6 surprising best resuscitation practices

Nothing is more important to the patient's outcome than properly performed chest compressions.

By Mike McEvoy, PhD, RN, CCRN, NRP

In-hospital resuscitation has gotten a lot of attention lately. Data analysis shows a significant number of cardiac arrests take place in hospitals—at least as many as, if not more than, in community settings. Evolving continually, resuscitation science is starting to offer best practices specific to hospitalized patients. This article describes six such practices to improve patient care. Of course, other best practices exist, but the ones you'll read about here are those most often cited in the literature. Some of them may surprise you.

1. Compression is king

When cardiopulmonary resuscitation (CPR) was first introduced, only physicians and nurses could administer it. Today, schoolchildren are taught CPR. Yet the current belief that anyone can perform CPR might lead some to believe no special skill is required and that chest compressions are tangential to more sophisticated interventions, such as drugs and intubation.

Nothing could be further from the truth. All resuscitation outcomes, from initial return of spontaneous circulation (ROSC) through discharge, relate directly to the quality of chest compressions. No other intervention is as important to watch, critique, and continually correct during a code. The longstanding CPR emphasis on airway first, then breathing, and finally circulation (ABC) was turned upside down by the 2010 Emergency Cardiac Care (ECC) guidelines from the American Heart Association (AHA). Circulation now tops the list, followed by airway and breathing (CAB). (See *Chest-compression rate and depth.*)

2. Pay attention to the bed

For a long time, CPR courses have emphasized the need to place the patient flat on a hard surface. Emergency dispatchers encourage callers to pull cardiac arrest victims out of the bed or chair onto the floor to promote good CPR. But dragging patients from their beds or chairs to the floor is highly impractical and probably dangerous for both patients and rescuers.

Unless a patient collapses at home or in a bathroom, hallway, or public area, resuscitation usually is done with the patient lying on a hospital bed or stretcher. This poses unique challenges (not well addressed in CPR classes) related to optimal height of the bed relative to the rescuer's height, mattress deflation, and use of backboards. Fortunately, good guidance exists on all three.

When you kneel on the floor next to a patient in cardiac arrest, you're in an ideal position to provide optimal chest compressions. When a patient in a hospital bed or stretcher requires CPR, height of the rescuer and the bed can affect performance of chest compressions. A well-designed study determined that the optimal bed height for chest compressions is the rescuer's knee height. So a short rescuer may need to use a stool, and when the rescuer providing compressions changes, bed height may need to be adjusted.

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1.2 contact hours

Learning Objectives

1. Discuss the role of effective compressions in cardiopulmonary resuscitation.
2. State six key resuscitation practices.
3. Describe effective monitoring during resuscitation efforts.

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The risk of skin breakdown has led to the design and use of bed surfaces with pressure-distributing mattresses. Some of these mattresses are foam; others use air-filled tubes or containers. Many hospital beds incorporate a rapid-deflate mechanism for use in emergencies when chest compressions are required. But regardless of the mattress type, it's common practice to place a rigid board under the patient's chest during chest compression.

Yet neither activation of rapid-deflate mechanisms nor use of a backboard under the bed seems to improve chest-compression performance. This is an important and somewhat counterintuitive research finding. If activating a rapid-deflate mechanism or placing a backboard under a patient delays or interrupts chest compressions, it should be considered harmful and postponed until it can be done without interference.

Chest-compression rate and depth

Data from thousands of cardiac arrests studied by the Resuscitation Outcomes Consortium suggest that a chest-compression depth of 2" (50 mm) may be optimal for initial return of spontaneous circulation (ROSC), 24-hour survival, and survival to hospital discharge. One study of compression rate and depth positively correlated ROSC with a mean rate of 90 compressions/minute and correlated no ROSC with a mean rate of 79 compressions/minute. In-hospital compression rates were suboptimal more than 40% of the time, leaving considerable opportunity for improving outcomes.

While optimal compression rate and depth aren't known, the American Heart Association's Cardiopulmonary Resuscitation (CPR) Quality Researchers renewed their call for increased attention to high-quality CPR in 2013. Calling poor-quality CPR a "preventable harm to patients," they emphasized the need for a compression rate of at least 100 to 120/minute, a depth of 2" (50 mm) or more in adults, allowing full chest recoil after each compression, and avoiding excessive ventilation. Ventilation rates of 12 breaths/minute or more, with more than minimal chest rise, make compression dramatically less effective. In fact, compression-only CPR (chest compressions without ventilation) provides equal or better outcomes than compressions with ventilations. So if you find yourself alone with a cardiac arrest victim, call for help and begin high-quality, compression-only CPR to give your patient the best chance of a successful outcome.

3. Real-time CPR performance feedback

You already may have a sense that CPR performed with the patient on a bed is more difficult and potentially less effective than CPR performed with the patient on the ground. Indeed, this is the case. And because chest compressions are crucial to good outcomes, we should use technology to monitor their effectiveness objectively. If an arterial pressure monitoring line is in place, compression depth can be targeted directly to produce a diastolic pressure above 25 mm Hg, although some clinicians prefer targeting to a mean arterial pressure of at least 60 mm Hg.

If invasive monitoring isn't in use, feedback devices are helpful. As early as 2004, real-time feedback devices were shown to improve in-hospital CPR. These devices have evolved, and modern feedback devices (commonly integrated with bedside monitor-defibrillators) use accelerometer-based technology to provide real-time feedback during compression delivery. Feedback devices dramatically improve chest-compression depth and rate and significantly shorten CPR interruptions.

However, accelerometer-based feedback devices haven't been shown to improve survival, which may be tied to their technological limitations. An accelerometer measures movement. When used as a CPR feedback device, it sits between the compressor's hands and the patient's chest, measuring downward movement of the rescuer's hands. When the patient is on a flat, immovable surface (such as a floor or a sidewalk), the rescuer's hand movements equal the depth of chest compressions. But when the patient is on a mattress or other moveable surface, the accelerometer can't determine how much of the total distance travelled by the hands represents chest-compression depth and how much represents mattress movement. This is especially a problem in hospitals, where most resuscitations occur with the patient on a bed or stretcher.

Closer analysis shows that accelerometer-based CPR feedback technologies don't compensate for mattress movement. This is true whether the mattress is made of foam or is inflatable and whether

Triaxial field induction for better feedback

A new device that overcomes limitations of the accelerometer as a cardiopulmonary resuscitation (CPR) feedback device has been in development for several years. Recently, it was approved for sale in the United States, Canada, and Europe. Using a technology called triaxial field induction (TFI), this CPR feedback device incorporates a back pad that slides under the patient's shoulder and a chest pad that goes under the compressor's hands to magnetically measure true compression depth, regardless of the surface the patient is on. The device is being marketed as a stand-alone CPR coaching device that can be used with any monitor or defibrillator. Unlike accelerometer devices, TFI has been shown to report actual chest-compression depths.

or not a backboard is placed between the patient and mattress surface. Thus, actual compression depth is 35% to 40% less than the depth reported by the accelerometer device. Unwittingly reducing compression depth by these percentages can easily reduce the potential for ROSC and survival to discharge by more than half. (See *Triaxial field induction for better feedback.*)

4. Capnography is mandatory

The ability to measure carbon dioxide (CO_2) concentration in exhaled breaths can be a lifesaver in many situations. Continuous end-tidal CO_2 ($EtCO_2$) monitoring is a standard of care for patients during anesthesia; the American Heart Association (AHA) recommends it for continuous use throughout a cardiac arrest. During a code, there are three distinct reasons for paying close attention to $EtCO_2$:

- to ensure that the endotracheal tube stays in the trachea
- to assess CPR quality
- to provide an early indicator of ROSC.

During CPR, confirmation that the endotracheal tube remains in place is critical, as tube dislodgment most often occurs during patient movement. Resuscitation (including chest compressions) involves maximal movement and thus considerable opportunity for the airway to become displaced. Capnography alerts the code team to airway dislodgment within seconds.

In developing its 2010 emergency cardiac care guidelines, AHA recognized that CPR feedback devices measure performance, not results. CO_2 is the byproduct of the body's oxygen use to create energy; it reflects not just respirations but cardiac output. An $EtCO_2$ measurement below 10 mm Hg during a code suggests chest compressions aren't deep or fast enough to maintain cardiac output, the rescuer is tired (that's why the compressor should be changed every 2 minutes), or excellent CPR isn't producing even minimal cardiac output. Some evidence suggest failure to achieve $EtCO_2$ above 10 mm Hg within the first 20 minutes of CPR after intubation is never associated with ROSC and could reasonably be used to justify ending resuscitation. Thus, $EtCO_2$ is a valuable tool for assessing patient outcome. Used in conjunction with newer CPR feedback technology, it adds information rescuers need for a complete picture of resuscitative effectiveness. The third benefit of capnography is early detection of ROSC. (See *Detecting return of spontaneous circulation.*)

5. Oxygen can hurt

Hypoxia can cause significant harm. While no evidence shows patient impairment or harm at an oxygen saturation (O_2 sat) above 84%, most people experience impaired mental function when O_2 sat is below 64% and typically lose consciousness when it falls below 56%. It seems odd, then, that oxygen—the drug we use most often—is implicated in patient harm.

In reality, this isn't new information. Long ago, intensive-care practitioners recognized that oxygen has the potential for harm. ECC guidelines issued by AHA in 2000 and 2005 recommended administering oxygen only when O_2 sat is below 90%. In the 2010 guidelines, oxygen is recommended only when measured O_2 sat is less than 94%. The 2010 guidelines also caution providers against overzealous oxygen administration, citing the known dangers of hyperoxia. (See *The trouble with oxygen.*)

6. Data will rule the future

In April 2013, AHA published the first-ever consensus statement on improving survival of in-hospital cardiac arrest, followed in July 2013 by a consensus statement on improving outcomes both inside and outside the hospital. The timing of these consensus statements coincides with increasing awareness of the significant number of in-hospital cardiac arrests—and perhaps a tinge of guilt over having spent so many years focused

Detecting return of spontaneous circulation

Two prehospital studies found that a sharp rise in end-tidal CO_2 ($EtCO_2$), as shown by capnography, was the earliest indicator of return of spontaneous circulation (ROSC), occurring significantly earlier than palpable pulses or blood pressure. In-hospital practitioners also find capnography an extremely valuable predictor not just of initial ROSC but of continued cardiac output after successful resuscitation. In the tense moments after successful resuscitation, few monitoring tools may be available to continuously observe cardiac output. $EtCO_2$ is just such a tool and should be watched carefully in the immediate postresuscitation period.

The trouble with oxygen

Why would oxygen hurt patients? One theory is that oxygen is a free radical—a highly reactive species because of its two unpaired electrons—and free radicals are known to harm the body. Every day, we endure thousands of free-radical attacks from sunlight, atmospheric chemicals, radiation, drugs, viruses, bacteria, dietary fats, and stress. Normally, our bodies fend off these attacks with antioxidants. But with aging, trauma, stroke, myocardial infarction (MI), or other tissue injury, the balance of antioxidants to free radicals tips and cell damage occurs. When free radicals outnumber antioxidants, oxidative stress ensues, resulting in cell damage. Tissue damage is directly proportionate to the amount of free radicals at an injury site. Flooding damaged tissues with oxygen increases the amount of free radicals and may directly cause greater tissue damage.

Some early research that supported limiting oxygen administration involved stroke patients. In mild and moderate strokes, supplemental oxygen significantly decreased survival. But in severe strokes, supplemental oxygen had no effect on outcomes. Likewise, we've long known about the potential dangers of giving oxygen to neonates; a 2004 landmark study showed a dramatic increase in deaths when distressed newborns were resuscitated with 100% oxygen compared to room air. A study of 5,549 trauma patients in Texas found supplemental oxygen nearly doubled mortality. Also, post-cardiac arrest patients undergoing therapeutic hypothermia have an increased risk of death and worse neurologic outcomes when their oxygen saturation (O_2 sat) remains high during the first 24 hours of cooling.

Lastly, and perhaps most contradictory to learned logic, oxygen has long been shown to adversely affect coronary blood flow. In a catheterization lab study of healthy volunteers, just 5 minutes of 100% oxygen was shown to increase coronary artery resistance (afterload) by roughly 40%, reduce coronary blood flow by roughly 30%, blunt coronary arteries' response to vasodilators, and markedly decrease nitric oxide production (the mechanism the body uses to initiate vasodilation). As these findings occurred in relatively healthy volunteers undergoing elective cardiac catheterizations, we can only imagine what additional damage could stem from needless oxygen administration for acute MI. Current Emergency Cardiac Care guidelines from the American Heart Association recommend oxygen administration only when O_2 sat is below 94%, titrated not to exceed an O_2 sat of 98%.

primarily on cardiac arrest in the community.

Our improved understanding of the incidence of in-hospital cardiac arrests stems from data collected by the Get With The Guidelines® Resuscitation (GWTG-R) database sponsored by the AHA (www.heart.org/quality). Originally launched in 1999 as the National Registry for CPR (NRCPR), the project collects in-hospital resuscitation data from throughout the United States and works to develop evidence-based guidelines for in-hospital CPR. In 2010, the registry became the GWTG-R; currently, it's collecting data on in-hospital cardiopulmonary arrest (CPA), acute respiratory compromise, medical emergency team or rapid response team calls, and post-cardiac arrest care. More than 700 hospitals now participate; the dataset has amassed more than 250,000 CPA patients and more than 500,000 resuscitation patients overall.

Participation is voluntary and uses a web-based data collection and reporting interface. Participants can run a wide variety of preconfigured and customized reports on their data and benchmark these against all other participants or select categories of participants, such as hospitals within the same state or like-sized hospitals. The analysis tools and benchmarking ability reveal excellent opportunities for improvement. Recent research found that hospitals participating in the GWTG-R database have better outcomes with each year of participation. Learning how the database operates doesn't seem to bias self-reported resuscitation data. A recent analysis of GWTG-R data found that hospitals with the best survival rates have fewer cardiac arrests than hospitals with lower survival rates—showing that data manipulation isn't portraying hospitals to appear better at resuscitation.

You might think such a large database also would yield significant findings about in-hospital resuscitations—and it has. Numerous published papers and research studies have used data from NRCPR and GWTG-R. These have enlightened us on the incidence of in-hospital cardiac arrest, causes, and the days and times when arrests are more likely. The importance of data collection, analysis, and reporting was a key component of recently released guidelines for in-hospital cardiac arrest. In fact, the AHA consensus statement called for mandated data collection and reporting of in-hospital cardiac arrest incidence and outcomes as an accreditation benchmark for all facilities. Public reporting of the data also was suggested, with the caveat that a good methodology for risk-adjustment of patients who suf-

fer in-hospital cardiac arrests would be needed for the public to properly compare one hospital to another. In August 2013, GWTG-R researchers developed and published just such a model, suggesting public reporting may be just around the corner.

Survival of in-hospital cardiac arrest depends on many factors. Beyond early recognition, none is more important than the quality of chest compressions. Good tools and data are available to help healthcare providers improve CPR. These include adjusting bed height and surface, feedback and coaching devices, and $EtCO_2$ measurement. Providers should be familiar with equipment limitations and in-hospital challenges to successful resuscitation, including the potential dangers of oxygen. Data collection and analysis are critically important to improving cardiac arrest outcomes and will drive future improvements as we continue to focus on reducing in-hospital cardiac arrest incidence and improving survival. ✯

Selected references

Abella BS, Edelson DP, Kima S, et al. CPR quality improvement during in-hospital cardiac arrest using a real-time audiovisual feedback system. *Resuscitation.* 2007;73(1): 54-61.

Altemeier WA, Sinclair SE. Hyperoxia in the intensive care unit: why more is not always better. *Curr Opin Crit Care.* 2007;13(1):73-8.

Banville I, Rose L, O'Hearn P, Campbell T, Nova R, Chapman F. Abstract 217: Quality of CPR performed on a mattress can be improved with a novel CPR feedback device. Resuscitation Science Symposium Abstracts. *Circulation.* 2011;124:A217. http://circ.ahajournals.org/cgi/content/meeting_abstract/124/21_MeetingAbstracts/A217. Accessed January 13, 2014.

Berg RA, Hemphill R, Abella BS, et al. Part 5: Adult basic life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2010;122(18 suppl 3):S685-705.

Berg RA, Sutton RM, Holubkov R, et al.; Eunice Kennedy Shriver National Institute of Child Health and Human Development Collaborative Pediatric Critical Care Research Network and American Heart Association's Get With the Guidelines–Resuscitation Investigators. Ratio of PICU versus ward cardiopulmonary resuscitation events is increasing. *Crit Care Med.* 2013;41(10):2292-7.

Chan PS, Berg RA, Spertus JA, et al.; AHA GWTG-R Resuscitation Investigators. Risk-standardizing survival for in-hospital cardiac arrest to facilitate hospital comparisons. *J Am Coll Cardiol.* 2013;62(7):601-9.

Chen LM, Nallamothu BK, Spertus JA, Li Y, Chan PS; American Heart Association's Get With the Guidelines–Resuscitation. Association between a hospital's rate of cardiac arrest incidence and cardiac arrest survival. *JAMA Intern Med.* 2013;173(13):1186-95.

Cho J, Oh JH, Park YS, Park IC, Chung SP. Effects of bed height on the performance of chest compressions. *Emerg Med J.* 2009; 26(11):807-10.

Cunningham LM, Mattu A, O'Connor RE, Brady WJ. Cardiopulmonary resuscitation for cardiac arrest: the importance of uninterrupted chest compressions in cardiac arrest resuscitation. *Am J Emerg Med.* 2012; 30(8):1630-38.

Girotra S, Nallamothu BK, Spertus JA, Li Y, Krumholz HM, Chan PS; American Heart Association Get with the Guidelines–Resuscitation Investigators. Trends in survival after in-hospital cardiac arrest. *N Engl J Med.* 2012;367(20):1912-20.

Hostler D, Everson-Stewart S, Rea TD, et al.; Resuscitation Outcomes Consortium Investigators. Effect of real-time feedback during cardiopulmonary resuscitation outside hospital: prospective, cluster-randomised trial. *BMJ.* 2011;342:d512.

Janz DR, Hollenbeck RD, Pollock JS, McPherson JA, Rice TW. Hyperoxia is associated with increased mortality in patients treated with mild therapeutic hypothermia after sudden cardiac arrest. *Crit Care Med.* 2012;40(12):3135-9.

Jude JR, Kouwenhoven WB, Knickerbocker GG. Cardiac arrest: report of application of external cardiac massage on 118 patients. *JAMA.* 1961;178:1063-70.

Meaney PA, Bobrow BJ, Mancini ME, et al.; CPR Quality Summit Investigators, American Heart Association Emergency Cardiovascular Care Committee, Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation. Cardiopulmonary resuscitation quality: improving cardiac resuscitation outcomes both inside and outside the hospital: a consensus statement from the American Heart Association. *Circulation.* 2013;128(4):417-35.

Merchant RM, Yang L, Becker LB, et al.; American Heart Association Get With The Guidelines–Resuscitation Investigators. Incidence of treated cardiac arrest in hospitalized patients in the United States. *Crit Care Med.* 2011;39(11):2401-6.

Morrison LJ, Neumar RW, Zimmerman JL, et al.; American Heart Association Emergency Cardiovascular Care Committee, Council on Cardiopulmonary, Critical Care, Perioperative and Resuscitation, Council on Cardiovascular and Stroke Nursing, Council on Clinical Cardiology, Council on Peripheral Vascular Disease. 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.* 2013;127(14):1538-63.

Neumar RW, Otto CW, Link MS, et al. Part 8: Adult advanced cardiovascular life support: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2010;122(18 suppl 3):S729 –67.

O'Connor RE, Brady W, Brooks SC, Diercks D, et al. Part 10: Acute coronary syndromes: 2010 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation.* 2010;122(18 suppl 3):S787-817.

Perkins GD, Kocierz L, Smith SC, McCulloch RA, Davies RP. Compression feedback devices overestimate chest compression depth when performed on a bed. *Resuscitation.* 2009;80(1):79-82.

Pozner CN, Almozlino A, Elmer J, Poole S, McNamara D, Barash D. Cardiopulmonary resuscitation feedback improves the quality of chest compression provided by hospital health care professionals. *Ann J Emerg Med.* 2011;29(6):618-25.

Standards for basic anesthetic monitoring. American Society of Anesthesiologists. 2011. https://www.asahq.org/~/media/For%20Members/documents/Standards%20Guidelines%20Stmts/Basic%20Anesthetic%20Monitoring%202011.pdf#search=%22standards for basic anesthetic monitoring%22. Accessed December 17, 2013.

Stiell IG, Brown SP, Christenson J, et al.; Resuscitation Outcomes Consortium (ROC) Investigators. What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation? *Crit Care Med.* 2012;40(4):1192-8.

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Purpose/Goal

To provide nurses with information that will help them ensure patients receive optimal care during cardiopulmonary resuscitation.

Learning Objectives

1. Discuss the role of effective compressions in cardiopulmonary resuscitation.
2. State six key resuscitation practices.
3. Describe effective monitoring during resuscitation efforts.

Please mark the correct answer online.

1. As you help Mrs. Sloan, your 62-year-old patient with pneumonia, to the bathroom, she collapses on the floor. You determine she has no pulse and isn't breathing. After calling for help, you start cardiopulmonary resuscitation (CPR), keeping in mind that the ideal chest compression depth is:

a. 0.5".
b. 1".
c. 2".
d. 3".

2. As you perform chest compressions, you remind yourself that the recommended compression rate is at least:

a. 100 to 120/minute.
b. 90 to 100/minute.
c. 80 to 100/minute.
d. 70 to 90/minute.

3. The optimal bed height for chest compressions is:

a. rescuer's mid-thigh height.
b. rescuer's knee height.
c. halfway between the lowest and highest bed level.
d. lowest level of the bed.

4. A patient in cardiac arrest has an arterial line. During CPR, the goal is to keep the diastolic pressure above:

a. 10 mm Hg.
b. 15 mm Hg.
c. 20 mm Hg.
d. 25 mm Hg.

5. Which statement about accelerometer-based feedback devices for CPR is accurate?

a. These devices compensate for movement of the mattress.
b. Actual compression depth may be 35% to 40% less than the depth reported by the device.
c. Accelerometer-based feedback devices have been shown to improve survival.
d. Actual compression depth equals the depth reported by the device.

6. What type of technology incorporates a back pad that slides under the patient's shoulder and a chest pad that goes under the compressor's hands to magnetically measure compression depth?

a. Biaxial field induction
b. Triaxial field induction
c. Optimal depth
d. Optimal push

7. The resuscitation team arrives to assist you with Mrs. Sloan. Which end-tidal CO_2 ($EtCO_2$) value would indicate your compressions for her aren't deep or fast enough?

a. 8 mm Hg
b. 10 mm Hg
c. 12 mm Hg
d. 15 mm Hg

8. You check Mrs. Sloan's oxygen saturation (O_2 sat). Which value would indicate she needs supplemental oxygen?

a. 89%
b. 94%
c. 96%
d. 98%

9. Too much oxygen can be harmful to patients because it:

a. increases the response to vasodilators.
b. increases nitric oxide production.
c. increases afterload.
d. decreases afterload.

10. Two prehospital studies found that the earliest indicator of return of spontaneous circulation (ROSC) was a:

a. sharp rise in $EtCO_2$.
b. palpable femoral pulse.
c. blood pressure.
d. palpable carotid pulse.

11. Which statement about Get With The Guidelines Resuscitation (GWTG-R) is correct?

a. GWTG-R is a mandatory system.
b. GWTG-R is a paper-based system.
c. An analysis of GWTG-R data showed that hospitals with the best survival rates have fewer cardiac arrests than those with lower survival rates.
d. An analysis of GWTG-R data showed that hospitals with lower survival rates have more cardiac arrests than those with higher survival rates.

12. What is the most important factor in successful resuscitation?

a. Depth of ventilations administered
b. Use of capnography for monitoring
c. Number of ventilations administered
d. Quality of chest compressions