Clinical question.

In infants and children in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of self-adhesive defibrillation pads (I) compared with paddles (C), improve outcomes (eg. successful defibrillation, ROSC, survival) (O)?

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, although related ACLS worksheet was completed previously

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).

Databases searched:
 Cochrane using "Electric Countershock/instrumentation"[Mesh] AND "pads" OR "paddles" in Title, Abstract or Keywords; 14 hits
 ECC EndNote Master Library using “pads” OR “paddles”; 64 hits

Adult studies were included in search strategy to allow extrapolation as LOE 5.

State inclusion and exclusion criteria

Included studies that (a) compared pads versus paddles, and (b) considered aspects of performance of pads or paddles that created a clear advantage or disadvantage (e.g. self adhesive pads are not reliant on paddle pressure, therefore studies showing ability to maintain appropriate paddle pressure were considered). Adult studies were considered as extrapolation (LOE 5).

Initial search: 113 articles. Excluded:
 Automated or remote defibrillation (18)
 Waveform and energy for countershock (8)
 Conductive media (3)
 Internal paddles or pads (6)
 Letters to editor or literature reviews (5)
 Resuscitation aspects not related to countershock (19)
 Design of paddles (3)
 Placement of pads or paddles without comparison (18)
 Problem reports from specific devices (12)
 Purchasing guide (1)
 Size of pads or paddles without comparison (6)

Number of articles/sources meeting criteria for further review:

15. Of these, two were LOE 4 and twelve were LOE 5 (mostly extrapolated from adult population).

Four articles were added after comparison with search strategy from international counterpart.
### Summary of evidence

#### Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<td><strong>Good</strong></td>
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<td>Bennetts 2004 E4</td>
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<tr>
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<td>Wilson 1987 E1, Deakin 2001 E4, Sado 2001 E4, Brown 2001 E7</td>
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</tbody>
</table>

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint  

E1 Rhythm conversion  
E2 Transthoracic impedance  
E3 Force exerted on defibrillation paddles  
E4 Loss of monitoring signal  
E5 Ease of use  

*Italics = Animal studies*
# Evidence Neutral to Clinical question

<table>
<thead>
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<th>Level of evidence</th>
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<td>Jakobsson 1990 E₁</td>
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<td>Deakin 1998 E₂</td>
<td>Perkins 2002 E₃</td>
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<td>Kerber 1984 E₁</td>
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**Level of evidence**

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint

* Italics = Animal studies

E₁ Rhythm conversion  
E₂ Transthoracic impedance  
E₃ Time to defibrillation  
E₆ Time off compressions

* This article appears to present the same clinical data as Kerber 1985 (shown below).

# Evidence Opposing Clinical Question

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Evidence</th>
<th>Evidence</th>
</tr>
</thead>
</table>
|                    |      |      |      | Dodd 2004 E₂  
Kirchof 2005 E₁  
Persse 1999 E₁ and E₂ | Ewy 1977 E₂  
Kerber 1985 E₁ and E₂* |
|                    |      |      |      | Cornwall 2005 E₁ |          |
| 1 2 3 4 5          |      |      |      |           |          |

**Level of evidence**

A = Return of spontaneous circulation  
B = Survival of event  
C = Survival to hospital discharge  
D = Intact neurological survival  
E = Other endpoint

* Italics = Animal studies

E₁ Rhythm conversion  
E₂ Transthoracic impedance

* This article appears to present the same clinical data as Kerber 1984 (shown above).
REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

The search failed to reveal any studies that directly compared the use of self adhesive defibrillation pads (SADPs) to paddles in the pediatric population. A historically controlled direct comparison of SADPs to paddles in adult cardiac arrest patients in the out of hospital environment showed a significant improvement in rhythm conversion and survival to hospital admission with the use of SADPs compared to paddles (Stults 1987). This is the most applicable evidence to the clinical question. Weaker evidence extrapolated from two clinical studies of cardioversion of atrial fibrillation suggests that rhythm conversion rates are comparable between SADPs and paddles (Kerber 1984, Jakobsson 1990). One lab study of healthy volunteers showed comparable impedance between SADPs and paddles (Deakin 1998).

Evidence from controlled environments suggests that SADPs have some disadvantages to paddles. Two animal studies (Ewy 1977 and Kerber 1985) showed that SADPs have a higher transthoracic impedance in the laboratory setting. The age of these studies should be taken into account, as the design of SADPs may have significantly improved since early studies of the technology. Another animal study (Persse 1999) showed that the application of pressure to SADPs improved both transthoracic impedance and rate of rhythm conversion for ventricular fibrillation in swine. One small clinical study (Dodd 2004) showed that SADPs have higher transthoracic impedance than paddles in the setting of cardioversion in a controlled environment. Another clinical study (Kirchof 2005) found both higher impedance and lower rates of rhythm conversion for cardioversion of atrial fibrillation using SADPs compared to paddles, particularly at low energy settings.

This evidence of worse performance by SADPs is limited by the fact that the evidence comes from environments where variables such as paddle pressure, correct placement of paddles and consistent placement of paddles are tightly controlled. SADPs are not reliant on paddle pressure and are placed once, improving the chances of consistent and correct placement. Therefore, evidence from the resuscitation setting (Stults 1987) is considered more compelling than intermediate endpoints from tightly controlled laboratory or clinical settings.

There may be advantages to the use of SADPs compared to paddles. Perkins showed that “hands off” defibrillation using SADPs was perceived by operators as safer, although actual differences in safety were not demonstrated (Perkins 2007). The use of SADPs allows the placement of pads under surgical drapes and in a controlled environment prior to arrest (Wilson 1987, Brown 2001). This may improve ideal placement and contribute the improved success rate shown by Stults. The use of SADPs avoids problems with smearing of conductive gel, which would diminish effectiveness (Catarine 1997). Paddles require the consistent application of force to achieve effectiveness, which has been shown to be poorly applied in resuscitation simulations (Bennetts 2003, Sado 2001, Deakin 2001). SADPs avoid this problem – thus presenting an advantage to the use of SADPs. Monitoring ECG rhythm through paddles with conductive media after defibrillation can produce a transient loss of the monitoring signal, which can resemble asystole (Bradbury 2000), a problem that does not exist when using SADPs.

SADPs are shown to be effective for other aspects of resuscitation. The use of SADPs did not impact the time to defibrillation (Perkins 2002). The use of SADPs did not impact no-flow time during cardiac arrest (Perkins 2007).

Appropriate size for small children or neonates is a potential issue with both paddles and SADPs. Cornwell reported two cases in which the appropriate size of SADPs was not available for neonates requiring electrical therapy (Cornwell 2005).

Acknowledgements:
Citation List


LOE 5, uncontrolled series of simulated defibrillation
Quality: Good, objective definition of outcome, confounding variables controlled and follow up sufficiently complete.
Direction: Positive, shows inability of providers to maintain recommended paddle pressure.
Summary: 72 medical and nursing staff were selected from resuscitation areas, and were blinded to the nature of the study. Participants used pediatric paddles to simulate a defibrillation of an infant manikin and adult paddles to simulate a defibrillation of a child manikin in random order. Paddle force was measured during the simulation. Median paddle force applied to the infant manikin was 2.8 kgf (optimum approximately 3 kgf) and 3.8 kgf (optimum approximately 5 kgf) to the child manikin. 47.2% of operators met or exceeded infant optimal force. 23.6% of operators met or exceeded child optimal force. This suggests that during resuscitation adequate force is rarely maintained.


LOE 5, mechanical model
Quality: Fair, compared return to monitoring signal after shock for paddles, paddles with conductive media pads and SADPs.
Direction: Positive, shows loss of monitoring signal from paddles with conductive media pads. No loss of signal from SADPs.
Summary: Measured signal from paddles without conductive media, paddles with conductive media pads and SADPs. Then subjected the test model to defibrillation shocks. Found immediate return of monitoring signal for paddles without media and SADPs. Found delays of 17 to 154 seconds in the return of monitoring signal when paddles and conductive media pads were used. Delays increased with successive shocks. Suggests that "spurious asystole" may occur when paddles with conductive media are used to assess ECG rhythm. This phenomenon did not occur with SADPs, supporting the use of SADPs.


LOE 5, extrapolated from adult
Quality: Poor, uncontrolled case description.
Direction: Positive, shows difficulty of use of paddles in prone cardiac arrest.
Summary: Case report and review of literature for prone cardiac arrest case. The article displays the difficulty of the use of paddles in prone cardiac arrest and suggests the pre-placement of defibrillation pads as a solution.


LOE 5, extrapolated from adults
Quality: Fair, compared placement of paddles with smearing of gel to non-smearing on same subjects.
Direction: Positive, shows possibility of decreased effectiveness due to smearing of conductive media with paddles which is not possible with SADPs.
Summary: Recruited ten healthy participants and compared interelectrode impedance for different paddle placements with and without smearing of conductive gel between paddles. Used mathematical formula to assess projected differences in transcardiac current from AHA recommended positioning (apex to anterior placement without gel smearing) to worst case scenario (paddles within 2 cm of each other with gel smeared between paddles). Found decrease in impedance from 58 ohms in AHA recommended to 36 ohms in worst case placement - suggesting a dramatic reduction in transcardiac flow. Sweating and vasodilation did not replicate this result.


LOE 4
Quality: Poor, lack of objective definitions and lack of control of confounding variables.
Direction: Negative, shows lack of neonatal sizes in SADPs.
Summary: Discusses two cases in which defibrillation could not be achieved using SADPs due to the size of the pads.


LOE 5, extrapolated from adult population.
Quality: Fair, compared paddles to pads in forty volunteers.
Direction: Neutral, shows comparable transthoracic impedance between pads and paddles.
Summary: TTI was measured in 40 healthy volunteers using paddles from HP, pads from HP, paddles from Physio-Control (PC) and
pads from PC. Found mean TTI of 68.2 ohms for HP paddles (surface area of 81.5), 62.8 ohms for HP pads (surface area of 99.2), 64.6 ohms for PC paddles (surface area of 84.5) and 95.6 ohms for PC pads (surface area of 63.9). Significant difference between HP paddles and HP pads (p=.003), HP paddles to PC paddles (p=.001), HP paddles to PC pads (p<.0001), HP pads to PC pads (p<.0001) and PC paddles to PC pads (p<.0001). Shows rough equivalence of pads to paddles when area is controlled. Recieved free pads from the manufacturers. No other support reported.


LOE 5, mechanical model
Quality: Poor, not controlled - compared performance to standard.
Direction: Positive, shows inability of providers to maintain recommended paddle pressure.
Summary: Recruited 54 physicians and nurses to demonstrate defibrillation. Participants blinded as to nature of the study. 40/54 were ACLS certified. 3/54 participants met the ERC guidelines for force of 12 kg f. Of 40 questioned, none were aware of the ERC recommendation. Suggests that actual application of force in resuscitation settings is variable and seldom meets guidelines. Supports a method of defibrillation that is not reliant on applied force for effectiveness.


LOE 5, extrapolation from adult
Quality: Good, random controlled
Direction: Negative, shows increased transthoracic impedance with SADPs.
Summary: 21 patients undergoing elective cardioversion were randomly assigned order of assessment of transthoracic impedance (TTI) using pads versus paddles in the anterior-anterior and anterior-posterior placement. Cardioversion followed these assessments. This was done by one of two cardiologists, both of whom were blinded to data and purpose of the study. In the anterior-anterior position, paddles had an average of 16.8 fewer ohms than pads (p<.0001). In the anterior-posterior position, paddles had an average of 25.6 fewer ohms than paddles (p<.0001). Surface area between pads and paddles were roughly equivalent (81.5 sq cm vs. 80.0 sq cm).


LOE 5, animal model
Quality: Fair, non random control.
Direction: Negative, shows worse transthoracic impedance in model.
Summary: Compared impedance in twenty four dogs. Measured impedance at 100 and 400 Ws, comparing SADPs from two different manufacturers to paddles. Alternated order of shocks between animals to control for decreased impedance from successive shocks. At 100 Ws paddles were 46 +/- 6 ohms for paddles versus 59 +/- 6 ohms for SAF-D-FIB (p<.001) and 50 +/- 5 ohms for paddles versus 57 +/- 3 ohms for DEFIB-PADS (p<.01). At 400 Ws paddles were 35 +/- 6 ohms for paddles versus 42 +/- 2 ohms for SAF-D-FIB (p<.01) and 39 +/- 4 ohms for paddles versus 46 +/- 2 ohms for DEFIB-PADS (p<.01).


LOE 5, extrapolated from adult
Quality: Good, random selection, underpowered
Direction: Neutral, no significant difference between rhythm conversion rates.
Summary: Twenty six consecutive patients with atrial fibrillation randomly assigned to receive cardioversion using pads versus paddles. 11/11 with SADPs converted compared to 13/15 with paddles converted (not significant). Not sufficiently powered to detect changes in rhythm conversion. 8/11 with SADPs converted after first shock of 200 J with SADPs, compared to 5/15 with paddles (not significant).


LOE 5, animal model and extrapolation from adult
Quality: Poor, the clinical portion was not controlled, the animal portion compared paddles to pads in rotating order.
Direction: Neutral,
Summary: Two components to this article. The animal study was a comparison of pads to paddles in eleven dogs. Transthoracic impedance was significantly lower for paddles at 50, 75, 100, 125 and 150J (p<.05). Current flow was significantly higher for paddles at 50, 75 and 100 J (p<.05). Success rate was significantly higher for paddles at 50J (p<.05). The differences shrank with increasing energy levels. Pads were then used to deliver 267 shocks to 80 patients in a clinical portion to the article. The clinical portion was not controlled. The authors report that success rates were comparable to those published in other reports using
paddles, but statistical analysis was not performed. The study was supported in part by PhysioControl.


LOE 5, extrapolation from adult  
Quality: Poor, the clinical portion was not controlled.  
Direction: Neutral.  
Summary: Pads were then used to deliver 267 shocks to 80 patients in a clinical portion to the article. The clinical portion was not controlled. The authors report that success rates were comparable to those published in other reports using paddles, but statistical analysis was not performed. The study was supported in part by PhysioControl.


LOE 5, extrapolation from adult  
Quality: Good, random controlled trial.  
Direction: Negative, shows improved rate of rhythm conversion with the use of paddles.  
Summary: 201 patients were randomly assigned to receive cardioversion using paddles versus pads and sinusoidal monophasic versus exponential biphasic waveforms. Paddles successfully converted 100/104 and pads successfully converted 85/97 patients (p=.04). This was conducted under controlled settings with a limited number of very experienced providers. The study was supported by an unrestricted grant from Medtronic.


LOE 5, mechanical model  
Quality: Good, randomized cross over trial.  
Direction: Neutral, shows that the time difference between paddles and pads was not significant.  
Summary: Twenty-two physicians, nurses and paramedical personnel were given short talk on AHA (CPR while charging) versus ERC (no CPR while charging) procedures for defibrillation, then demonstrated procedures in random order. Paddles and pads were used for each procedure and no-flow time was measured. Using AHA procedure, insignificant difference between paddles, 1.6s and pads, 1.3s (p=.9). Using ERC procedure, insignificant difference between paddles, 7.4s and pads, 7.0s (p=.09). Difference between AHA and ERC procedures was significant (p<.0001). Participants rated agreement with the statement "the defibrillation was safe" using a 1-5 Likert scale (1 = strongly disagree, 5 = strongly agree). No difference between ERC techniques (p=.12). AHA pads were rated as significantly safer than AHA paddles (p=.001). No actual safety violations were observed.


LOE 5, survey and model from simulation  
Quality: Fair, random selection of participants to survey and participate without warning.  
Direction: Neutral, shows equivalent time to defibrillation.  
Summary: Compared time to defibrillation of twenty ACLS providers selected to demonstrate three techniques for defibrillation: (a) paddles and gel pads after "quick look" by paddles, (b) ECG leads and paddles and (c) using of SADPs. No significant difference in charging times. Showed 54 sec average time for ECG leads and paddles, compared with average of 28 sec for paddles (p<.01) and 23 sec for SADPs (p<.01). No significant difference between paddles and SADPs.


LOE 5, animal model  
Quality: Good, random allocation of group  
Direction: Negative, shows application of direct pressure to SADPs decreases transthoracic impedance, suggesting an advantage of paddles.  
Summary: Studied 32 pigs with random placement into four groups. Pigs were placed in VF, groups I and II for thirty seconds and groups III and IV for five minutes. Groups I and III received shocks through SADPs without force. Groups II and IV received shocks with 25 pounds of force applied to the SADPs. The first shock measurement of transthoracic impedance was Group I 46.3 ohms compared to Group II 36.0 ohms (p<.05) and Group III 43.3 ohms compared to Group IV 39.1 ohms (p<.05). The rhythm conversion rate following the first shock was Group I 50% compared to Group II 87.5% (not significant) and Group III 37.5% compared to Group IV 62.5% (not significant). Thirty minute survival was 8/8 for groups I and II (not significant), 1/8 for group III compared to 3/8 for group IV (not significant). The study did not have sufficient power to study differences in survival.

**LOE 5, mechanical model**

**Quality:** Poor, not controlled - compared performance to standard.

**Direction:** Positive, shows inability of providers to maintain recommended paddle pressure.

**Summary:** Recruited 50 physicians and nurses to demonstrate defibrillation. Participants were told of the ERC recommendation for paddle force and shown their current amount of applied force. 12% of participants met the ERC guidelines for force of 12 kgf. Suggests that providers are only rarely capable of achieving the recommended force. Strongly suggests that actual application of force in resuscitation is far less than recommendation. Supports a method of defibrillation not reliant on applied force for effectiveness.


**LOE 5, extrapolation from adult**

**Quality:** Fair, time controlled.

**Direction:** Positive, shows improvement in survival of event.

**Summary:** Studied SADPs to paddles using historical controls in the out of hospital environment. VF was terminated in 55/58 patients using paddles, 49/69 patients using paddles (p<.005). Survival to hospital admission was 30/58 patients using paddles, 21/69 patients using paddles (p<.025). Survival to discharge was 13/58 patients using pads versus 10/69 patients using paddles (not significant). Noted significantly less time from rescuer arrival to first shock, 1.6 +/- 0.7 for pads versus 2.5 +/- 1.4 for paddles (p<.001). Study was supported in part by the pad manufacturer.


**LOE 5, extrapolation from adult population**

**Quality:** Poor, not controlled - prospective case series compared to other published reports.

**Direction:** Positive, shows ability to place pads prior to arrest in unusual situations such as cardiac cath facilities.

**Summary:** Data was collected prospectively from 31 patients felt by cardiologist to be at higher risk of dysrhythmia during cardiac cath procedure. Ventricular dysrhythmias developed in seven patients. A total of 42 shocks were delivered. 7/11 200J shocks terminated the arrhythmia, as did 22/31 300J shocks. These were reported by the authors to be similar to previously published rates - although no attempt was made to compare populations. The pad manufacturer donated the pads for this study.