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Part 6: Electrical Therapies :

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for VF SCA. However, in 2 randomized controlled trials,[14,15] a period of 1 ½ to 3 minutes of CPR by EMS personnel before defibrillation did not improve ROSC or survival to hospital discharge in patients with out-of-hospital VF or pulseless ventricular tachycardia (VT) compared with immediate defibrillation, regardless of EMS response interval, in systems with low overall survival. In 1 retrospective before/after study,[16] immediate CPR by EMS personnel was associated with no significant difference in survival to discharge but significantly improved neurological status at 30 days or 1 year compared with immediate defibrillation in patients with out-of-hospital VF. In a retrospective observational study,[17] probability of survival was increased if chest compressions were performed during a higher proportion of the initial CPR period as compared to a lower proportion.

When VF is present for more than a few minutes, the myocardium is depleted of oxygen and metabolic substrates. A brief period of chest compressions can deliver oxygen and energy substrates, increasing the likelihood that a shock may terminate VF (defibrillation) and a perfusing rhythm will return (ie, ROSC).[18]

When an out-of-hospital cardiac arrest is not witnessed by EMS personnel, EMS may initiate CPR while checking the ECG rhythm and preparing for defibrillation. There is insufficient evidence to determine if 1 ½ to 3 minutes of CPR should be provided prior to defibrillation. CPR should be performed while a defibrillator is being readied (Class I, LOE B). One cycle of CPR consists of 30 compressions and 2 breaths. When compressions are delivered at a rate of about 100 per minute, 5 cycles of CPR should take roughly 2 minutes (range: about 1 ½ to 3 minutes).

EMS system medical directors may consider implementing a protocol that allows EMS responders to provide CPR while preparing for defibrillation of patients found by EMS personnel to be in VF. In practice, however, CPR can be initiated while the AED is being readied.

With in-hospital SCA, there is insufficient evidence to support or refute CPR before defibrillation. However, in monitored patients, the time from VF to defibrillation should be under 3 minutes. When 2 or more rescuers are present, one rescuer should begin CPR while the other activates the emergency response system and prepares the defibrillator.

1-Shock Protocol Versus 3-Shock Sequence

At the time of the 2010 Consensus Conference, there were 2 new published human studies that compared a 1-shock protocol versus a 3-stacked-shock protocol for treatment of VF cardiac arrest. Evidence from these 2 well-conducted pre/post design[19,20] studies suggested significant survival benefit with the single-shock defibrillation protocol compared with 3-stacked-shock protocols. If 1 shock fails to eliminate VF, the incremental benefit of another shock is low, and resumption of CPR is likely to confer a greater value than another shock. This fact, combined with the data from animal studies documenting harmful effects from interruptions to chest compressions and human studies suggesting a survival benefit with a 1-shock protocol, indicate that it is reasonable to use 1-shock for VF, then immediate CPR (Class IIa, LOE B).

First-shock efficacy for biphasic shocks is comparable or better than 3 monophasic shocks.[21–25] Although the optimal energy level for defibrillation using any of the monophasic or biphasic waveforms has not been determined, a recommendation for higher initial energy when using a monophasic waveform was weighed by expert consensus with consideration of the potential negative effects of a high first-shock energy versus the negative effects of prolonged VF. The consensus was that rescuers using monophasic defibrillators should give an initial shock of 360 J; if VF persists after the first shock, second and subsequent shocks of 360 J should be given. This single dose for monophasic shocks is designed to simplify instructions to rescuers but is not a mandate to recall monophasic AEDs for reprogramming. If the monophasic AED being used is programmed to deliver a different first or subsequent dose, that dose is acceptable.

After shock delivery, the rescuer should not delay resumption of chest compressions to recheck the rhythm or pulse. After about 5 cycles of CPR (about 2 minutes, although this time is not firm), ideally ending with compressions, the AED should then analyze the cardiac rhythm and deliver another shock if indicated (Class I, LOE B). If a nonshockable rhythm is detected, the AED should instruct the rescuer to resume CPR immediately, beginning with chest compressions (Class I, LOE B).

Concern that chest compressions in the presence of a postshock organized rhythm might provoke recurrent VF has been expressed by 1 animal and 2 human studies,[26–28] but this has not been shown to adversely affect survival if the current algorithms are followed.[19,20]

Furthermore, in animal studies, frequent or long interruptions in precordial chest compressions for rhythm analysis[29] or rescue breathing[30,31] were associated with postresuscitation myocardial dysfunction and reduced survival rates. Data from a prospective observational study showed that interruption in chest compressions is associated with a decreased probability of successful conversion of VF to a perfusing rhythm after shock.[32] In a recent clinical observational study of out-of-hospital CPR[33] and an in-hospital study of CPR[34] by healthcare providers, chest compressions were performed only for 51%[33] to 76%[34] of total CPR time.

The rhythm analysis for a 3-shock sequence performed by commercially available AEDs can result in delays of up to 37 seconds between delivery of the first shock and delivery of the first postshock compression.[29] This delay is difficult to justify in light of the first-shock efficacy of >90% reported by current biphasic defibrillators.[28,35–39]

AED manufacturers should seek innovative methods to decrease the amount of time chest compressions are interrupted for AED operation. Training materials for lay rescuers should emphasize the importance of continued CPR until basic or advanced life support personnel take over CPR or the victim begins to move.

Shortening the interval between the last compression and the shock by even a few seconds can improve shock success (defibrillation and ROSC).[18,32,40] Thus, it is reasonable for healthcare providers to practice efficient coordination between CPR and defibrillation to minimize the hands-off interval between stopping compression and administering shock (Class IIa, LOE C). For example, when 2 rescuers are present, the rescuer operating the AED should be prepared to deliver a shock as soon as the compressor removes his or her hands from the victim's chest and all rescuers are "clear" of contact with the victim. Rescue