A Simulation Study of the Reaction of the Human Heart to Biphasic Electrical Shocks

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This article presents a study which examines the effects of biphasic electrical shocks on human ventricular tissue.

When sudden cardiac arrest strikes, CPR alone doesn't save lives. It is merely a temporary measure that maintains minimal oxygen flow to the brain. Early defibrillation is required to re-establish a regular heartbeat.

A defibrillator can deliver a controlled electrical shock to a heart that has a life-threatening rhythm, such as ventricular fibrillation (VF). Death can occur from VF in few minutes if no therapeutic intervention is applied. Up to now, electrical shocks are the only effective known therapy against VF.

Defibrillation requires a true middle-of-the-road approach. You must have enough current to reach the heart (stop the lethal rhythm), but not so much peak current that you risk damaging the heart. In this study, electrical shocks varied in magnitude from 0.1 to 5V.

Impedance is the body's resistance to the flow of current. Some people have higher impedance than others. Certain factors can increase impedance, such as: a large and/or hairy chest; very dry skin; excess air in the lungs; and improper application of defibrillation electrodes.

Biphasic waveforms adjust for impedance by varying the characteristics of their waveforms. Hearts respond differently to different waveforms, which is why the introduction of biphasic waveforms to external defibrillators can have a positive impact.

With a monophasic waveform, current flows in one direction, from one electrode to the other, stopping the heart so it has the chance to re-start on its own. With a biphasic waveform, current flows in one direction in the first phase of the shock and reverses for the second phase.

External defibrillators that utilize biphasic waveforms are now available and licensed for clinical use. These devices allow smaller, lighter batteries to be used with a lengthening of the defibrillator battery life.

Low energy biphasic shocks are as effective as higher energy monophasic shocks and may result in less damage to the heart and reduced frequency of post-shock contractility and arrhythmic problems. Published evidence indicates that biphasic waveform shocks of 200 J or less are safe and have equivalent or higher efficacy than damped sinusoidal waveform shocks of 200 J or 350 J. At present, different manufacturers of defibrillators use different energy levels. The precise waveforms used in biphasic shocks vary considerably with different models. There is inadequate comparative data to be able to decide which is the most effective energy level, shock sequence, or biphasic waveform.

Several studies in animals and humans have shown that defibrillators using biphasic waveforms are more effective for terminating ventricular fibrillation (VF) than those using monophasic waveforms.

Public access defibrillation can succeed only if lay rescuers and nontraditional responders are trained and equipped to use AEDs. However, widespread dissemination of AED training and equipment requires devices that are small, light, modestly priced, durable, low-maintenance, almost intuitively obvious to operate, and capable of being stored for long periods without recharging.

Home AEDs range in price from $1,500 to $3,000. Manufacturers also recommend purchasing extra battery packs and various storage devices.

References

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