Title : TIME AND THERAPY AFFECT ENERGY NEEDS FOR DEFIBRILLATION

Authors: : Ronald W. Yakaitis, M.D. and Gordon Ewy, M.D.

Affiliation: Department of Anesthesiology, Kino Community Hospital, Tucson, Arizona 85713; and Department of Cardiology, University of Arizona Health Sciences Center, Tucson, Arizona 85724

Introduction. Controversy exists about the relative advantages and disadvantages of "high" versus "low energy" defibrillation. A number of clinical factors can influence both the success of defibrillation as well as the energy requirement. Three such factors are 1.) duration of fibrillation, 2.) use of epinephrine, and 3.) resuscitation technique. There are no controlled studies assessing the effect of these forces on the energy dose needed for defibrillation (ED_{df}). Such is the purpose of this report.

Methods. Ninety mongrel dogs were anesthetized with pentobarbital, intubated, and mechanically ventilated. Arterial blood gases were maintained within prescribed normal ranges. Arterial blood pressure (ABP, direct measurement) and Lead II of the electrocardiogram were continuously recorded. Ventricular fibrillation was artificially induced through a bipolar electrode catheter inserted into the right ventricle. Dogs were divided into three "treatment" groups according to the mode of resuscitation. Each of these groups was subdivided depending upon the duration of fibrillation imposed. Thus, for Treatment A, three sets of 10 dogs each were subjected to, respectively, 1, 5 and 9 minutes of ventricular fibrillation. Resuscitation was then initiated with the administration of epinephrine, 1 mg IV, followed by one minute of artificial ventilation and closed chest cardiac massage (AV/CCCM). At this point external defibrillation was attempted with successive energy doses of 1, 2, 4 and 8 watt-seconds/kg body weight. Countershocks were discontinued after either the maximum dose or the dose producing conversion to any other type of electrical configuration. If defibrillation was not accompanied by a concurrent resumption of ABP, AV/CCCM was continued for one more minute. Successful resuscitation was defined as defibrillation plus restoration of a spontaneous ABP (systolic pressure > 60 torr for > 2 minutes). Essentially the same protocol was employed in Treatment B animals except for the elimination of epinephrine during resuscitation. Treatment C was an evaluation of the "blind" countershock technique (i.e., immediate defibrillation without AV/CCCM or epinephrine). Thus, for Treatment C, after 1, 3 and 5 minutes of fibrillation, countershock was performed with the successive energy doses previously described.

All data were statistically analyzed, and Gomperitz curves were constructed to demonstrate relationships between duration of fibrillation, therapeutic modes, incidences of defibrillation and resuscitation, and ED_{df}.

Results. As anticipated, the overall incidence of defibrillation was indirectly proportional to the duration of fibrillation. Comparing Treatments A and B after 1 and 5 minutes of fibrillation, epinephrine had no significant effect on ED_{df}. There was some suggestion of improved success with the drug after 9 minutes. According to the Gomperitz curves, regardless of duration of fibrillation or therapeutic measure, maximum success of defibrillation should be accomplished with an ED_{df} of approximately 6 watt-seconds/kg. In terms of resuscitation, spontaneous ABP returned more frequently when epinephrine was employed. Although Treatment C proved moderately successful for conversion after 3 minutes of fibrillation, the incidence of subsequent resuscitation fell to nearly zero.

Discussion. In this preparation, epinephrine proved relatively superfluous for defibrillation following short (< 5 mins.) periods of fibrillation. The data suggest that its value lies primarily in restoring ABP, particularly after longer periods of fibrillation. The "blind" countershock technique was beneficial for both defibrillation and resuscitation only after 1 minute of fibrillation. Thereafter, the incidence of resuscitation decreased markedly. Duration of fibrillation exerted the greatest influence on probability of defibrillation and ED_{df}. Conclusions to be drawn are: 1.) epinephrine does not significantly affect ED_{df} during at least the first 5 minutes of fibrillation and 2.) regardless of therapeutics, for as much as 10 minutes of fibrillation, 6 watt-seconds/kg is the estimated ED_{df} associated with the maximum achievable incidence of defibrillation. The latter conclusion would cast some doubt upon the necessity for "high energy" defibrillation apparatus.

This work was supported in part by the Arizona Affiliate of the American Heart Association, Inc.