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

**Worksheet author(s)**

<table>
<thead>
<tr>
<th>Claudia Ranniger</th>
</tr>
</thead>
</table>

**Date Submitted for review:**
September 16, 2008; revised November 24, 2008; revised Oct 1, 2009

**Clinical question.**

"In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P) requiring defibrillation, does the presence of supplementary oxygen in the immediate vicinity (I) compared with no supplementary oxygen (C), increase the risk of fire with defibrillation attempts (O)."

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

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

**Conflict of interest specific to this question**

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? None

**Search strategy (including electronic databases searched).**

1. Pubmed: Mesh heading 'electric countershock' AND (keywords 'fires' OR 'oxygen inhalation therapy'); keywords 'fires' AND oxygen inhalational therapy; Mesh headings ‘fires; and ‘electric countershock’.
2. Cochrane: keyword search of 'electrical countershock', 'fire', and 'oxygen inhalational therapy' in all combinations.
3. Scopus: ('defibrillation' OR 'electrical countershock') AND ('fire' OR 'oxygen' OR 'oxygen inhalational therapy'); also 'cited by' function using all previously identified articles.
4. Review of all references of previously selected articles
5. AHA Endnote Master Library: keywords (‘electrical countershock OR defibrillation) AND ('fire' OR 'oxygen' OR 'oxygen inhalational therapy')
6. Google news search of ‘defibrillation’ and ‘fire’ or ‘burn’

**State inclusion and exclusion criteria**

Studies which did not answer the question were eliminated. Relevant articles and published case reports were included.

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

16
## Summary of evidence

### Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Deakin 2007 (E); Robertshaw 1998 (E)</td>
<td>Deakin 2007 (E); Robertshaw 1998 (E)</td>
<td>ECRI 1987 (E); Lefever 1995 (E); Miller 1972 (E); Theodorou 2003 (E); Hummel 1988 (E)</td>
<td>Australian Resuscitation Council 2005 (E); Deakin 2005 (E); ECRI 1994 (E); McAnulty 1999 (E); Ward 1996 (E)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

### 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*
### Evidence Neutral to Clinical question

<table>
<thead>
<tr>
<th>Level</th>
<th>Good</th>
<th></th>
<th></th>
<th></th>
<th>Fair</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Poor</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Hummel 1988 (E)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hurt 2003 (E);</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wrenn 1990 (E);</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pitkin 1999 (E)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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*

### Evidence Opposing Clinical Question

<table>
<thead>
<tr>
<th>Level</th>
<th>Good</th>
<th></th>
<th></th>
<th></th>
<th>Fair</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Poor</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Cantello 1998 (E)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Development of a defibrillation-related fire requires the triad of flammable material, spark, and oxidizer.

Sparks are caused by poor conduction between the delivery device and the patient, and may be caused by high impedance electrode gel (Hummel), poor paddle or pad contact, interposition of materials such as medical patches under the defibrillation pad or paddle (Wrenn), and proximity of alternate conductors, such as ECG leads that are directly adjacent to the defibrillation delivery device (ECRI 1987).

Flammable materials in the form of bedsheets and clothing may be difficult to remove entirely during defibrillation; however care should be taken to remove them from areas directly adjacent to the defibrillator pad/paddle as they are important sources of fuel. Case reports of fires caused by electrocautery in the presence of inflammable chemicals that are commonly used in patient care, such as benzoin, suggest that providers are not adequately aware of the dangers of these agents when mixed with electricity (Hurt).

Supplemental oxygen, while lifesaving, may increase the risk of defibrillation-related fires. Case reports of defibrillation related fires all have supplemental oxygen therapy in common (Hummel, Miller, Lefever, Theodorou, ECRI 1987). Most cases occurred in the setting of disconnected high flow oxygen devices that were placed on the bed adjacent to the patient’s head; one case occurred with an oxygen face mask that was left in place during defibrillation (Miller). No cases in which the patient was connected to a ventilator circuit were identified.

Analysis of ambient oxygen concentration has been conducted using mannekins (Robertshaw, Cantello, Deakin 2007). Oxygen concentration appears to be elevated only locally (< 1 meter) from the ‘spill’ site (disconnected ventilator, ventilation bag overflow valve) at typical oxygen flow rates of 10-15 L/min (Robertshaw, Cantello). In cases where higher oxygen flow rates are used, as was done to drive a CPR device using 70 L/min (Deakin 2007), the oxygen concentration directly over the patient is quite elevated (up to 36%), although it decreases rapidly with distance and is near-normal at 1 meter. Equilibrium values are reached in 60-120 seconds, suggesting that if elevated ambient oxygen concentrations exist, some washout time is needed.

Interestingly, no new cases of defibrillation-related fire were identified by this search relative to the 2005 ILCOR guidelines. One potential reason is the increasing use of self-adhesive defibrillator pads in preference to paddles. Adhesive pads do not require electrode gel, can be applied once and remain there for the duration of the resuscitation (thus reducing placement errors) and do not require supplemental pressure to ensure good contact with the patient’s skin. These factors may reduce sparking and the concomitant risk for fire.

Acknowledgements:

Citation List


Comments: LOE>5, supportive.
Expert consensus and literature review, suggests not allowing supplemental oxygen to flow over patient during defibrillation.


Comment: LOE 5, opposing.
A mannekin study in which a 10 L/min oxygen supply was provided to a ventilation bag/endotracheal tube system that was not being manually compressed and therefore vented via reservoir overflow valve behind the patient’s head. Elevated ambient oxygen levels of 28% were recorded at the overflow valve, but not at the patient chest or mouth. Authors use these results to suggest that the removal of oxygen from the patient pre-defibrillation may result in unnecessary delay and dislodgement of the tube. (Contrast to Robertshaw and McAnulty, 1998)

Comment: LOE > 5, supportive.
A consensus based on expert opinion and literature review, suggests that removing sources of oxygen (facemask, nasal cannula) that are not directed into the trachea or scavenged (via ventilator tubing) decreases risk. Suggests use of defibrillation pads over paddles as a means of reducing sparking.


Comment: LOE 5, supportive.
Use of oxygen-powered devices to support resuscitative measures can increase ambient oxygen concentrations in the immediate vicinity of the patient. In this case, high flow rates (70L/min) resulted in elevated oxygen concentration that persisted for up to 60 seconds after the device was turned off. However, ambient oxygen concentration increased much less (<0.5 %/min) at a distance of 1 m from the device. This must be considered if the patient is to receive electrical countershock.


Comments: LOE 4, supportive.
Contributing factors may have included placement of ventilator tubing with high flow oxygen next to patient’s head, the placement of paddles near an ECG lead, and inadequate paddle pressure resulting in arcing to the nearby ECG lead.


Comments: LOE 5, supportive.
States that the ECRI ‘continues to receive reports’ of defibrillation fires, no specifics noted, with a good discussion of preventive measures.


Comment: LOE 5, neutral.
Highly conductive materials are less likely to generate sparking than nonconductive materials.


Comments: LOE 5, neutral.
Presence of ethyl chloride or benzoin caused unexpected fires with use of electrocautery. Suggests need to remove chemicals from skin near potential sparks.


Comments: LOE 4, supportive.
Case report of defibrillation spark igniting fire in presence of high flow supplemental oxygen delivery system placed next to the patient’s head.

Comment: LOE 5, supportive.


  Comment: LOE 4, supportive.
  Supplemental oxygen was delivered via facemask.


  Comment: LOE 5, neutral
  The authors review the indications for and safety of defibrillation in hyperbaric chambers. No data to suggest that any defibrillations were performed at greater than 21.5% oxygen.


  Comments: LOE 5, supportive.
  This study suggests that elevated oxygen concentrations are attained when the supplemental oxygen delivery system vents freely next to the patient. However, the authors note that no change in ambient concentration is noted when the oxygen supply remains connected to the endotracheal tube.


  Comments: LOE 4, supportive.
  Case report of localized fire after neonate defibrillated with adult paddles, with high flow oxygen next to child in infant warmer.


  Comment: LOE 5, supportive.
  A commentary on a Medical Devices Agency (Lefever 1995) case report to clarify recommendations regarding the removal of supplemental oxygen delivery during defibrillation.


  Comments: LOE 4, neutral.
  Suggests that inflammable and nonconductive materials should be moved away from area of defibrillation.