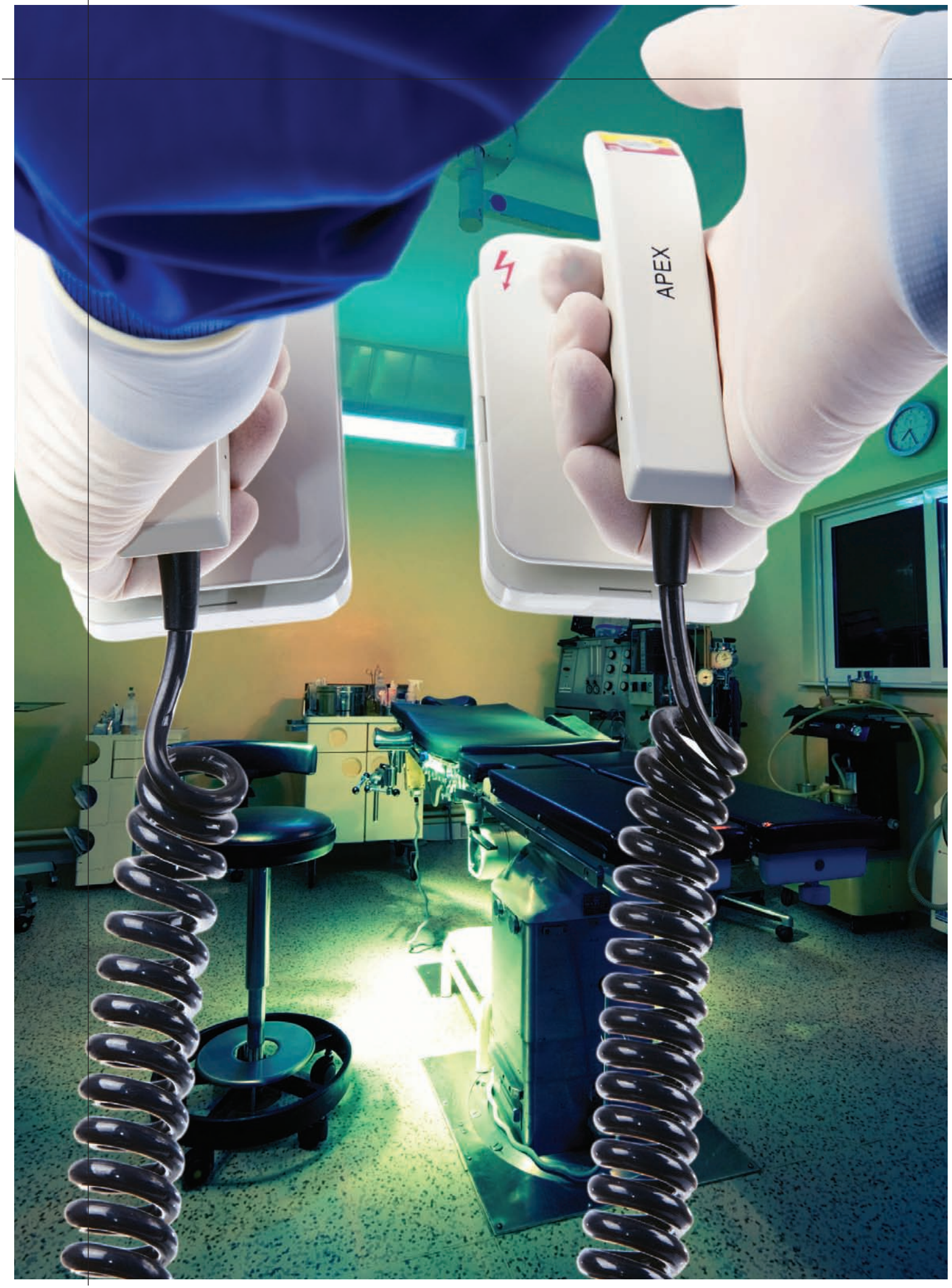

Cardiac arrest in the OR

Be prepared to deal with this uncommon but life-threatening situation.

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You're just coming on shift and see a number of OR personnel hurrying into one of the suites. You ask the OR scheduler what's going on and are told that the patient has just suffered a cardiac arrest. Are you prepared to intervene if this situation occurs in your OR? This article describes what to do.

Nearly 10 million inpatient and outpatient surgical procedures were performed in the United States in 2006, the most recent year for which figures are available.[1,2] For every 10,000 cases, between 4.6 and 19.7 cardiac arrests occur, meaning that between 4,600 and 19,700 surgical patients could have suffered cardiac arrest in 2006.[3] Although this may not seem like very many arrests, compared to the number of functioning ORs in the United States, the likelihood that an OR nurse will care for a patient who experiences a cardiac arrest during a procedure is very real. Recognizing cardiac arrest and intervening promptly are key to patient survival.[4]

Who's at risk

The American Heart Association (AHA) defines cardiac arrest as "an abrupt loss of cardiac function."[4] Cardiac arrest is a result of a disturbance in the heart's electrical system, disrupting perfusion to the rest of the body. This abrupt loss of cardiac function may be a result of a number of conditions, diseases, and situations, including delivery of anesthetics. In fact, the Mayo Clinic found that 10.8% of perioperative cardiac arrests were attributable to anesthetics.[3] Understanding

the risk factors for cardiac arrest will help OR nurses be more cognizant of the potential for certain patients to arrest. Cardiac risk factors include:

- *Coronary artery disease.* Most patients who have a cardiac arrest have underlying coronary artery disease, diagnosed or undiagnosed.[5] Patients with a history of heart disease have a higher risk of having a cardiac arrest during surgery than those patients without heart disease. Therefore, anyone having the risk factors for heart disease will also be at risk for cardiac arrest. Some of these factors include family history of heart disease, smoking, hypertension, hypercholesterolemia, obesity, diabetes, and alcohol abuse. In addition to this, any person who's had a previous cardiac arrest or a family history of cardiac arrest is at a high risk for having an arrest themselves. Previous myocardial infarctions (MIs) put a person at risk for a cardiac arrest.
- *Cardiomyopathy.* A disease of the heart muscle that may increase a patient's risk for cardiac arrest, cardiomyopathy has four main types: Dilated cardiomyopathy, in which the left ventricle becomes dilated and the heart muscle weakens; hypertrophic cardiomyopathy, in which the heart muscle thickens; arrhythmogenic right ventricular (RV) cardiomyopathy, in which the muscle tissue of the RV is replaced with fibrous and fatty tissue; and restrictive cardiomyopathy, in which the walls of the ventricles stiffen.
- *Valvular or congenital heart disease.*
- *Conduction defects or abnormalities.* Long QT syndrome, Wolff-Parkinson-White syndrome, bradycardia, tachycardia, heart blocks, Brugada syndrome, or ventricular tachycardia (VT) or ventricular fibrillation (VF) after MI also increase the risk for cardiac arrest.
- *Ejection fraction less than 40% with VT.*
- *Heart failure.* Patients with heart failure are six to nine times more likely to have a cardiac arrest than patients without heart failure.[5,6]

Noncardiac risk factors include:

- *Age and male gender.* Age over 45 for men (55 for women) increases the likelihood of arrest. Men are two to three times as likely to have a cardiac arrest as women.[5]
- *Lifestyle factors such as smoking, sedentary lifestyle, obesity, alcohol abuse, illegal drug use, hypercholesterolemia, and nutritional imbalances (low potassium or magnesium).*
- *Chronic illnesses* such as hypertension, diabetes, and obesity.
- *Proarrhythmic medications.* Certain drugs may also put a patient at risk for cardiac arrest by provoking an abnormal, unexpected, and life-threatening cardiac rhythm.

Warning signs

Nursing research has found that about 84% of patients exhibit at least one behavioral change within 8 hours of a cardiac arrest, and 90% of patients develop a physiologic abnormality within 8 hours of a cardiac arrest.[7,8] These physiologic abnormalities included neurologic changes (most frequently, a decrease in the level of consciousness); respiratory changes including tachypnea, bradypnea, and hypoxemia; and cardiovascular changes including tachycardia, bradycardia, hypotension, and severe hypertension.[8]

During the preoperative patient interview, the circulating nurse should note any recent behavioral changes in the patient or any physiologic abnormalities and report these findings to the surgical team. Additionally, if the patient indicates a recent complaint of chest discomfort, palpitations, dyspnea, indigestion, edema, dizziness, or headache, these findings should be addressed before surgery.[7]

Should a cardiac arrest occur, recognizing it is the first critical step to being able to respond appropriately. A person who suffers cardiac arrest loses consciousness and becomes unresponsive. Because most OR patients are under general anesthesia and nonresponsive, OR personnel don't generally rely on responsiveness as an initial finding of cardiac arrest. Other assessment data are used to determine if a patient has gone into arrest. Included in this assessment data are regular BP and pulse checks and oxygen saturation and cardiac rhythm monitoring. Keeping a close eye on these physiologic parameters will alert the OR personnel to an impending or actual cardiac arrest.

Changes in physiologic parameters that may indicate an impending cardiac arrest include any significant change from baseline in heart rate or BP, new-onset cardiac dysrhythmia (especially ventricular dysrhythmia), and oxygen desaturation.

Addressing underlying causes

If an underlying cause or contributing factor to cardiac arrest isn't identified and treated, the likelihood of successful resuscitation is decreased significantly. The AHA outlines a number of contributing factors that may precipitate or add to the complications of cardiac arrest.[9] They are commonly called the "H's

and T's" and stand for common conditions and situations that may contribute to cardiac arrest (see *Contributing factors*). In addition to these contributing factors, all of the risk factors of cardiac arrest must be taken into account as possible causes for the arrest.

Responding to an arrest

Tissue and brain death begin to develop within 4 to 6 minutes after patients lose their supply of oxygen due to a cardiac arrest.[5] The arrest may be reversible if the patient is defibrillated and successfully resuscitated within a few minutes of the arrest.[5] If a defibrillator isn't immediately available, follow the steps of basic life support to perfuse the vital organs until the defibrillator is available. To maintain circulation and vital tissues perfusion, effective chest compressions with minimal interruptions are essential.

In the OR, maintain the patient's airway via an artificial airway, and ventilate the patient via mechanical ventilation or manual bag-valve–mask device maneuvers. Airway management in the OR is generally the responsibility of the anesthesia provider.

Effective CPR for adults, as outlined by the AHA, has five main components, with some additional considerations. The five components are:

- Providing chest compressions of adequate rate (at least 100/minute)
- Providing chest compression of adequate depth (at least 2 inches [5 cm])
- Allowing complete chest recoil after each compression
- Minimizing interruptions in the chest compressions
- Avoiding excessive ventilation.[4]

Additional important considerations include regular rotation of individuals doing chest compressions to maximize CPR effectiveness and to avoid caregiver fatigue and patient hyperventilation.[10] Perform CPR before and after defibrillation; prompt CPR can improve the patient's chance of survival.[10]

As soon as the automated external defibrillator (AED) or a defibrillator on the emergency or crash cart is available, attach it to the patient and deliver a shock, if appropriate. Defibrillation is the cornerstone therapy for VF and pulseless VT.[4] In the OR, if the patient is attached to a cardiac monitor, identification and interpretation of the rhythm may be faster than in clinical areas outside the OR. Immediately following the delivery of the first shock, resume CPR.

Contributing factors[9]

These conditions may contribute to cardiac arrest:

- Hypovolemia
- Hypoxia
- Hydrogen ions (acidosis)
- Hypo- or hyperkalemia
- Hypothermia
- Toxins (drug overdose)
- Tamponade, cardiac
- Tension pneumothorax
- Thrombosis (pulmonary or cardiac)
- Trauma

A patient in cardiac arrest will generally present in pulseless VT, VF, asystole, or pulseless electrical activity (PEA).[9] Because pulseless VT and VF are both rhythms that still have electrical activity, although chaotic, they're treated the same, with defibrillation and medication. By the same token, asystole (the absence of detectable ventricular electrical activity) and PEA won't respond to electrical shocks, and are treated with medication only, until shockable electrical activity is achieved.[9] (See *Steps for VF and pulseless VT*.)

Effective resuscitative efforts are generally conducted in 2-minute increments, as outlined by the AHA's adult cardiac arrest algorithm available on the AHA's website at http://circ.ahajournals.org/cgi/reprint/122/18_suppl_3/S729.[9] In the case of pulseless VT and VF, each 2-minute increment of CPR is finished by an assessment of the rhythm and a single electrical shock, if warranted. CPR is immediately started again, during which time one of a variety of medications may be given and pumped around the circulatory system, followed by rhythm assessment and another single shock as needed. Interruptions in chest compressions should be no longer than 10 seconds (except for interventions such as defibrillation or advanced airway insertion) to maximize the effectiveness of the CPR. This sequence is continued until the patient's rhythm changes, the patient begins to stir, or the resuscitative efforts are stopped.

The 2-minute increments are nearly identical for asystole and PEA, with the exception of the shock. Instead of delivery of a shock at the end of the 2-minute increment, chest compressions are stopped to assess the rhythm. If the victim continues in asystole or PEA, chest compressions are resumed and one of a variety of mediations is delivered and

pumped around the circulatory system. This sequence is also continued until there is a change in the victim's rhythm, the victim begins to stir, or the resuscitative efforts are stopped.

Medications that may be used during the resuscitative effort for pulseless VT or VF are divided into two categories: vasopressors such as epinephrine and vasopressin, and antiarrhythmics such as amiodarone. Lidocaine may also be considered in the event that amiodarone isn't available. Magnesium sulfate can be given as the first-line medication for patients with torsades de pointes, a type of pulseless VT.[9]

- *Epinephrine* is administered for pulseless VT, VF, asystole, and PEA. A potent vasoconstrictor, epinephrine works on alpha-adrenergic receptors to increase cardiac and cerebral perfusion in patients during cardiac arrest.[7] Administer 1 mg I.V. push (or via an established intraosseous [IO] site), repeating the dosage every 3 to 5 minutes during the resuscitative effort.[9,11] Follow each dose with a bolus of 10 to 20 mL of 0.9% sodium chloride solution and elevate the patient's arm for 10 to 20 seconds after the dose. Monitor BP, heart rate, respiratory rate, and cardiac rhythm during administration. If I.V. access isn't available, epinephrine can also be given via an endotracheal (ET) tube, at a dose of 2 to 2.5 mg.[9]
- *Vasopressin*, a nonadrenergic peripheral vasopressor, may be given in the place of the first or second dose of epinephrine because the results of both medications have been shown to be similar for patients with pulseless VT, VF, asystole, or PEA. In high doses, vasopressin is a potent vasoconstrictor, affecting the coronary and renal vasculature. Because of vasopressin's longer half-life (10 to 20 minutes), only one dose of 40 units is given I.V. push or via an established IO site.[9,11] Monitor the patient's BP, heart rate, and cardiac rhythm during administration. Administering vasopressin in cardiac arrest is considered an off-label use.[12]

Steps for VF and pulseless VT

After recognizing altered patient status, dysrhythmia, and loss of pulse, call a code and follow these steps:

- Begin chest compressions/CPR with breaths delivered via a bag-valve–mask device or ET tube.
- Attach the defibrillator or AED and analyze the patient's rhythm.
- Recognize VF or pulseless VT.
- Deliver one shock per defibrillator recommendations.
- Continue CPR and prepare the first medication (a vasopressor, typically epinephrine or vasopressin).
- Consider possible causes of the arrest (the H's and T's). If causes are identified, treat them as soon as possible.
- After 2 minutes, stop CPR and analyze the patient's cardiac rhythm. If it's still VF or pulseless VT, administer one shock.
- Resume CPR, give first medication, prepare second medication (a vasopressor, or an antiarrhythmic such as amiodarone).
- After 2 minutes, stop CPR and analyze the patient's cardiac rhythm. If it's still VF or pulseless VT, administer one shock. Continue CPR and deliver the second medication.
- Repeat the previous step at 2-minute intervals until the patient's rhythm changes, the patient stirs, or the code is stopped. After 2 minutes, other medications that may be used include a second dose of amiodarone, epinephrine every 3 to 5 minutes, and lidocaine or magnesium if indicated.

Steps for asystole and PEA

After recognizing altered patient status, dysrhythmia, and loss of pulse, call a code and follow these steps:

- Begin chest compressions/CPR with breaths delivered via a bag-valve–mask device or ET tube.
- Attach the defibrillator or AED and analyze the patient's rhythm.
- Recognize asystole or PEA.
- Resume CPR and prepare and deliver the first medication (a vasopressor such as epinephrine or vasopressin). Also prepare the second medication (also epinephrine or vasopressin).
- Consider possible causes of the arrest (the H's and T's). If causes are identified, treat them as soon as possible.
- After 2 minutes, stop CPR and analyze the patient's cardiac rhythm. If it's still asystole or PEA, resume CPR, give second medication, and prepare the next dose of epinephrine.
- Repeat the previous step at 2-minute intervals until the patient's rhythm changes, the patient stirs, or the code is stopped.

• *Amiodarone*, a Class III antiarrhythmic, has properties of all four classes of antiarrhythmics. Its primary action is to block potassium ion channels of the cell, altering the action potential, thus helping to control or convert certain dysrhythmias. Other actions of amiodarone include blocking sodium and calcium channels and alpha- and beta-adrenergic blockade. As a result of these various properties, amiodarone is used in several of the advanced cardiac life support (ACLS) algorithms, including those for pulseless VT and for VF.[9,11] Amiodarone is FDA-approved for use in life-threatening recurrent VF and recurrent hemodynamically unstable VT.[12]

During cardiac arrest, for treating a patient's pulseless VT or VF, amiodarone 300 mg I.V. push may be given initially, followed by a dose of 150 mg given 3 to 5 minutes after the first dose. Monitor the patient's vital signs and cardiac rhythm during administration. Adverse pulmonary effects of amiodarone administration include postoperative acute respiratory distress syndrome and pulmonary toxicity.[12] Monitor the patient's respiratory function and oxygen saturation and assess the patient for signs and symptoms of pulmonary toxicity, such as crackles, decreased breath sounds, friction rub, and wheezing. Because antiarrhythmic agents, such as amiodarone, may be ineffective or may induce dysrhythmias in patients with hypokalemia or hypomagnesemia, monitor the patient for cardiac dysrhythmias and correct the electrolyte imbalance.[12]

• *Lidocaine*, a Class IB antiarrhythmic, may be used as an alternative to amiodarone for patients with pulseless VT or VF.[9] Lidocaine primarily blocks sodium channels, suppressing automaticity (automatic firing of the heart) and depolarization, particularly in rapidly firing tissue. Administer 1 to 1.5 mg/kg, I.V. push, for the first dose. Subsequent doses of 0.5 to 0.75 mg/kg may be given at 5- to 10-minute intervals, up to a maximum dosage of 3 mg/kg.[9,11] Monitor the patient's cardiac rhythm continually, and monitor BP and respiratory status frequently; lidocaine can cause toxicity, characterized by confusion, blurred or double vision, nausea and vomiting, and ringing in the ears.

If amiodarone or lidocaine is successful in restoring a perfusing rhythm, continuous I.V. infusions of either drug may be started.

• *Magnesium* may be used in special circumstances, including pulseless VT or VF and associated torsades de pointes. This electrolyte is essential for many of the cell's processes.[11] Magnesium combines with adenosine triphosphate (ATP) to drive the sodium-potassium pump, which is integral to the cells being able to return to a resting state after depolarization. If the sodium-potassium pump isn't working properly, the patient is at risk for developing dysrhythmias and cardiac arrest, most notably related to long QT syndrome.

Hypomagnesemia increases the risk of QT prolongation and torsades de pointes. Long QT syndrome may be inherited or acquired (drug-induced). A patient with acquired long QT syndrome and hypomagnesemia is at increased risk for torsades de pointes.

For a patient with torsades de pointes, 1 to 2 g of magnesium may be diluted in 10 mL of D_5W and administered I.V. or IO over 5 to 20 minutes.[9,11]

Maintaining sterile field

If a patient's cardiac arrest occurs after the sterile field has been established and the surgery is underway, special care must be taken to maintain the sterility of the surgical site during the resuscitative effort. Additionally, because of the sterile nature of the OR, traffic control may be necessary. Staff responsibilities should be handled according to facility policies and procedures, but may be similar to the following:

The *anesthesia provider* or *surgeon* usually will direct the code, depending on the type of surgery and anesthetic used. Typically the anesthesia provider will administer the medications, but a perianesthesia nurse trained in ACLS may administer medications.

The *circulating nurse,* as one of the only nonsterile persons in the OR, will usually fill the responsibility of calling for the code and documenting the specifics of the actions taken during the code. The circulating nurse may also be the one to act as the traffic controller in the OR, while other OR personnel outside the suite will help to control the traffic into and around the OR. The circulating nurse may also need to help maintain sterility of the field, but remember that the resuscitative effort is paramount to the sterility of the area. Delegation will also be a task of the circulating nurse, as various requests or actions are needed.[7]

The *scrub person* will usually be responsible for maintaining sterility of the field, as far as possible, and sterility of any surgical incisions or openings. Sterile sponges soaked in sterile 0.9% sodium chloride solution should be used to pack any surgical openings, and openings should be covered with a

sterile drape as far as possible. The scrub person can also assist the surgeon in controlling bleeding, suctioning, or wound closure.[7]

The *OR manager* or *charge nurse* will assign assistance to the code team from outside the OR. This person also will be in charge of contacting the ICU or nursing supervisor regarding a possible admission. The OR schedule may need to be changed, depending on the length of the arrest and how many surgeries and ORs are affected by the code. Other OR personnel will be expected to assist the code team as delegated by the circulating nurse or the OR manager or charge nurse.[7]

Being prepared

Although cardiac arrests in the OR aren't common, knowing how to handle this situation is crucial. Start by becoming familiar with the BLS and ACLS guidelines. Participate in regular mock codes, which ORs may use to help prepare personnel for a cardiac arrest. With knowledge and practice, OR nurses will be a little more at ease in the event of an actual cardiac arrest. **OR**

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The author and planners have disclosed that they have no financial relationships related to this article.

DOI-10.1097/01.ORN.0000403416.97753.bb