement, initiate a PI (performance improvement) project. If a problem is not indicated, routinely reassess to identify gaps, and ensure integrity of the data collected.
- Ensure frontline involvement in rapid response improvement activities. Maintain their engagement and remove barriers to progress.
- If a PI plan is put in place, measure the associated process outcomes.
- Standardize the hospital's triage system to admit patients to the appropriate level of care according to their clinical condition and severity. Measure and report the relationship of the triage level to rapid response team activation.
- Communicate guidelines to staff regarding when to activate the rapid response team and assess competency. Use mock codes for educational purposes.
- Consider additional education beyond biennial completion of the standard basic life support courses to improve resuscitation performance, with emphasis on high quality CPR. See [Appendix A](#) and [Appendix B](#).
- Establish a Resuscitation Outcomes Steering Committee (ROSC). See [Appendix C](#) for more information.
- Improve the ease with which patients and family members can activate the rapid response team. Implement a consistent, inclusive patient and family education program to explain how, why, and when to activate a rapid response call. See "[Education for Patients and Family Members](#)" section.
- Ensure that cardiac arrest and rapid response protocols are embedded into [clinical workflows](#), whether electronic or paper.
- Include an established score, like the [National Early Warning Score 2](#), in the medical chart to detect variations in clinical condition of the patient.
- Ensure there are enough staff to effectively manage necessary preventive care.
- Ensure adequate training and documentation of resuscitation competencies and skills.
- Eliminate barriers to making rapid changes to documentation templates and order sets.
- Debrief on a regular basis to solicit team feedback about barriers to sustained compliance. Adjust the plan quickly and nimbly as needed.
- Hold staff accountable for providing the standard of care and reward success.
- Ensure that leaders have a simple process to oversee rapid response and resuscitation improvement work while also considering how it aligns with other initiatives across the organization.

# Clinical Workflow Infographic

## ADMISSION AND ROUTINE CARE

- Identify patients at high risk of cardiac arrest or other clinical deterioration. See [What We Know](#) section for risk factors.
- Assess history of cardiac conditions and medical interventions, including previous admissions to the ICU and previous activation of the rapid response team in the current hospitalization. Assess medications, allergies, and chronic conditions.



## EARLY WARNING SIGNS

- Monitor for clinical antecedents to arrest including, but not limited to, abnormal vital signs, shortness of breath, dizziness, and tachycardia.
- Monitor for and ask about family concern.
- Use this information to inform to adjust the appropriate frequency of monitoring.
- Consider activating the rapid response team according to organizational calling criteria.

## CARDIAC ARREST EVENT

- Check for patient response.
  - ◊ If the patient responds:
    - ◊ Stay with the patient and call for help to initiate the rapid response team.
    - ◊ Assess airway, breathing, circulation, disability, and exposure (ABCDE).
    - ◊ Provide oxygen and apply pulse oximetry and EKG to monitor.
    - ◊ Record vital signs and calculate early warning score. See [National Early Warning Score \(NEWS\)](#) for more information.
    - ◊ Establish venous access and extract blood samples.
    - ◊ Ensure the crash cart is nearby for the healthcare team.
  - ◊ If the patient does not respond:
    - ◊ Check for pulse. If no pulse, call a code blue and immediately initiate CPR. Follow the [CPR guidelines established by the American Red Cross](#) for US hospitals.
    - ◊ Have staff obtain a crash cart, resuscitation equipment, and a defibrillator.
    - ◊ Ensure an open airway with the head tilt chin lift maneuver.
    - ◊ If risk of spinal injury, establish a clear airway using jaw thrust chin lift combination, maintaining in line stabilization. If obstruction persists, apply a slight tilt. Establishing the airway takes priority over spinal injury.
    - ◊ Check breathing for approximately 10 seconds. Gasp are common in the early stages of cardiac arrest and should not be mistaken for breathing.
    - ◊ Administer supplemental oxygen as soon as available.
    - ◊ Use the airway technique of greatest proficiency to minimize compression interruption. The optimal combination of airway and ventilation procedures during compressions and after return of spontaneous circulation is uncertain but **current research supports a step wise approach based on setting, patient status, and availability of equipment and trained personnel.** See [Safer Airway Management APSS and Airway and Ventilation Management During Cardiopulmonary Resuscitation and After Successful Resuscitation](#) for technique comparison.
    - ◊ Follow the [American Red Cross guidelines](#) once an AED becomes available.
    - ◊ Continue CPR until the person exhibits signs of life, or advanced care team members arrive.
      - Follow the [advanced life support algorithm](#).
    - ◊ Prepare intravenous cannula and drugs to be administered as soon as there are sufficient staff present and resuscitation is underway.
  - ◊ If the patient has a pulse but is not breathing:
    - ◊ Ventilate and check pulse every 10 seconds.
    - ◊ Start compressions and continue ventilations if presence of a pulse is even slightly doubted.
    - ◊ All patients in respiratory arrest will deteriorate into cardiac arrest without prompt intervention.
  - ◊ Investigate as soon as possible for all causes of cardiac arrest. The most common causes include, but are not limited to, hypovolemia, hypoxia, acidosis, hypoglycemia, and tension pneumothorax.

## POST-ARREST MANAGEMENT (Peberdy et al., 2010)


- Confirm secure airway and titrate ventilation.
- Order X-Ray to investigate potential causes of the arrest.
- Maintain SpO2 ≥94%.
- Minimize potential lung injury and oxygen toxicity with mechanical ventilation.
- Maintain a tidal volume of 6-8 mL/kg and titrate minute ventilation to Petco2 ~35-40 mm Hg Paco2 ~40-45 mm Hg. Take into consideration alveolar protection in ARDS and non ARDS patients.
- Monitor blood pressure frequently to prevent hypotension. Ensure systolic blood pressure is ≥90 mm Hg or MAP >65mmHg.
- Treat hypotension with dopamine, norepinephrine, fluid bolus, and/or epinephrine.
- If the patient is hypotensive, immediately after achieving return of spontaneous circulation (ROSC), initiate an IV bolus of normal saline or lactated Ringer's to add fluid volume and stabilize blood pressure.
- Ensure continuous cardiac monitoring to detect arrhythmia.
- Place 12-lead EKG and obtain troponin levels.
- Assess and treat acute coronary syndrome.
- Assess and treat myocardial stunning.
- Maintain adequate body temperature.
- Practice targeted temperature management.
- Measure serial lactate.
- Measure serum potassium.
- Measure serum creatinine.
- Assess urine output.
- Conduct neurological exams to assess for brain injury and reflex.
- Monitor blood glucose levels.
- Consider induced hypothermia and targeted temperature management after the event to preserve major organ function.
- Collaborate with the interdisciplinary team to determine patient placement in a higher level of care.
- Admit to the ICU.

# Performance Improvement Plan

Follow this checklist if the leadership team has determined that a performance improvement project is necessary:

- Gather the right project team.** Be sure to involve the right people on the team. You'll want two teams: an oversight team that is broad in scope, has 10-15 members, and includes the executive sponsor to validate outcomes, remove barriers, and facilitate spread. The actual project team consists of 5-7 representatives who are most impacted by the process. Whether a discipline should be on the oversight team or the project team depends upon the needs of the organization. Patients and family members should be involved in all improvement projects, as there are many ways they can contribute to safer care.

**Complete this Lean Improvement Activity:** Conduct a [SIPOC](#) analysis to understand current state and scope of the problem. A SIPOC is a lean improvement tool that helps leaders to carefully consider everyone who may be touched by a process, and therefore, should have input on future process design.




RECOMMENDED IN-HOSPITAL CARDIAC ARREST IMPROVEMENT TEAM	
<ul style="list-style-type: none"> <li>Admitting and registration staff</li> <li>Quality and safety specialists</li> <li>Temperature management team</li> <li>Physicians</li> </ul>	<ul style="list-style-type: none"> <li>Nurses</li> <li>Respiratory therapists</li> <li>Rapid response team members</li> </ul>

Table 1: Understanding the necessary disciplines for an in-hospital cardiac arrest improvement team

- Understand what is currently happening and why.** Reviewing objective data and trends is a good place to start to understand the current state, and teams should spend a good amount of time analyzing data (and validating the sources), but the most important action here is to go to the point of care and observe. Even if team members work in the area daily, examining existing processes from every angle is generally an eye-opening experience. The team should ask questions of the frontline during the observations that allow them to understand each step in the process and identify the people, supplies, or other resources are needed to improve patient outcomes.

Create a [process map](#) once the workflows are well understood that illustrates each step and the best practice gaps the team has identified ([IHI, 2015](#)). Brainstorm with the advisory team to understand why the gaps exist, using whichever [root cause analysis tool](#) your organization is accustomed to ([IHI, 2019](#)). Review the map with the advisory team and invite the frontline to validate accuracy.



IN-HOSPITAL CARDIAC ARREST PROCESSES TO CONSIDER ASSESSING	
<ul style="list-style-type: none"> <li>Witness of event</li> <li>Time to relevant intervention</li> <li>Airway placement</li> <li>Time/duration of CPR and resuscitation</li> </ul>	<ul style="list-style-type: none"> <li>Defibrillation process</li> <li>Targeted Temperature Management</li> <li>Chest compression continuity</li> <li>Recognition of early warning signs</li> </ul>

Table 2: Consider assessing these processes to understand where the barriers contributing to in-hospital cardiac arrest may be in your organization

- **Prioritize the gaps to be addressed and develop an action plan.** Consider the cost effectiveness, time, potential outcomes, and realistic possibilities of each gap identified. Determine which are a priority for the organization to focus on. Be sure that the advisory team supports moving forward with the project plan so they can continue to remove barriers. Design an experiment to be trialed in one small area for a short period of time and create an action plan for implementation.

**The action plan should include the following:**



- Assess the ability of the culture to change and adopt appropriate strategies
- Revise policies and procedures
- Redesign forms and electronic record pages
- Clarify patient and family education sources and content
- Create a plan for changing documentation forms and systems
- Develop the communication plan
- Design the education plan
- Clarify how and when people will be held accountable

**TYPICAL GAPS IDENTIFIED IN IN-HOSPITAL CARDIAC ARREST**

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Absence of an organized system that identifies and responds to deteriorating patients</li> <li>• Lack of knowledge of deterioration signs</li> <li>• Misperceptions regarding arrest preventability</li> <li>• Inadequate/inappropriate monitoring</li> <li>• Institutional barriers, including unclear criteria, for summoning additional help</li> <li>• Improper training and expertise of rapid response team members</li> </ul> | <ul style="list-style-type: none"> <li>• Poor engagement of patient and family members</li> <li>• Inadequate CPR training and education</li> <li>• Lack of chest compression continuity among other responsibilities including rhythm analysis, defibrillation, airway management, vascular access</li> <li>• Reluctance to begin chest compressions</li> <li>• Poor ventilation delivery</li> </ul> |
|---|--|

Table 3: By identifying the gaps in in-hospital cardiac arrest compliance, organizations can tailor their project improvement efforts more effectively

- **Evaluate outcomes, celebrate wins, and adjust the plan when necessary.** Measure both process and outcome metrics. Outcome metrics include the rates outlined in the leadership checklist. Process metrics will depend upon the workflow you are trying to improve and are generally expressed in terms of compliance with workflow changes. Compare your outcomes against other related metrics your organization is tracking. Routinely review all metrics and trends with both the advisory and project teams and discuss what is going well and what is not. Identify barriers to completion of action plans, and adjust the plan if necessary. Once you have the desired outcomes in the trial area, consider spreading to other areas ([IHI, 2006](#)).

It is important to be nimble and move quickly to keep team momentum going, and so that people can see the results of their labor. At the same time, don't move so quickly that you don't consider the larger, organizational ramifications of a change in your plan. Be sure to have a good understanding of the other, similar improvement projects that are taking place so that your efforts are not duplicated or inefficient.

Read this paper from the Institute for Healthcare Improvement to understand how small local steps can integrate into larger, system changes



**IN-HOSPITAL CARDIAC ARREST COMPARATIVE OUTCOMES**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Survival to discharge</li> <li>• Readmission</li> <li>• Length of stay</li> <li>• Patient status at code</li> <li>• Location of code</li> </ul> | <ul style="list-style-type: none"> <li>• Debrief after code</li> <li>• Transfers to ICU (planned and unplanned)</li> <li>• 30 and 90 day mortality</li> <li>• Signs of unexpected deterioration before code</li> </ul> |
|--|--|

Table 4: Consider evaluating related metrics to better understand in-hospital cardiac arrest presence and contributing factors

# What We Know About In-Hospital Cardiac Arrest

Cardiac arrest is defined as the sudden cessation of cardiac activity resulting in unresponsiveness in the patient, accompanied by a cease of normal breathing and circulation ([Patel, 2020](#)). An intervention to resuscitate the patient is required within moments to prevent significant harm or death. The longer the patient is without effective intervention, the greater the risk for cognitive and physical deterioration ([Mędrzycka-Dąbrowska et al., 2018](#)). Therefore, the outcomes of the patient are largely dependent on the preparedness of the hospital before the event even occurs. Studies show that preparedness of a rapid response team is associated with a 15% reduction in mortality ([Rocha et al., 2018](#)).

## Risk Factors

- Older age
- Poor functional status prior to arrest
- Those with sepsis
- Those with pneumonia
- Those with hypotension
- Those with renal and hepatic dysfunction

The majority of patients demonstrate signs and symptoms of instability and deterioration 6-8 before arrest occurs ([Mezzaroba et al., 2016](#)). These symptoms commonly include desaturation and hypotension.



## Clinical Implications

In US adults only, there are an estimated 290,000 cases of in-hospital cardiac arrests each year ([Andersen, 2019](#)).

In-hospital cardiac arrest is a major preventable cause of patient morbidity and mortality. It is estimated that between 17% ([Peberdy et al., 2003](#)) and 24% ([Go et al., 2013](#)) of in-hospital cardiac arrest patients survive to hospital discharge. For those patients who do survive to discharge, nearly 25% will be newly placed in a skilled nursing facility and many will likely suffer brain injury, injury to the nervous system, or other complications ([Peberdy et al., 2003](#)).

It has been suggested that the rates of survival post-in-hospital cardiac arrest are lower for black patients (25.2%) than for white patients (37.4%) ([Chan, 2009](#)).

Addressing the underlying potential causes of cardiac arrest is essential for effective prevention.



In-hospital cardiac arrest etiology is distinguished by cardiac and noncardiac. Most in-hospital cardiac arrest events are related to cardiac complications, including, but not limited to, arrhythmia, myocardial infarction, or heart failure (50-60% of cases) ([Andersen 2019](#)). The second most common etiology is non-cardiac, or respiratory insufficiency (15-40% of cases) ([Andersen 2019](#)).

Night onset and lack of a witness are significant causes for mortality in in-hospital cardiac arrest patients ([Chon et al., 2013](#)).

It is important to understand the patient's advance directives before initiating CPR. DNR status should be clearly communicated in multiple ways, including, but not limited to, armbands, room signs, and flagging the chart. The bedside nurse should know the status prior to calling the rapid response team. The rapid response team shouldn't do anything until they speak to the bedside nurse, regardless of code status. If there is no signed paperwork in the chart, the patient is automatically a full code.

## Resources



### Resources for resuscitation improvement:

- [AHA: Get with the Guidelines](#)
- [AHA: Post-Cardiac Arrest Care Fact Sheet](#)
- [AHA: Resuscitation Fact Sheet](#)
- [Resuscitation Council UK: In-Hospital Resuscitation Guidelines](#)
- [In-hospital Cardiac Arrest and Preceding National Early Warning Score \(NEWS\): A Retrospective Case-Control Study](#)
- [Cardiac Arrest Survival Post Resuscitation In-Hospital Score \(CASPRI\)](#)
- [Airway and Ventilation Management During Cardiopulmonary Resuscitation and After Successful Resuscitation](#)

### For general improvement:

- [CMS: Hospital Improvement Innovation Networks](#)
- [IHI: A Framework for the Spread of Innovation](#)
- [The Joint Commission: Leaders Facilitating Change Workshop](#)
- [IHI: Quality Improvement Essentials Toolkit](#)
- [SIPOC Example and Template for Download](#)
- [SIPOC Description and Example](#)

## Education for Patients and Family Members

**Explain why their loved one may be at an increased risk for cardiac arrest.** Be sure to make all information relevant to their circumstance and involve the factors that put this specific patient at risk. The patients and family members should understand what a cardiac arrest is, the clinical implications associated, and why their help and vigilance is needed.

**Indicate what to watch out for.** Patients and family members should know exactly what they can watch out for that might indicate deterioration. It is important that they understand that they should report to staff at the first sign of a complication or potential deterioration. Patients and family members should know exactly what to do, who to call, and how to report and should feel encouraged to do so immediately. They play a pivotal role in early recognition of warning signs and should understand their importance in the health of their loved one.

**Describe what can be anticipated.** Patients and family members should understand what will happen after they've made the report of potential deterioration. Additionally, they should understand what might happen in the event of a cardiac arrest. It is better to prepare and equip the patients and their family members with this knowledge early to avoid as much anxiety as possible later. It is important to explain the basic components of resuscitation, such as activation of the rapid response team and CPR.

**Explain what is expected of them during their care.** Patients and family members should understand the significant value they hold to the care team in watching out for signs of potential cardiac arrest. By giving patients and family members a "job" while they are in the hospital, they can be immersed fully in the routine care, can hold other team members accountable, can feel more confident voicing their concerns or opinions, and can serve as an extra set of informed and vigilant eyes to optimize early detection. This team involvement can also reduce their anxiety by transforming concern into proactive action. Patients and family members can:

- Watch for changes in vital signs
- Watch for altered mental status
- Be vigilant about medications changed, added, or removed.
- Keep a log of these medication changes.
- Understand where the nearest AED is located.
- Understand where and how to call for help.

**Explore next steps.** Planning for life after the hospital, whether in assisted living, returning home, or another option, should begin as early as possible between the healthcare providers and the patient and family. Patients and family members should understand that, if their loved one survives to discharge, their living post-discharge will likely have to be adjusted significantly.

- If the patient is a smoker, the healthcare team should encourage smoking cessation and provide additional resources for further information, groups, or strategies for smoking cessation.
  - Try to understand what specific barriers that patient as an individual faces in cessation.
- Describe the organization's resuscitation standards that were followed.
  - If any of the protocols changed due to this specific patient's circumstance, articulate that to the patient and family members.
- Have a discussion with the patient and family around end of life care and advanced directives.
  - Make every attempt to thoroughly understand the religious or cultural nuances in any of the patient's or family members' decisions or questions.
- Ensure thorough explanation of necessary post-discharge appointments, therapies, medications, and potential complications.
  - Assess for patient preference in time and location of follow-up appointments, if possible.
- Provide patients and family members resources, including direct contact phone numbers, to the hospital for post-discharge questions.
  - Make sure the resources are in their own language.
- Help the patient and family members set realistic expectations and goals for recovery.

Each conversation with a patient and family member should be inclusive and void of bias. Additionally, these conversations should leave ample time for discussion and the facilitator should encourage questions from the patient and family members



Patients and family members should understand that, although all clinicians in the hospital do their best, no one is ultimately coordinating their care. Patients and family members should understand that they are the managers of their care and as such, should demand to be an active part of the care team including conversations and decisions.



# Measuring Outcomes

## Cardiac arrests

### Key Performance Indicators

Arrest Related Death: An Arrest Related Death (ARD) is defined as a patient receiving arrest resuscitative efforts (either CPR or defibrillation) at any time during admission who does not survive to hospital discharge

### Outcome Measure Formula

**Numerator:** Total number of arrest related deaths

**Denominator:** Total number of admissions

Rate is typically displayed as ARDs per thousand admissions

### Metric Recommendations

#### Direct Impact:

Any patient receiving resuscitative efforts

#### Lives Spared Harm

Lives Spared Harm =  $(\text{ARD Rate}_{\text{baseline}} - \text{ARD Rate}_{\text{measured}}) \times \text{Admissions measured}$

#### See also the "Rapid Response Teams" APSS outcome metrics:

- Cardiac arrests on the wards (number of cardiac arrests/number of bed days)
- Predictability (number of ward arrests from above meeting rapid response team warning criteria/all ward arrests)
- Timeliness of response to ward deterioration (number of patients meeting warning criteria seen within the institutions time frame/total number of patients meeting warning criteria)
- Timeliness of critical interventions (number patients receiving critical care interventions/total number of patients receiving rapid response team calls)
- Ease with which patients and family members can activate the rapid response team.

# Endnotes

## Conflicts of Interest Disclosure

The Patient Safety Movement Foundation partners with as many stakeholders as possible to focus on how to address patient safety challenges. The recommendations in the APSS are developed by workgroups that may include patient safety experts, healthcare technology professionals, hospital leaders, patient advocates, and medical technology industry volunteers. Workgroup members are required to disclose any potential conflicts of interest.

## Workgroup

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## References

- Airway Safety | Patient Safety Movement. (2020). Patient Safety Movement. <https://patientsafetymovement.org/clinical/airway-safety/>
- American Red Cross Training Services. (2020). CPR Steps | Perform CPR | Red Cross. Red Cross Training & Certification, and Store. <https://www.redcross.org/take-a-class/cpr/performing-cpr/cpr-steps>
- Andersen, L. W., Holmberg, M. J., Berg, K. M., Donnino, M. W., & Granfeldt, A. (2019). In-Hospital Cardiac Arrest. *JAMA*, 321(12), 1200. <https://doi.org/10.1001/jama.2019.1696>
- Awada and Maher. (2013). Reduction in Red Blood Cell Transfusions during Neurosurgery with Noninvasive and Continuous Hemoglobin Monitoring. Proceeding of the Society for Technology in Anesthesia Annual Meeting
- Billen, B., Grandal, L., & Søvik, S. (2016). National Early Warning Score (NEWS) as an emergency department predictor of disease severity and 90-day survival in the acutely dyspneic patient - a prospective observational study. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine*, 24(1), 24. <https://doi.org/10.1186/s13049-016-0273-9>
- Chan, P. S. (2009). Racial Differences in Survival After In-Hospital Cardiac Arrest. *JAMA*, 302(11), 1195. <https://doi.org/10.1001/jama.2009.1340>
- Chon, G. R., Lee, J., Shin, Y., Huh, J. W., Lim, C.-M., Koh, Y., & Hong, S.-B. (2013). Clinical Outcomes of Witnessed and Monitored Cases of In-Hospital Cardiac Arrest in the General Ward of a University Hospital in Korea. *Respiratory Care*, 58(11), 1937-1944. <https://doi.org/10.4187/respcare.02448>
- Blind, K. The Impact of Regulation on Innovation. Edward Elgar Publishing. doi:10.4337/9781784711856.00022 Davis, D. (2010). A New Resuscitative Protocol. *Journal of Emergency Medical Services*. Retrieved from <http://www.jems.com/articles/print/volume-35/issue-9/patient-care/new-resuscitative-protocol.html>
- Davis D.P., Aguilar S.A., Graham P.G., Lawrence B., Sell R.E., Minokadeh A., Husa R.D. (2015). A Novel Configuration of a Traditional Rapid Response Team Decreases Non-intensive Care Unit Arrests and Overall Hospital Mortality. *J Hosp Med*; 10(6):352-7.
- Davis D.P., Graham P.G., Husa R.D., Lawrence B., Minokadeh A., Altieri K., Sell R.E. (2015). A Performance Improvement-based Resuscitation Programme Reduces Arrest Incidence and Increases Survival from In-hospital Cardiac Arrest. *Resuscitation*; 92:63-9.
- Ehrenfeld, J. M. (2010). Impact of Continuous and Noninvasive Hemoglobin Monitoring on Intraoperative Blood Transfusions. *American Society of Anesthesiologists*.
- Go, A. S., Mozaffarian, D., Roger, V. L., Benjamin, E. J., Berry, J. D., Borden, W. B., Bravata, D. M., Dai, S., Ford, E. S., Fox, C. S., Franco, S., Fullerton, H. J., Gillespie, C., Hailpern, S. M., Heit, J. A., Howard, V. J., Huffman, M. D., Kissela, B. M., Kittner, S. J., ... Turner, M. B. (2013). Heart Disease and Stroke Statistics—2013 Update. *Circulation*, 127(1). <https://doi.org/10.1161/cir.0b013e31828124ad>

- Gonçalves, P. D. S., Polessi, J. A., Bass, L. M., Santos, G. P. D., Yokota, P. K. O., Laselva, C. R., Fernandes Junior, C., Cendoroglo Neto, M., Estanislao, M., Teich, V., & Sardenberg, C. (2012). Reduced frequency of cardiopulmonary arrests by rapid response teams. *Einstein (São Paulo)*, 10(4), 442-448. <https://doi.org/10.1590/s1679-45082012000400009>
- Kim, W. Y., Shin, Y. J., Lee, J. M., Huh, J. W., Koh, Y., Lim, C.-M., & Hong, S. B. (2015). Modified Early Warning Score Changes Prior to Cardiac Arrest in General Wards. *PLOS ONE*, 10(6), e0130523. <https://doi.org/10.1371/journal.pone.0130523>
- Liu, W.-L., Lai, C.-C., Hii, C.-H., Chan, K.-S., Hsing, S.-C., Cheng, K.-C., & Tan, C.-K. (2011). Outcomes and Cost Analysis of Patients With Successful In-Hospital Cardiopulmonary Resuscitation. *International Journal of Gerontology*, 5(4), 196-199. <https://doi.org/10.1016/j.ijge.2011.09.016>
- Mędrzycka-Dąbrowska, W. A., Czyż-Szybenbejl, K., Kwiecień-Jaguś, K., & Lewandowska, K. (2018). Prediction of cognitive dysfunction after resuscitation - a systematic review. *Advances in Interventional Cardiology*, 14(3), 225-232. <https://doi.org/10.5114/aic.2018.78324>
- Mezzaroba, A. L., Tanita, M. T., Festti, J., Carrilho, C. M. D. M., Cardoso, L. T. Q., & Grion, C. M. C. (2016). Evaluation of the five-year operation period of a rapid response team led by an intensive care physician at a university hospital. *Revista Brasileira de Terapia Intensiva*, 278-284. <https://doi.org/10.5935/0103-507x.20160045>
- Morrison, L. J., Neumar, R. W., Zimmerman, J. L., Link, M. S., Newby, L. K., McMullan, P. W. J., ... Edelson, D. P. (2013). Strategies for Improving Survival After In-hospital Cardiac Arrest in the United States: 2013 Consensus Recommendations: a Consensus Statement from the American Heart Association. *Circulation*, 127, 1538-63. (2001). National Academies Press. doi:10.17226/10027.
- Neumar, R. W., Otto, C. W., Link, M. S., Kronick, S. L., Shuster, M., Callaway, C. W., ... Morrison, L. J. (2010). Part 8: Adult Advanced Cardiovascular Life Support: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*, 122, S729-67.
- Nolan, J. P., Soar, J., Zideman, D. A., Biarent, D., Bossaert, L. L., Deakin, C., ... Böttiger, B. (2010). European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. *Resuscitation*, 81(10), 1219-1276. doi:10.1016/j.resuscitation.2010.08.021.
- Patel, K., & Hipskind, J. E. (2020). Cardiac Arrest. *StatPearls*. <https://www.ncbi.nlm.nih.gov/books/NBK534866/#:~:text=As%20defined%20by%20the%20American%20no%20signs%20of%20circulation.>
- Peberdy, M. A., Kaye, W., Ornato, J. P., Larkin, G. L., Nadkarni, V., Mancini, M. E., Berg, R. A., Nichol, G., & Lane-Trullt, T. (2003). Cardiopulmonary resuscitation of adults in the hospital: A report of 14 720 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. *Resuscitation*, 58(3), 297-308. [https://doi.org/10.1016/s0300-9572\(03\)00215-6](https://doi.org/10.1016/s0300-9572(03)00215-6)
- Peberdy, M. A., Callaway, C. W., Neumar, R. W., Geocadin, R. G., Zimmerman, J. L., Donnino, M., Gabrielli, A., Silvers, S. M., Zaritsky, A. L., Merchant, R., Vanden Hoek, T. L., & Kronick, S. L. (2010). Part 9: Post-Cardiac Arrest Care: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*, 122(18\_suppl\_3), S768-S786. <https://doi.org/10.1161/circulationaha.110.971002>
- Rocha, H. A. L., Alcântara, A. C. C., Rocha, S. G. M. O., & Toscano, C. M. (2018). Effectiveness of rapid response teams in reducing intrahospital cardiac arrests and deaths: a systematic review and meta-analysis. *Revista Brasileira de Terapia Intensiva*, 30(3), 366-375. <https://doi.org/10.5935/0103-507X.20180049>
- Schein, R. M. H., Hazday, N., Pena, M., Ruben, B. H., & Sprung, C. L. (1990). Clinical Antecedents to In-Hospital Cardiopulmonary Arrest. *Chest*, 98(6), 1388-1392. <https://doi.org/10.1378/chest.98.6.1388>
- Schmid, A., Hoffman, L., Happ, M. B., Wolf, G. A. and DeVita, M. (2007). Failure to Rescue. *JONA: The Journal of Nursing Administration*, 37(4), 188-198. doi:10.1097/01.nna.0000266838.23814.65.
- Society of Hospital Medicine. Mentored Implementation for Quality Improvement. Retrieved from [http://dev.hospitalmedicine.org/Web/QualityInnovation/Mentored\\_Implementation/Landing\\_Page.aspx](http://dev.hospitalmedicine.org/Web/QualityInnovation/Mentored_Implementation/Landing_Page.aspx).
- Subbe, Bannard-Smith, Bunch, Champunot, DeVita, Durham, Edelson, Gonzalez, Hancock, Haniffa, Hartin, Haskell, Hogan, Jones, Kalkman, Lighthall, Malycha, Ni, Phillips, Rubulotta, So, and Welch. (2019). International Society for Rapid Response Systems. Quality metrics for the evaluation of Rapid Response Systems: Proceedings from the third international consensus conference on Rapid Response Systems. *Resuscitation*.

## Appendices

### Appendix A: Reason for Additional Education Beyond Biennial Completion of the American Heart Association Life Support Training Courses

The primary mechanism for maintaining resuscitation competency for most institutions is limited to biennial completion of the American Heart Association life support training courses. This approach as the sole mechanism to maintain competency has several limitations, particularly for in-hospital providers (Morrison et al., 2013; Davis, 2010):

- Biennial training is not frequent enough to maintain CPR skills, which appear to decay within 3-4 months.
- ACLS/BLS curricula are not contextual and may not reflect the unique capabilities and technologies of a particular institution and its providers.
- ACLS/BLS curricula cannot be modified to address institutional CQI needs.
- Treatment algorithms upon which the ACLS/BLS courses are based cannot incorporate the variety of new technologies that offer potential to improve outcomes.
- The ACLS/BLS curriculum does not include arrest prevention.

### Appendix B: Advanced Resuscitation Training (ART): A Model for Reducing Preventable Deaths

The ART program was developed in 2007 at the University of California at San Diego (UCSD) and represents a comprehensive system of care that targets the reduction of preventable deaths in both the out-of-hospital and in-hospital environments. The ART model links scientific evidence, CQI data, technology, institutional treatment algorithms, and training. Ownership and accountability are transferred to the institution, enhancing both relevance and engagement.

ART training can be described as “adaptive” in that educational content is delivered to individual provider groups, defined by provider type (nurse, physician, respiratory therapist, technician) and clinical unit, based on patient mix and level of care provided. In addition, performance improvement data is used to address institutional and unit-specific issues. Annual training is conducted in 4-hour blocks, with content dedicated equally to prevention and response to cardiac arrest. Training format includes traditional didactics, dedicated skills sessions, and simulation. In addition to the scheduled training, ad hoc sessions are conducted based on performance improvement data trends or sentinel events.

ART clinical guidelines reflect the core elements of the International Liaison Committee on Resuscitation. Specific treatment recommendations as part of the institutional algorithm reflect available technologies as well as the collective interpretation and preferences of institutional clinical leadership. Training sessions are structured around the unique algorithms and the application of technology as part of a contextual learning philosophy.

ART employs a novel taxonomy for categorizing arrests based on physiological pattern and clinical condition. This allows anticipation of arrest based on static and dynamic risk factors and identification of deterioration patterns that allow for rapid response team activation and intervention prior to arrest. A stepwise approach to early detection is employed to maximize both sensitivity and specificity and integrate clinical data, technology, and hospital processes. This same taxonomy forms the basis for ART CQI efforts to guide program refinement and incorporates a strategy to categorize arrest etiology for each at-risk patient. This facilitates a systematic approach to reducing preventable deaths within each category by targeting prevention as well as effective resuscitation. In addition, this taxonomy aligns with multiple hospital-based patient safety initiatives: Sepsis, perioperative respiratory depression and sleep apnea, occult hemorrhage, dysrhythmias, deep venous thrombosis/pulmonary embolism detection and treatment, respiratory distress, neurological emergencies, and general critical care.

The ART program has been successfully implemented at UCSD as well as multiple pilot sites across the US. As a direct result of ART program implementation:

- Arrest incidence has been reduced by more than 50%.
- Survival following arrest has doubled and good neurological outcomes have tripled.
- Life support expenditures have been reduced by 25%.
- A 10-fold return on investment has been realized, with potential savings in reduced cost-of-care, medicolegal payouts, and improved reimbursement for pay-for-performance/value-based purchasing.

### **Appendix C: Resuscitation Outcomes Steering Committee (ROSC)**

A Resuscitation Outcomes Steering Committee (ROSC) represents a multi-disciplinary institutional group with primary responsibility for the program. This group should have both ownership and accountability for outcomes and should have access to local data with the goal of using it to better understand the institution's patients' needs and to optimize the response to deterioration. Reporting from the institutional ROSC should be upward to institutional leaders, horizontal to other committees, hospital units, and service lines, and downstream to providers.

- Engaging individual providers and enhancing their personal sense of ownership and accountability will help create a culture of patient safety. This can be accomplished by:
  - o Engagement and public support of the institutional ROSC by hospital leaders and broad representation of various hospital groups on the ROSC.
  - o Effectively modifying training content to address provider-specific needs and issues, and giving routine feedback of institutional resuscitation data.

Ultimately, the resuscitation program should become the primary vehicle to reduce preventable deaths and ensure an institutional culture of safety.