When Advanced Cardiac Life Support Isn't Enough

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Heart disease is the leading cause of death in the United States. Approximately 1 of every 4 American deaths is heart related according to the Centers for Disease Control and Prevention.[1] Cardiac arrest standards of care—that is, early defibrillation, cardiopulmonary resuscitation (CPR), advanced cardiac life support (ACLS), cardiac catheterization laboratory (CCL) access, and targeted temperature management—may not be enough. Australia and Denmark are improving resuscitation rates for dysrhythmia patients with ventricular fibrillation (VF) and ventricular tachycardia (VT) by adding complex modalities. These modalities may include automated CPR, extracorporeal membrane oxygenation (ECMO), ventricular assist devices (VAD), and intra-aortic balloon pump devices.[2,3] The CCL team locates the cause of the dysrhythmia and determines best therapies. Hospitals without CCLs, or access within an hour, may elect to stabilize VF/VT protocol patients for transport. Although not all hospitals will have all capabilities, the processes outlined in this article may be added during cardiac arrests to improve survival for VF/VT protocol patients.

Modalities

- **Automated compression devices** were invented in the 1960s, and in 2006 they were proven to provide more accurate and consistent CPR during sudden cardiac arrest than were humans. These devices are used in ambulances, hospitals, intensive care units (ICUs), CCLs, and rescue units. Besides offering high-quality CPR, automated compression devices free staff to perform critical duties without interrupting quality compression and perfusion.[4]

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- **Targeted temperature management** is a slow, controlled reduction in core body temperature induced in selected patients with sudden cardiac arrest to decrease metabolic needs while improving neurologic survival. Implementation of hypothermia requires planning, education, and integration of multiple services within an institution. It is recommended that all central lines be in place prior to cooling.[5]
- **ECMO** is used when the heart and lungs cannot function normally or independently. Patients undergo anticoagulation, and then dual cannulation is performed so blood enters and exits via a circuit. Carbon dioxide is removed while oxygenating red blood cells. Adapted from heart-lung bypass machines devised by Dr. Robert Bartlett of the University of Michigan Hospital in the 1970s, ECMO is similar to cardiopulmonary bypass, but it can be used for a longer period. ECMO risks are bleeding, infection, air emboli, and blood clots.[6] In cardiac arrest situations, ECMO is used for thermoregulation and perfusion stabilization to enable coronary angiography and primary coronary intervention to reverse causative coronary artery ischemia and improve functionally favorable survival.[7]
- Intra-aortic balloon pump devices provide counterpulsation to balance myocardial oxygen supply and demand when cardiac output is poor during a cardiac arrest. Cardiac output, ejection fraction, and coronary perfusion are increased by using systolic unloading and diastolic augmentation via an inflating helium balloon. This procedure reduces left ventricular wall stress, systemic vascular resistance, and pulmonary capillary wedge pressure. In 1971, it was used in patients with myocardial infarction cardiogenic shock to reduce refractory shock within the first 12 hours of infarction, enabling patients to survive to hospital discharge.[8]
- **VADs** support heart function and blood flow in patients with weakened hearts, such as occurs during cardiac arrest. The device takes blood from a lower chamber of the heart and helps pump it to vital organs. A VAD may support the right, left, or both ventricles. Some VADs pump blood like a heart, whereas others pump a continuous flow of blood. With continuous-flow VADs, there is not a normal pulse.[9]

The Australia and Denmark successes suggest that resuscitation attempts should be extended, because the prognosis for refractory cardiac arrest patients "is not as poor as we previously thought."[3] However, the protocol is both resource and labor intensive. Preplanning and coordination of adequate or sufficient resources must be orchestrated and staff trained. In addition, ethical implications exist. Should resuscitation be pursued for the purpose of saving lives or to increase organ availability, or both? What about conflict of interest? The purpose of this article is to describe one hospital's experiences in implementing an enhanced cardiac arrest protocol and the ramifications for patients, families, and prehospital and ED staff.

Implementation of An Enhanced Cardiac Arrest Protocol

In 2013, the Minnesota Resuscitation Consortium developed an organized community approach for the use of automated CPR machines in patients with shockable rhythms in order to gain early access to the CCL (see the VF/VT protocol in Figure 1). The Minnesota Resuscitation Consortium is a collaborative effort between the University of Minnesota, local hospital systems, first responders, community groups, and education programs that collects resuscitation data for policy decision making and to improve patient outcomes. As a result, our emergency department agreed to accept rural area patients using automated CPR devices for this protocol. These patients may have had more than 1 hour of CPR machine time. Patients excluded from the protocol were those with asystole and pulseless electrical activity (PEA) for the following reasons.

- Asystole is the absence of electrical activity or myocardial contractions, as well as no cardiac output or blood flow. Because health care practitioners use asystole as a condition to certify legal or clinical death, efforts to resuscitate asystole patients would be futile.[10]
- PEA is any rhythm observed on an electrocardiogram that does not produce a pulse. PEA may have an underlying treatable cause, often associated with the phrase "H′s & T's." The H′s are hypovolemia, hypoxia, hydrogen ion (acidosis), hyperkalemia or hypokalemia, and hypothermia. The T's include toxins, tamponade (pericardial), tension pneumothorax and thrombosis. Therefore, until the PEA cause is determined and corrected, early CCL access would not be practical.[10]

In our VF/VT protocol, EMS begins automated CPR and then alerts the emergency department that a protocol patient is en route (see Figure 1). The emergency department then phones the page operator to alert the VF/VT team members (Figure 2). Upon ambulance arrival, the

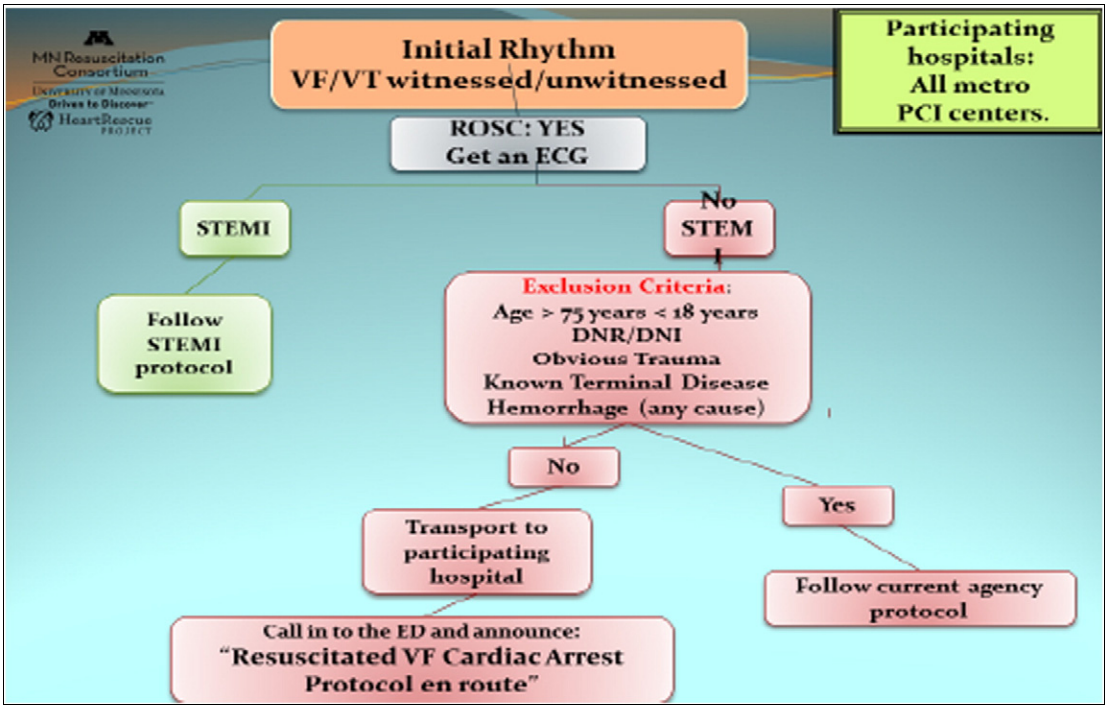

FIGURE 1

Ventricular fibrillation (VF)/ventricular tachycardia (VT) protocol. Emergency medical services establish a stable airway and apply the cardiopulmonary resuscitation machine. ED personnel activate the cardiac catheterization laboratory (CCL) and establish intraosseous access. All other orders occur in the CCL. *DNI,* Do not intubate; *DNR,* do not resuscitate; *ECG,* electrocardiogram; *PCI,* percutaneous coronary intervention; *ROSC,* return of spontaneous circulation; *STEMI,* ST-elevation myocardial infarction.