Ergonomically Flawed Electrode Design Can Create Delays in Defibrillation

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Abstract

INTRODUCTION

Time is the most important factor affecting survival from ventricular fibrillation cardiac arrest.[1] Defibrillation survival decreases by 7-10% for every additional minute of delay.[2] Consequently, international guidelines now endorse a goal of only 2-4 minutes from collapse until defibrillation for in-hospital cardiac arrests.[2]

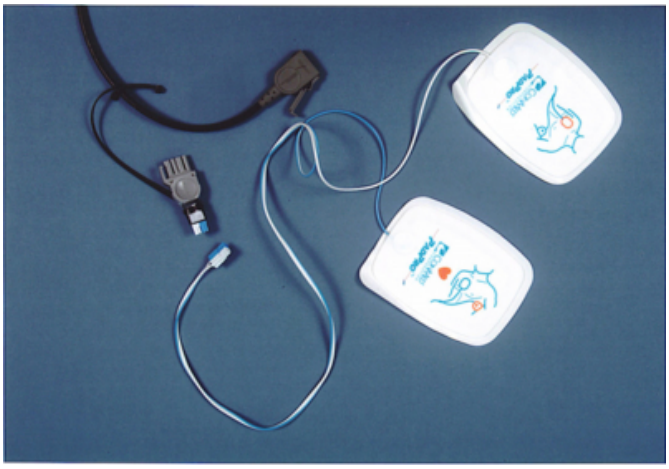
Cardiac arrest teams are designed to coordinate a timely response, especially to ventricular fibrillation arrest. Unfortunately, excessive delays may occur because the team may be slow to transport, set up, or activate defibrillation equipment. Delays in defibrillation should be viewed for what they are -- a perilous source of medical error. Intuitively one would expect to attribute most defibrillation delays to human error. However, the tremendous impact that flawed equipment design has on medical system error in general is now being increasingly recognized.[3] We seek to demonstrate through the following series that flawed defibrillation electrode design can lead directly to intolerable defibrillation delays.

CASE REPORTS

Our institution uses either Quik-Combo® (Medtronic, Redmond WA) defibrillator electrodes or Padpro® defibrillator electrodes (model 2516 Padpro LLC, Ann Arbor MI) hooked up to a Lifepak® 12 defibrillator (Medtronic, Redmond WA). Unlike the Quik-Combo, the Padpro electrodes require a customized plug adaptor to be connected in series between it and the Lifepak 12 therapy cable (see figure 1). We determined that medical staff confusion over the Padpro and its additional adaptor created unjustifiable delays in defibrillation for two patients.

Figure 1

Figure 1: Padpro® defibrillator electrode model 2516 with its specialized plug adaptor demonstrating the several connections required to operate.



CASE 1

A 63 year-old man suddenly developed ventricular fibrillation while being examined by a physician -- ironically in an emergency department bed immediately adjacent to the defibrillator cart. The emergency department team responded within a few seconds, but they had significant difficulty determining the correct connections between the Padpro electrode, its adaptor, and the Lifepak therapy cable. Defibrillation was delayed for a total of 175 seconds, but he returned to normal sinus rhythm promptly with the first dose of 200J. He recovered fully, and was discharged after a 3 day hospital course.

CASE 2

A 71 year-old man developed ventricular fibrillation while on a monitored intensive care unit. In this instance, the Padpro adaptor apparently had an undetected improper connection to the defibrillator device. Defibrillation was

similarly delayed for at least an additional two minutes while the medical team identified the problem, adjusted the adaptor, and properly established the correct connections. The patient was successfully defibrillated and was discharged in good condition 6 days later.

DISCUSSION

Advances in shortening the interval of the in-hospital “chain of survival” have been achieved through the use of cardiac monitored beds,[4] dedicated cardiac arrest teams,[5] and the generous deployment of defibrillators throughout the hospital.[2, 6] However, the specific impact of defibrillation electrodes (and their adaptors) on time to defibrillation has not been reported to our knowledge. Resuscitation experts recommend that defibrillation equipment should be both standardized and ergonomically simple to operate under stressful conditions.[6, 7] Although they seem to be trifling items in the context of a dramatic “code blue” cardiac arrest, defibrillation electrodes can create critical medical staff confusion if not ergonomically designed properly. As the physician-philosopher William James acknowledged a century ago: “A chain is no stronger than its weakest link, and life is after all a chain”.[8]

The Institute of Medicine's landmark report on medical error stated that: “Unsafe acts are like mosquitoes... The only effective remedy is to drain the swamps in which they breed. In the case of errors and violations, the “swamps” are equipment designs that promote operator error”. [3] Motivated by this mandate and our own experience, we have convened studies to compare the time and effort it takes to apply and activate different defibrillator electrodes under simulated cardiac arrest conditions. By encouraging improved ergonomic design of these devices, we hope that defibrillator delays can be markedly reduced in the future.

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