TIME TO SHOCK VS. VOICE PROMPT DURATION: OPTIMIZATION OF DEFIBRILLATORS FOR PUBLIC ACCESS AND HOME DEPLOYMENT

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PURPOSE
The time interval from onset of ventricular fibrillation (VF) to successful defibrillation shock has been identified as a primary correlate to survival. Widespread deployment of automated external defibrillators (AEDs) for public access defibrillation (PAD) and home use offers the potential of reducing this interval by minutes. Unfortunately, studies have reported that a significant percentage (25-50%) of minimally trained responders may fail to adequately attach the defibrillation electrode pads when using current generation AEDs1. Could survival be improved via additional AED voice prompts that emphasize pad application, at the expense of somewhat delayed defibrillation?

MATERIALS AND METHODS
Probability of survival is calculated using the widely accepted mortality rate of 10% per minute of untreated VF2 in conjunction with the probability of successful pad application, P[A]. By assuming that P[A] may be improved via more detailed voice prompts, the trade-off between voice prompt duration and overall survival is examined.

RESULTS AND DISCUSSION
The widely cited VF mortality rate of 10% per minute is based largely on data obtained from professional response systems, where defibrillation pads are placed successfully in nearly 100% of responses. Recent data from simulated use studies indicate that this assumption is not valid for certain minimally trained lay responders using the current generation of AEDs1. Improvements in successful pad placement, however, are possible via improved human interface design. Figure 1A illustrates pad placement typical of untrained responders employing a conventional AED in a mock rescue. Figure 1B shows pad placements typical of untrained responders using an experimental AED enhanced with additional pad placement voice prompts.

Since resuscitation is dependent on successful pad placement, the conventional mortality rate may be reformulated to include the probability of successful pad placement:

\[ P[S] = \left(1 - \frac{t}{600}\right)^{P[A]}, \quad t \leq 600 \]  

where S represents survival, A represents the event that pads are successfully applied, P[A] is the probability of successful pad application, and t is the time from arrest to defibrillation (seconds).

As an example, consider a hypothetical PAD system with 4.5 minute time to defibrillation and 75% P[A], the expected survival rate is 41% (point A, figure 2). If the AED is enhanced with 15 seconds of additional voice prompts to accomplish 90% P[A] (which must be verified by testing), the survival rate is improved to 47% (point B, figure 2). In this scenario, survival benefit can be realized with up to 54 seconds of added voice prompts (point C, figure 2) in order to achieve 90% P[A].

CONCLUSIONS
Probability calculations may be used to optimize the trade-off between duration of AED voice prompts, successful pad placement, and time to defibrillation shock. AEDs for public access or home use should be designed, via improvement of human factors such as voice prompts, to enhance the successful placement of defibrillation pads, even at the expense of some increase in time to shock. An AED capable of sensing and adapting its user interface to the capability and pacing of the responder could potentially improve overall survival by minimizing time to defibrillation for trained responders, while ensuring effective pad placement for the minimally trained responder.

References
2 American Heart Association, Guidelines 2000 for CPR and ECC. Supplement to Circulation 2000;102(8).