Rebuttal to:

"Comparison of six clinically used external defibrillators in swine"

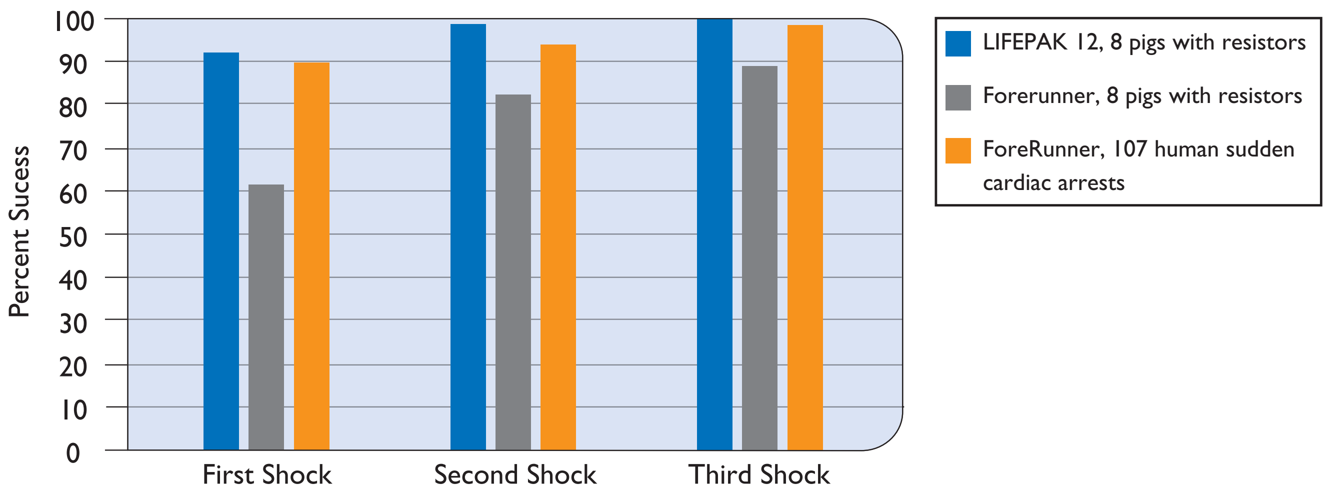
(Walker RG, Melnick SB, Chapman FW, et al. Resuscitation 2003;57:73-83)

The purpose of this animal study was to investigate the effect of variations in patient electrical impedance (i.e. resistance) on the efficacy of clinically used defibrillation waveforms. In the first protocol, a comparison between biphasic and monophasic therapies was made. In a second protocol, four biphasic defibrillators (Cardiac Science, Philips, Zoll, Physio-Control) were compared. In the biphasic protocol, pigs were modified with a large (50 ohm) external resistor in an attempt to model "high" impedance patients.

Inconsistent with Human Clinical Experience

In this animal study, first shock efficacy reported for SMART Biphasic was 62% for the combination of a 40 ohm animal with a 50 ohm resistor (90 ohms total) after only 30 seconds of VF. This finding is directly contradicted by a study of SMART Biphasic performance in 100 human victims of long down-time (average call-to-shock > 9 minutes) ventricular fibrillation, in which the first shock defibrillation rate for high resistance patients (>100 ohms) was actually slightly greater (93%) than reported for the overall patient population.[1] A second study of 107 human cardiac arrests (data plotted below) concluded that "transthoracic impedance had no discernible effect on defibrillation success with two or more shocks, nor on BLS ROSC [Return Of Spontaneous Circulation with Basic Life Support], ROSC, hospital admission or hospital discharge rates… there appears to be no rationale for energy escalation" with SMART Biphasic.[2] This result has been further confirmed in the context of atrial fibrillation, in which a randomized controlled trial of cardioversion found no impedance effect (n = 96, p = 0.94).[3]

8 pigs with resistors (average impedance 92 ohms)
versus 107 human VF arrests (average impedance 91 ohms)



[1] Gliner BE, Jorgenson DB, Poole JE, et al. Treatment of out-of-hospital cardiac arrest with a low-energy impedance-compensating biphasic waveform automatic external defibrillator. Biomed Instrumentation & Technol 1998;32:631-644.
[2] White RD, Blackwell TH et al, The influence of transthoracic impedance on defibrillation, resuscitation, and survival in out-of-hospital cardiac arrest treated by basic life support providers with an impedance-compensated biphasic waveform automatic external defibrillator. Annals of Emer Med 2002;40:S95.
[3] Page RL, Kerber RE, Russell, JK, et al. Biphasic Versus Monophasic Shock Waveform for Conversion of Atrial Fibrillation. JACC 2002;39:1956-63.

HEARTSTART DEFIBRILLATORS

How can this be?

Whenever an animal model is contradicted by human clinical experience, it is necessary to question the validity of the animal model.

The utilization of an external series resistor in an animal study can be useful for obtaining the desired waveform shape, but it dramatically alters the delivered dose in a manner that is not representative of human anatomy—it is not analogous to increased transthoracic resistance. In order to examine the effects of energy dosing, a study must report the energy delivered to the animal. The energy doses reported in this study, however, include the non-therapeutic energy wasted in the external series resistor. The energy actually delivered to the animal was less than 50% of the reported value (see table below). **For example, the "90 ohm" animal in this study received only a 65 J dose from the Philips AED, whereas a 90 ohm human would receive a full 150 J dose.** Due to the artificially reduced doses in this study, a decrease in efficacy is really a forgone conclusion, and is not relevant to actual performance of the defibrillator in treating human cardiac arrest. As a matter of fact, all biphasic shocks in this study which delivered at least 120 J to the animal, regardless of which AED delivered them, exhibited high (94% or better) efficacy. If anything, the Walker study raises a concern of potential overdose with high-energy defibrillators when no resistor is present, as is the case in clinical practice.

Device	Energy Setting of Defibrillator	Energy Wasted in Resistor	Energy Delivered to the animal
Cardiac Science	Variable, up to 360	66% of nominal	44% of nominal, up to 157
Philips	150-150-150	85-85-85	65-65-65
Zoll	120-150-200	68-85-113	52-65-87
Physio Control	200-300-360	113-170-203	87-130-157

Truth in Advertising?

The company that sponsored this study, Medtronic Physio-Control, also manufactures "Infant/Child Reduced Energy Electrodes" which incorporate a similar external resistor between the defibrillator and the patient. The product is advertised as reducing the 200 J defibrillator dose to approximately 50 J delivered to the infant. We fail to understand how an external resistor can reduce energy when applied to an infant, but deliver the full 200 J dose (as reported in this study) when applied to a pig.

Summary

SMART Biphasic therapy, as used in all Philips defibrillators, has demonstrated equivalent or superior efficacy to high-energy therapies in numerous peer-reviewed studies of human clinical performance. It has further been shown equally effective with high-resistance compared to lower resistance patients. The conclusion of Walker et al that a higher energy dose from these AEDs may be necessary with moderate to high impedance patients is inconsistent with human clinical experience. This discrepancy may be due to the author's inclusion of non-therapeutic energy, consumed in an external resistor, as part of their dose comparisons. All shocks which delivered at least 120 J to the animal, regardless of which AED they came from, exhibited high (94% or better) efficacy. Finally, one must question the validity of using animals to refute already confirmed findings in humans. This is an unnecessary expenditure of animal life and fails to address questions yet unanswered by human research.

* Snyder DE, Morgan CB. External series resistors accurately model waveform time course, but not cardiac dose in animal models of defibrillation. Resuscitation 2003;56:238 [abstract].