WORKSHEET for Evidence-Based Review of Science for Emergency Cardiac Care

Clinical question.

In adult patients in a shockable non-arrest rhythm requiring cardioversion (prehospital or in-hospital) (P), does any specific cardioversion strategy (I) compared with standard management (or other cardioversion strategy) (C), improve outcomes (e.g. termination of rhythm).

Is this question addressing an intervention/therapy, prognosis or diagnosis? intervention/therapy

State if this is a proposed new topic or revision of existing worksheet: new topic

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? no

Search strategy (including electronic databases searched).

PubMed 1950-2009:
#1 Search "Electric Countershock"[Majr] 6,893 hits
#2 Search "Heart Arrest"[Majr] 16,379
#3 Search #1 NOT #2 6,013
#4 Search #3 AND (randomized controlled trial[Publication Type] OR (randomized[Title/Abstract] AND controlled[Title/Abstract] AND trial[Title/Abstract])) 360

EMBASE 1947-2009:
#1 'cardioversion'/exp/mj 3,898
#2 'heart arrest'/exp/mj OR 'heart arrest' 25,844
#3 #1 NOT #2 3,635
#4 #3 AND ([controlled clinical trial]/lim OR [randomized controlled trial]/lim) AND [humans]/lim 241

AHA EndNote X Master library
#1 electric countershock 764
#2 cardioversion 271
#3 #1 OR #2 978
#4 heart arrest 2,985
#5 #3 NOT #4 533

Cochrane Library
#1 MeSH descriptor Electric Countershock 625
#2 MeSH descriptor Heart Arrest explode tree 809
#3 #1 NOT #2 525

The combined searches yielded 983 non-duplicate articles.

• State inclusion and exclusion criteria

The following studies were not included: not shockable rhythms requiring cardioversion [266] and arrests [367].
The following studies were excluded: no specific cardioversion strategy [195], no control group [24], outcome not cardioversion or survival [13], internal cardioversion device [54], and not an acute care study [2].

• Number of articles/sources meeting criteria for further review:

37 abstracts met criteria for final review. Of these thirty were LOE 1, six were LOE 2, and one was LOE 4.
## Summary of evidence

### Evidence Supporting Clinical Question

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<tr>
<th>Good</th>
<th>Evidence Supporting Clinical Question</th>
<th>Level of evidence</th>
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<tr>
<td>Deakin, 2006, 329 E2 ‡</td>
<td>Pinski, 1999, 439 E1 §</td>
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<td>Rashba, 2004, 1572 E1 §</td>
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**Level of evidence**
- **A** = Return of spontaneous circulation
- **D** = Intact neurological survival
- **E2** = time to cardioversion
- **B** = Survival of event
- **E1** = cardioversion
- **C** = Survival to hospital discharge
- **E1 =** cardioversion
- **Italics =** Animal studies
- **Better studies in my opinion**: 
  - * = biphasic truncated exponential vs. biphasic rectilinear waveform
  - † = antero-posterior superior to antero-lateral
  - ‡ = biphasic (BP) vs. monophasic (MP)
  - § = higher vs. lower initial energy
  - || = energy-adjusting vs. fixed energy
  - ¶ = MP electrode polarity
  - ** = adhesive electrodes superior to metal paddles
  - For BP vs. MP studies, **dark red font** = industry sponsored, **black font** = sponsorship unknown, **green font** = conflict of interest was denied

### Evidence Neutral to Clinical question

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<td>Mortensen, 2008, 57 E1 ‡</td>
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<td>Ricard, 2001, 96 E1 ‡</td>
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Evidence Opposing Clinical Question

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A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E1 = Cardioversion  
E2 = Time to cardioversion  

Type of intervention:  
* = Biphasic truncated exponential vs. biphasic rectilinear waveform  
† = Antero-posterior superior to antero-lateral  
‡ = Biphasic vs. monophasic (MP)  
§ = Higher vs. lower initial energy  
‖ = Energy-adjusting vs. fixed energy  
¶ = MP electrode polarity  
** = Adhesive electrodes superior to metal paddles

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REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

DISCUSSION: There are several cardioversion strategies available when shocking a non-arrest rhythm that requires cardioversion. Some of these strategies are beneficial.

- A number of studies suggest that biphasic shock waves are superior to monophasic shock waves. The benefit is seen primarily in terms of the efficacy of the first shock. There is also some evidence that suggests that the total number of shocks delivered and cumulative energy is decreased when biphasic shocks are used. There is much less evidence to suggest that biphasic shock waves make a difference in overall conversion rate, when multiple shocks are considered. There is also no evidence to suggest that biphasic shocks change survival or reduce adverse outcomes.

- Eight studies are supportive of the hypothesis that a biphasic waveform is superior to a monophasic waveform. Six (75%) of these studies were sponsored by manufacturers of biphasic cardioverter-defibrillators. The remaining two studies did not list or deny a funding source. Seven studies are neutral to this hypothesis. Of these, one (14%) was funded by a manufacturer of a biphasic device, and one denied a conflict of interest. The remaining five (71%) did not specify or deny a funding source.

- There is conflicting evidence as to whether antero-lateral or antero-posterior electrode placement is superior when providing a cardioversion shock. The studies that do support a specific strategy, however, were performed with monophasic cardioverter/defibrillators. Newer studies performed with machines that delivered biphasic waveforms did not show a benefit from either strategy, despite being adequately powered.

- Studies performed with both monophasic and biphasic cardioverter devices demonstrate better first-shock conversion when the operator uses a higher initial energy. The evidence suggests that the improved conversion rates seen with higher first-shock energies are accounted for by increased energy needed for cardioversion in the overweight and obese. Those of normal weight may not benefit from higher first-shock energy. There is evidence that using an initial monophasic cardioversion of 360J results in less muscle injury as demonstrated by a lower CK when compared to an initial shock at 200J. Overall conversion rates do not seem to be related to first-shock energy settings, and there is no evidence that patients suffer harm or benefit from higher or lower first-shock settings.

- There is no evidence that biphasic truncated exponential waveforms are superior or inferior to biphasic rectilinear waveforms in terms of patient outcome.

- There is no evidence that lead polarity in monophasic cardioverter affects outcomes.

- Limited evidence suggests that metal paddles may be superior to adhesive electrodes for cardioversion.

Acknowledgements:
Nil

Citation List

Level 1. Fair quality (randomization procedures not described, not blinded). Neutral.
141 patients undergoing elective DC cardioversion for atrial fibrillation at St. Mary's Hospital in Rochester were randomized to therapy from either a Lifepak 12, using a biphasic truncated exponential waveform or a Zoll-M, using a biphasic rectilinear waveform. The study was powered to have an 80% probability of finding a 16% difference between in cardioversion effectiveness. There was no difference in overall effectiveness, total number of shocks or first shock effectiveness. This study failed to show a difference, but did not prove that no difference exists. The authors also noted that there was no apparent advantage of delivering a first shock at less than 150J with either device.


Level 1. Good quality. Funding not disclosed. Supportive for antero-lateral cardioversion as compared to antero-posterior.
59 non-pregnant adults undergoing their first elective DC cardioversion at a single UK hospital. Computerized randomization. Sequential 360J countershocks: group 1: antero-lateral, followed by antero-posterior; group 2, the opposite. Study halted at interim safety analysis. 18/30 in the antero-lateral group had first shock conversion, compared to 10/29 in the antero-posterior position. Groups were similar at the start of the trial and, aside from the allocated treatment, were treated equally. All patients who entered the trial were accounted for and were analysed in the groups to which they were randomized. Measures were objective, and patients, but not investigators, were blinded.


Level 1. Fair quality. Supportive but of questionable clinical impact.
139 adults undergoing elective DC cardioversion. Facility or facilities not identified. The study compared ST-elevation through the defibrillation pads at 15 seconds after shock artifact. It compared 2 groups: a group treated with biphasic cardioversion from a Welch-Allyn MRL cardioverter and a monophasic cardioverter. It excluded 13 patients. The authors do not report if the groups were similar at the start of the study. Aside from the allocated treatment, were treated equally. All patients who entered the trial were accounted for and were analyzed in the groups to which they were randomized. The patients and the data collecting investigators were blinded. The study was funded by Welch-Allyn MRL. The study is neutral on the outcome of overall success, with 93% of the patients in the biphasic group and 87% of the patients monophasic group converting (p = 0.35), and neutral on the outcome of a reduction in total shocks with biphasic (median 2) vs. monophasic (median 3) shocks (95% CI of difference between the medians 0 - 1). The study did show a statistically significant change in the median post-shock ST changes after the second and third shocks with more ST elevation in the monophasic as compared to the biphasic groups. There was no significant changes in the ST wave between groups after the 1st, 4th or 5th shocks. The is no evidence that the sample size was selected through a power calculation before the study commenced.

**Intervention:** higher energy levels. **Outcome:** cardioversion. **LOE 1.** Fair quality (randomization list not concealed and not blinded). 261 tested. Supportive. No mention of industry funding.


**Level 1 study, supportive.** Fair (randomization scheme not described. British study. 107 consecutive patients, elective external cardioversion for stable persistent VF. Randomization scheme not defined. Group 1: first 360J shock Anterioapical. Group 2 - 200J. 48/50 converted in the 360J group vs 43/57 in the 200 J group. All groups had the same follow-on shocks after the first shock. RR of conversion with treatment was 1.27, 95% CI 1.09 - 1.49. Mean AST and CK lower in the 360 group, but this is a DO, not a PO outcome. No mention of industry funding.


**Level 1 study, supportive.** Fair (not randomized). Cardioversion based on pad location. Italian study. 301 consecutive patients undergoing electrical cardioversion for stable AF. Randomly assigned to receive either AL or AP cardioversion -- randomization scheme not described. Groups were similar before the study. Using an escalating energy scheme, the AP group was 131/150 cardioversions, and the AL group had 114/151; RR of successful cardioversion in the AP group was 1.16, 95% CI 1.04 - 1.29. Funding source not identified.


**LOE 1, Fair Quality.** Neutral. AP vs. AL. 103 adults undergoing elective cardioversion for AF at one hospital in Lithuania. The assignment of patients was randomized, but the randomization scheme was not described, nor did the authors state if it was concealed. All patients were accounted for at conclusion. No blinding described. Groups similar at the start and treated equally.


**LOE 1.** Poor. Neutral. Japanese study of AP vs lateral using monophasic defibrillator with full-scale, escalating dose cardiversion for elective atrial fibrillation. No power study -- risk of type 2 error. Randomization scheme not described. No reporting of success rates in AP vs. lat.
Funding source not identified.


Intervention: Biphasic v. monophasic. Measured time to cardioversion. LOE 1. Good quality (not clear if all patients who entered were accounted for and some difference in groups at the start of the study.) 74 patients. Supportive. Found that the first sinus beat occurs at a mean of 2.2 seconds after shock when BP waveform used, vs. 3.3 seconds after MP shock.
Funded by unrestricted grants from Welch Allyn Inc. (manufacturer of the biphasic cardioverter/defibrillator used in this trial), Wessex Heartbeat and the Association of Anaesthetists of Great Britain and Ireland.


Intervention: higher energy levels. Outcome: cardioversion. LOE 1. Fair quality (randomization list not concealed and groups not equal at the start). A potential key article. Supportive. 380 patients. Compared biphasic shocks at a 100-150-200 escalation to 200 J starting energy. First shock overall success rate improved when delivered at 200J. Overall no significant difference. Higher energy on first shock helpful in overweight or obese patients.
Funded by a grant from Northern Ireland Chest Heart and Stroke Association.


LOE 2. Poor quality. Neutral. Metal paddles vs. electrodes. 26 patients from Sweden -- not listed as consecutive -- possibly a convenience sample. LifePak 8. Pseudo-randomization by date of birth. Antero-lateral paddle position; patients sedated. AF treated with 200-300-300-360. Table 1 data was inadequate. 13/15 individuals treated with metal paddles converted vs. 11/11 treated with self-adhesive patches. No measure of significance mentioned. No mention of funding.


Intervention: higher energy levels. Outcome: cardioversion. LOE 1. Poor quality (randomization list not concealed, not clear that all patients who entered where accounted for, not blinded, groups did not receive equal treatment, and groups not same at the start). 64 humans. Supporting. Monophasic shocks, patients randomized to initial energy setting. Those shocked with higher energy had better rates of conversion. No comment on funding.

Intervention: biphasic v. monophasic. Outcome: cardioversion. LOE 1. Fair quality (randomization list not concealed, groups did not receive equal treatment and groups not the same at the start). 154 humans. Neutral outcome. First shock, overall efficacy, and total number of shocks were the same in both groups (all patients on amiodarone). No comment on financial support.


LOE 2. Poor quality. Neutral. Anterolateral vs. anteroposterior electrode placement. Included a seven-month cohort of patients treated with AP positioning followed by patients treated with AL positioning -- some violations to group assignment. No table 1 data. Funded by the NHLBI and PhysioControl.


Intervention: energy-adjusting vs. standard cardioversion. LOE 2. Poor quality. 573 humans. Supporting outcome. Patients cardioverted with a monophasic cardioverter that automatically increased energy for patients with high transthoracic impedance had better rates of conversion than those cardioverted with non-energy adjusting machines. Funded by NHLBI and a grant from Hewlett-Packard Corporation.


Intervention: biphasic v. monophasic. Outcome: cardioversion. LOE 1. Fair quality (randomization list not concealed and not blinded). 56 humans. Supportive outcome. This was a study of patients who had previously failed monophasic shocks. Patients shocked with an ascending energy scheme from a biphasic cardioverter had better rates of conversion than those shocked at 360 J from a monophasic machine. Supported by a grant from St. Michael's Hospital Health Sciences Research Program, Toronto, and Medtronic Physio-Control.


Intervention: anterolateral v. anteroposterior electrode position. Outcome: cardioversion. LOE 1. Good quality. 108 humans. Supportive results. Cardiologists treated patients in Germany. Most patients had failed
radioablation. Monophasic shocks. Appropriately powered -- terminated early due to significant results. Study reported that there was no specific funding source.


LOE 1. Good quality. Supports both BP and paddle over adhesive patch electrodes. Randomized, non-blinded, single-center German trial. Atrial fibrillation, sedated and anti-coagulated. All shocks in AP position. Sample size calculations performed a priori. Randomization by computer scheme with concealment. Trial of metal paddles vs. adhesive patches and MP v. BP waveform. All patients tx with 50-100-200-300-360. 313 consecutive patients, 111 did not meet inclusion or met exclusion, 202 randomized (1 spont. cardioversion). Better conversion rates and lower energies in BP v. MP and paddle v. patch. Funded by Medtronic.


Intervention: biphasic v. monophasic. Outcome: cardioversion. LOE 1. Quality: fair (randomization list not concealed, not clear if all patients who entered were accounted for at the end, not blinded, groups not the same at the start). 100 humans. Supportive results. 93% conversion with biphasic waveform vs. 83% with monophasic, p=0.003. Biphasic shocks resulted in lower cumulative energy, were more succesful at all energy levels and resulted in fewer shocks. No commend regarding funding.


ABSTRACT ONLY - Unable to locate manuscript.


Intervention: biphasic v. monophasic. Outcome: cardioversion. LOE 1. Poor quality (randomization list not concealed, not clear if all patients who entered the study were accounted for at the end, no blinded, groups may not have received equal treatment). 72 humans. Results were supportive. 97% v 38% conversion. Significantly less pain with biphasic trunked exponential v. monophasic waveforms. Supported by a grant from Medtronic PhysioControl.

Intervention: biphasic v. monophasic. Outcome: cardioversion. LOE 1. Good quality. 87 humans. Neutral results. Significantly less increase in CK in the biphasic compared to the monophasic groups. No comment regarding financial support -- the investigators denied a conflict of interest.


Intervention: electrode placement location. Outcome: cardioversion. LOE 1. Poor quality (randomization list not concealed, not clear if all patients who entered the study were accounted for at the end, study not blinded, and groups not the same at the start of the study). 90 humans. Neutral results. No comment regarding financial support.


Intervention: waveform -- biphasic v. monophasic. Outcome: cardioversion. LOE 1. Quality fair (randomization list not concealed, not clear if all patients who entered the study were accounted for at the end, not blinded). 174 humans. Results supporting. Biphasic superior to monophasic for both first shock and cumulative shocks. Supported in part by grants from the NIH and Zoll Medical Corporation. One investigator is an employee of and another is a consultant to Zoll Medical Corporation.


Intervention: type of waveform: biphasic v. monophasic. Outcome: cardioversion. LOE 1. Quality fair (not blinded and the groups may have not received equal treatment (propofol or etomidate)). 95 humans. Results neutral. For patients with atrial flutter. Biphasic superior to monophasic for first shock but equivalent overall. Financial support not mentioned.


Intervention: monophasic electrode polarity. Outcome: cardioversion. LOE 1. Quality poor (randomization list not concealed, not clear if all patients who entered the study were accounted for at the end, not clear if all patients were analyzed as assigned, not blinded, and groups were not the same at the start). 200 humans. Results neutral. No comment regarding financial support.

**Intervention:** waveform -- biphasic v. monophasic. **Outcome:** cardioversion. **LOE 1.** Quality good. 210 humans. Results supportive. Biphasic superior for shocks 1 - 3, but same as monophasic for shock #4. Supported by a grant from Heartstream, Phillips Medical Systems.


**Intervention:** higher energy levels. **Outcome:** cardioversion. **LOE 2.** Quality good. 330 humans. Results supportive. For patients with atrial flutter, a monophasic first shock of 100 J is superior to 50 J. No comment regarding financial support.


**Intervention:** electrode polarity. **Outcome:** cardioversion. **LOE 1.** Quality poor (randomization list not concealed, not clear if all patients who started the study were accounted for at the end, not clear if all patients analyzed as assigned, not blinded, groups not the same at the start). 110 humans. Results neutral. Treated atrial fibrillation with AP electrodes using monophasic shocks. No comment regarding funding.


**Intervention:** higher energy levels. **Outcome:** cardioversion. **LOE 1.** Quality poor: (randomization list not concealed, not clear if all patients that entered the study were accounted for at the end, not blinded, and groups were not the same at the start). 120 humans. Results supporting. AP electrode placement for atrial fibrillation with a biphasic waveform. Random assignment to 20, 500, 100 or 200 J starting energy. No comment regarding funding.


**Intervention:** waveform (biphasic v. monophasic). **Outcome:** cardioversion. **LOE 1.** Quality fair (not blinded and groups did not receive equal treatment). 57 humans. Results neutral. Atrial fibrillation treated with AL electrodes. First shock did show biphasic waveform superior to monophasic, but overall, no cumulative difference. No comment regarding financial support.


Intervention: electrode location (AL v. AP). Outcome: cardioversion. LOE 1. Quality fair (randomization list not concealed, not blinded and groups may have not received equal treatment). 123 humans. Results neutral. Adequately powered biphasic treatment of AF. No mention of funding but the authors deny a conflict of interest.


Intervention: electrode placement (AL v. AP). Outcome: cardioversion. LOE 1. Quality fair (randomization list not concealed, not blinded, and groups were not the same at the start). 294 humans. Results neutral. Biphasic waveforms. One investigator is a recipient of a Research and Development Fellowship from the Norther Ireland Health and Personal Social Services Office. Philips Medical provided the defibrillators and pads for the study.