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Review article

Single-shock defibrillation success in adult cardiac arrest: A systematic review☆

Laurie J. Morrison[a,b,*], Rowan M. Henry[a,c], Vivien Ku[a,d], Jerry P. Nolan[e], Peter Morley[f], Charles D. Deakin[g]

[a] Rescu, Keenan Research Centre, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada
[b] Division of Emergency Medicine, University of Toronto, Toronto, Ontario, Canada
[c] Faculty of Medicine, Queen's University, Kingston, Ontario, Canada
[d] Faculty of Arts and Sciences, Queen's University, Kingston, Ontario, Canada
[e] Royal United Hospital, Bath, United Kingdom
[f] Royal Melbourne Hospital, University of Melbourne, Melbourne, Australia
[g] University of Southampton, Southampton, United Kingdom

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ABSTRACT

Objective: Current resuscitation guidelines advise a single biphasic shock followed by chest compressions; however, it is unclear if this applies to all waveforms and energy levels. We conducted a systematic review of the literature to determine the comparative success rates for single-shock defibrillation across waveforms evaluated in out-of-hospital cardiac arrest patients.
Methods: EMBASE, MEDLINE, EBM Reviews, dissertation abstract databases, and clinicaltrials.gov were searched. Two investigators independently reviewed titles, abstracts and full texts in a hierarchical manner for study eligibility with a quadratic kappa score at each level. Two authors abstracted data independently and the quality of the articles was assessed using the five-point Jadad scale. Outcomes were termination of ventricular fibrillation (VF)/ventricular tachycardia (VT) at 5 s post shock (TOF), return of organized rhythm (ROOR) and return of spontaneous circulation (ROSC).
Results: A total of 3281 potentially relevant citations were identified and, of these, eight papers were selected with Kappa values of 0.53 for titles, 0.71 for abstracts, and 0.94 for articles. Quality scores varied from 0 to 4/5. Biphasic first-shock success for all three outcomes of interest was similar regardless of energy levels, and uniformly superior to monophasic first-shock success. Median time to first shock varied across trials based on level of randomization (first responders versus advanced life support tiered response) and may contribute to observed differences. Lack of variability across two waveforms precluded a meta-analytical approach.
Conclusions: This systematic review suggests that evaluated biphasic waveforms have similar first-shock success as measured by the three outcomes of interest and all are superior to monophasic shocks.

Contents

☆ A Spanish translated version of the summary of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2013.07.008.

* Corresponding author at: Rescu, Keenan Research Centre, Li Ka Shing Knowledge Institute, St. Michael's Hospital, 30 Bond Street, Toronto, Ontario, Canada M5B 1W8.
E-mail address: MorrisonL@smh.ca (L.J. Morrison).

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1. Introduction

One of the critical links in the Chain of Survival is rapid defibrillation [1]. With every minute that passes between collapse and defibrillation, survival rates from witnessed ventricular fibrillation (VF) sudden cardiac arrests (SCA) decrease by 7–10% if no cardiopulmonary resuscitation (CPR) is provided and 3–4% if bystander CPR is provided [2–5]. Thus, early defibrillation remains the first line therapy for VF and pulseless ventricular tachycardia (VT).

Another critical component to successful CPR is minimizing the time without chest compressions (no flow time [NFT]). Recently, there has been a focus on strategies to reduce NFT during CPR and external defibrillation [6–8]. Two prospective before-and-after studies have shown that there is a significant survival benefit associated with a single-shock defibrillation protocol compared with a three-stacked-shock protocol [9,10]. As a result, the 2010 CPR guidelines have recommended a single-shock protocol [11]; however, the international consensus on science statement and treatment recommendations for 2010 suggested that first-shock efficacy across different waveforms remains an important scientific knowledge gap [12].

Defibrillators are available in various waveforms: monophasic waveforms, which include monophasic damped sinusoidal (MDS) waveforms and monophasic truncated exponential (MTE) waveforms, as well as biphasic waveforms, which include biphasic truncated exponential (BTE) waveforms and rectilinear biphasic (RLB) waveforms. Although there is a consensus that biphasic waveforms are more effective than monophasic waveforms when delivered as three stacked shocks [11], there has yet to be a definitive trial or systematic review and systematic meta-analysis on one-shock defibrillation success across all monophasic and biphasic waveforms. Additionally, the optimal energy for first-shock success has not been determined. The objective of this paper is to conduct a systematic review and meta-analysis of randomized controlled trials of first-shock success in defibrillation of out-of-hospital cardiac arrests, across all waveforms and energy levels.

2. Methods

MEDLINE (1948 to May 2011, updated to June 2012), EMBASE (1947 to May 2011, updated to June 2012), EBM Reviews (Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, Cochrane Methodology Register, and Health Technology Assessment), dissertation and thesis abstracts, Web of Science Conference Proceedings and clinicaltrials.gov were all searched from conception to May 2011 (updated to June 2012) using medical subject heading (MeSH) terms and relevant text phrases (Fig. 1, online Appendix B). In addition, bibliographies of relevant studies were hand searched. Key investigators in the field and defibrillator manufacturers were contacted to identify and obtain unpublished data.

Studies were considered for inclusion if they met the following inclusion criteria: randomized controlled trial (RCT) or meta-analysis of biphasic or monophasic defibrillation waveforms in the setting of adult patients undergoing a sudden cardiac arrest (VT or VF or shockable initial rhythm). Studies must have included a measure of first-shock success as an outcome. Any short or long-term outcome measure of first-shock success was considered, such as termination of VF/VT at 5 s post shock (TOF), return of organized rhythm (ROOR), return of spontaneous circulation (ROSC), survival to hospital admission or survival to hospital discharge. Studies were excluded if they met any of the following criteria: traumatic cardiac arrest, children or adolescents, animal models, electrophysiology procedures, implantable cardioverter-defibrillators, atrial fibrillation/atrial flutter, open chest defibrillation, or intra-operative defibrillation.

We did not limit our consideration solely to RCTs that directly compared monophasic to biphasic waveforms; any RCT that reported first-shock success data was considered. For example, an RCT comparing monophasic shocks of differing energy levels would be considered if it reported first-shock success results.

Articles obtained in the literature search were screened hierarchically by relevant title initially, then abstract, and finally by the full article itself. Two independent reviewers (RMH, VK) used

Completed May 19 2011
Database: Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid MEDLINE(R) <1948 to Present>

1	exp Heart Arrest/ (28208)
2	exp Tachycardia, Ventricular/ (10443)
3	exp Ventricular Fibrillation/ (13572)
4	Resuscitation/ (19856)
5	exp Cardiopulmonary Resuscitation/ (9024)
6	heart arrest.tw. (521)
7	cardiac arrest.tw. (16017)
8	cardiopulmonary resuscitation.tw. (7303)
9	cardio-pulmonary resuscitation.tw. (162)
10	resuscitation.tw. (31379)
11	cardiopulmonary arrest.tw. (1236)
12	cardio-pulmonary arrest.tw. (27)
13	or/1-12 (85243)
14	Electric Countershock/ (11282)
15	Defibrillators/ (738)
16	electric countershock*.tw. (69)
17	cardiac electroversion*.tw. (1)
18	electric* defibrillation*.tw. (305)
19	electroversiontherap*.tw. (0)
20	cardioversion*.tw. (4161)
21	automated external defibrillator*.tw. (641)
22	automated external defibrillation*.tw. (67)
23	external defibrillator*.tw. (913)
24	external defibrillation*.tw. (246)
25	defibrillator*.tw. (10728)
26	defibrillation*.tw. (5653)
27	or/14-26 (22325)
28	13 and 27 (9954)
29	exp Defibrillators, Implantable/ (8664)
30	exp Atrial Fibrillation/ (26762)
31	28 not (29 or 30) (6271)
32	limit 31 to english language (5225)
33	limit 32 to animals (1165)
34	limit 33 to humans (211)
35	32 not (33 not 34) (4271)
36	limit 35 to (clinical trial, all or meta analysis) (343)
37	limit 35 to "therapy (sensitivity)" (1332)
38	limit 35 to systematic reviews (161)
39	36 or 37 or 38 (1486)
40	remove duplicates from 39 (1469)

Fig. 1. MEDLINE literature search using MeSH terms and key words (See online Appendix B for all database searches).