Shockingly simple? Should you use manual or automated defibrillation in out of hospital cardiac arrest?

In this month's EMJ, Derkenne and colleagues present an interesting study on the accuracy and speed of Emergency Physicians in assessing whether a defibrillator trace is shockable or non-shockable[1]. The study utilized a web-based application to present sixty ECG rhythms from real-life out of hospital cardiac arrest (OHCA) cases to pre-hospital emergency physicians and compared their responses to a gold standard interpretation defined by three experts. 190 complete responses were included in the analysis which identified a median sensitivity of 0.91 [interquartile range 0.81–1.00] to deliver a shock for shockable rhythms and specificity of 0.91 [0.80–0.96] to withhold a shock for a non-shockable rhythm. Sensitivity was highest where the shockable rhythm was ventricular tachycardia or coarse ventricular fibrillation(VF) (1.0 [1.0-1.0]) but significantly lower for fine VF (0.6 [0.2-1.0]). We would recommend that you test yourself on the simulator (**https://simul-shock.firebaseapp.com**) to see how you would have scored!

This study raises a valuable question: whether pre-hospital practitioners should use an automated external defibrillator (AED) or manual mode for the interpretation of rhythm and need for shock delivery in patients with OHCA. EP's manage patients conveyed to the Emergency Department in cardiac arrest on a daily-weekly basis and defibrillators are used in manual mode – the same skills are likely to be transferrable to the pre-hospital setting with a smaller team. However, in many settings the majority of OHCA management is provided by paramedics and some Emergency Medical Services (EMS) insist that the AED mode is used for all OHCA cases. This aims to reduce the cognitive burden for a small resuscitation team, ensures two-minute cycle timings are maintained, and eliminates human performance variability in rhythm interpretation. The latter is particularly important when attendance at cardiac arrests or opportunities for training may be infrequent for an individual paramedic. The major disadvantage is that most AEDs require chest compressions to pause for 5-20 seconds to allow the machine to provide rhythm analysis: in comparison EP's in this study took a median of 2.0-2.8 seconds to identify each cardiac rhythm. Pauses in chest compressions are associated with a reduced likelihood of return of spontaneous circulation and are a particular concern in the majority of cardiac arrests where the underlying rhythm will not benefit from defibrillation.

The present study showed that Emergency Physicians exceeded the performance goals set for artifact free ECG analysis by AEDs for coarse VF (performance standard >90% sensitivity) and those observed when an AED is applied in real-life practice (sensitivity for coarse VF 99% [95% confidence interval 98-99%].[2] By contrast performance for fine VF was lower than that observed for real life performance for AEDs (sensitivity 88% [95% CI 81-97) and for non-shockable rhythms (specificity performance standard >95% specificity) and real life performance (specificity 98% [95% CI 97-99]). This pattern of findings - shorter time to shock decision, high sensitivity for coarse VF, lower sensitivity for fine VF and lower specificity for non-shockable rhythms when comparing clinician performance with AED performance is not new[3,4] and represents the trade-off made by EMS systems when prioritizing automated over manual defibrillation.

It is unsurprising that Derkenne's simulated study found that clinicians diagnosed VT and coarse VF quicker and more accurately for defibrillation compared to fine VF, PEA or asystole. Previous 2015 European Resuscitation Council guidelines advised that "very fine VF which is difficult to distinguish from asystole is unlikely to be shocked successfully into a perfusing rhythm." Therefore continuing good-quality CPR may improve the amplitude/frequency of VF, thereby improving the chances of subsequent successful defibrillation and avoiding myocardial injury from unnecessary shock delivery or interruption of chest compressions.[5] The 2021 European Resuscitation Council Guidelines now state: "The 2015 ERC ALS Guideline stated that if there is doubt about whether the rhythm is asystole or extremely fine VF, do not attempt defibrillation; instead, continue chest compressions and ventilation. We wish to clarify that when the rhythm is clearly judged to be VF a shock should be given".[6] This challenges the previously adopted concept that very fine VF should not be defibrillated and simplifies the decision-making to "any VF = shock". Not all prehospital practitioners may be current with this development. It is also important to recognize that the progression from coarse VF to fine VF to asystole is a continuum. Whilst coarse VF is easy to recognise, as it becomes finer, visual differentiation between fine VF and asystole is more difficult and likely to be subject to individual variation between clinicians. AEDs traditionally defibrillate fine VF with a measured amplitude typically <0.2mV but not asystole typically defined as having an amplitude <0.1mV. International guidelines do not state amplitude size to define each rhythm and it is unlikely to be feasible to calculate on a defibrillator monitor screen, with a moving rhythm, and whilst providing all elements of resuscitation during a cardiac arrest.

AED use has demonstrated a clear survival benefit when used by lay bystanders through reducing the time from onset of cardiac arrest to first shock, but there is no definitive evidence to date that automated waveform analysis increases survival when compared to manual defibrillation by trained advanced life support providers. In 2017, a study conducted in a single Australian high performing, paramedic-based Emergency Medical Services (EMS) compared the outcomes of cardiac arrest patients using manual mode with the results after three years of using AED rhythm analysis and defibrillation.[7] The study found a significant increase in the proportion of patients with an initial shockable rhythm receiving the first shock within 2 minutes of arrival. However, alarmingly the revised protocol also resulted in a reduction in ROSC of −5.7% (95% CI, −1.9% to −9.4%) and overall survival (−6.7% (95% CI, −3.3% to −10.1%). The authors concluded these data supported the use of a manual defibrillation protocol with regular team training in rhythm recognition and simulated practice to ensure CPR continues during defibrillator charging. Lower rates of survival have also been observed in the pre-hospital setting (shockable rhythms) and in-hospital setting (for non-shockable rhythms) with AED use.[8-10]

So what does this study mean for those responsible for deciding on an AED versus manual defibrillation strategy? We believe there is no simple right or wrong answer.

The key considerations are the performance characteristics of an individual EMS system. For those able to demonstrate high levels of performance (high sensitivity for shockable rhythms and high specificity for non-shockable rhythms) and short time to decision intervals, a strategy of manual defibrillation is likely to be optimal. For systems where providers do not consistently achieve or exceed the performance standards set for AEDs, automated shock decisions are likely to be best. Key to deciding the best strategy is the continuous measurement of system performance. This could be approached through testing EMS staff on applications such as simul-shock.firebaseapp combined with direct measurement of system performance linked to continuous quality improvement programmes.

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