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

**Worksheet author(s)**

<table>
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<th>Brenner, Barry MD, PhD</th>
<th>Date Submitted for review: October 1, 2009 (Revised Nov 5th, 2009)</th>
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<tr>
<td>Fred Severyn MD</td>
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**Clinical question.**

In adult cardiac arrest due to asthma (P), does any modification of treatment (I) as opposed to standard care (according to treatment algorithm) (C), improve outcome (O) (eg. ROSC, survival)?

**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: Revision**

**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).**

We searched Cochrane, Pubmed, EMBASE, AHA End notes, looked at related articles in Pubmed, checked references at the end of the relevant articles, hand searched in Resuscitation, and forward searched 4 key articles on Web of Science.

MESH terms: Status asthmaticus, asthma, bronchospasm and Abstract terms: “Cardiac arrest”, cardiopulmonary arrest, “chest compression”, and “life support”

MESH terms: Status asthmaticus, asthma, bronchospasm and MESH terms: “Heart arrest” “cardiopulmonary resuscitation”

**State inclusion and exclusion criteria**

Inclusion: Cardiac Arrest

Exclusion: Near fatal, arrest not due to asthma

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

Overall, 408 articles were reviewed for relevance to cardiac arrest due to asthma. 21 articles were included involving the modifications in CPR related to patients with acute asthma. 3 review articles (12, 17, 19) were included for orientation, seminal discussion, and were cited references by many other articles on the subject. 387 articles did not correspond with ILCOR clinical question or did not help to clarify changes in CPR in patients with acute asthma. These were articles on epidemiology of fatal asthma, case reports, and discussions of beta agonist toxicity. The authors (BB and FS) agreed on all articles included in the final list.
### Summary of evidence

#### Evidence Supporting Clinical Question

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<th>Fair</th>
<th>Poor</th>
<th>Level of evidence</th>
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<td>Fisher M, 1993</td>
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<td>Mabuchi, 1991 D</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*
### Evidence Neutral to Clinical question

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**Italics = Animal studies**

### Evidence Opposing Clinical Question

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**Italics = Animal studies**
**REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:**

**Prevention.** One issue is how to prevent near fatal and fatal asthma and the role of guidelines such as NAEPP or Global Initiative for Asthma (GINA) guidelines. Adherence to GINA guidelines may markedly reduce asthma mortality. In comparing 53 patients with near fatal asthma (mechanically ventilated or arrest) managed subsequently according to the GINA guidelines vs 40 historic controls not managed by guidelines, mortality was 0% in those managed by the GINA guidelines vs 15% in the historic controls at 4 years (P=0.005). (17)

**Defibrillation in Asthma.** The issue of defibrillation in cardiac arrest from acute asthma was essentially unchanged from 2005 recommendations. It seems to make sense intuitively that increased PEEP will increase transthoracic diameter and impedance, and may require increased joules for defibrillation, especially if first shock was unsuccessful.

**Ventilation in Asthma.** If the patient is difficult to ventilate in cardiac arrest, one treatable reason may be that inhaled bronchodilators may not have been given during the initial resuscitation. The patient probably still requires bronchodilation if they arrested in response to severe bronchospasm. During resuscitation the patient should still receive inhaled beta agonists which can be instilled into the endotracheal tube. One case report of endotracheal administration of high dose epinephrine by the endotracheal tube resulted in ROSC and discharge from hospital (10). Other bronchodilators may be effective in relieving bronchospasm, especially if the asthmatic in cardiac arrest has not received any inhaled bronchodilation. If ventilation is difficult, strategies employing reduced breaths, tidal volume, and prolonged expiratory phase are most effective (22).

The issue of external chest compression (ECC) for near fatal and asthmatics in cardiac arrest was promoted by Dr. Malcolm Fisher from New South Wales, Australia in the late 1980’s and early 1990’s. It was based on the concept of auto-PEEP and dynamic hyperinflation preventing effective ventilation and treated by manually decompressing the lungs at the end of expiration by very firm lateral pressure at the base of the ribs. In some cases this was done for up to 2 hr in an ICU setting but usually 15 to 20 minutes. Twenty-three of 31 patients improved with this method (1, 5-8). One patient seemed to deteriorate (16), but in a cardiac arrest situation it seems the potential would be for a greater benefit than risk. In a personal communication for an update on ECC with Dr. Fisher (March, 2009), he explained that too few patients with asthma were mechanically ventilated currently in the ICU so the procedure was not in use there. Dr. Paul Middleton, Senior Medical Advisor, Ambulance Service NSW, wrote to me that the procedure was still protocol for paramedics in New South Wales (May, 2009). In June, 2007 to June 2008 109 patients with acute asthma were transported and received ECC. There was significant improvement in the measured parameters of pulse, oxygen saturation, and mental status and measured by GCS (each p < 0.04) and no adverse effects (LOE4) (personal communication of unpublished data May 26, 2009).

Even as such with the development of auto-PEEP and dynamic hyperinflation, 31 cases have been reported of unexpected ROSC and some with intact neurologic survival after disconnection and discontinuance of mechanical ventilation. This was reported in the 2005 Advanced Life Support report in Circulation 2005; 112; III-25-III-54 (LOE4). It would be intuitive that this disconnection and discontinuance of mechanical ventilation combined with external chest compression noted above may be even more effective for relieving gas trapping and dynamic hyperinflation. The risk/benefit of how long to discontinue is unknown, with ranges from 30 seconds to 120 seconds. We would suggest 30-60 seconds as a reasonable interval. Open lung decompression in asthma-induced cardiac arrest has been associated with immediate improvement in ease of ventilation and ROSC (4,15,18), but at this time, these same ends may be achieved without invasive thoracotomy, such as with external compression and/or disconnection from ventilation for a period of time.

Patients with acute asthma may undergo cardiac arrest related to tension pneumothorax both in spontaneously breathing asthmatics (11) and those on mechanical ventilation (2, 12). This is a potentially treatable cause of pulseless electrical activity (PEA) and asystole in asthmatics in cardiac arrest who are difficult to ventilate. Needle compression and finger or tube thoracostomy has resulted in return of spontaneous circulation and discharges neurologically intact from the hospital (2, 11, 12). Needle decompression with a standard intravenous catheter may be too small in 50% of adult patients to relieve a tension pneumothorax (11). At this time in patients with cardiac arrest due to acute asthma and difficult to ventilate, if there is no response to external compression and disconnection and discontinuing ventilation with PEA or asystole, we would recommend needle decompression followed by finger or tube thoracostomy.
Transthoracic ultrasound in the future may be able to guide the real-time presence of tension pneumothorax in cardiac arrest, but prospective studies documenting its efficacy in cardiac arrest are lacking.

Extracorporeal membrane oxygenation (ECMO) has resulted in marked improved survival overall in cardiac arrest in general (27%) as well as in asthma with cardiac arrest and prompt purposeful neurologic recovery with some long term survival despite no prior cardiac response to ACLS for 10 minutes (13,14,19). In specialized centers set up for ECMO in cardiac arrest, this may be beneficial if applied early in the resuscitation of the acute asthmatic in cardiac arrest. In patients with severe refractory acute asthma which failed all therapies, application of ECMO in all 28 asthmatics resulted in a remarkable 80% survival to hospital discharge (personal communication of unpublished but submitted data, May 21, 2009 by Thomas Brogran MD Associate Professor of Pediatrics/Critical Care. University of Washington. Associate Director of Medical ECMO (LOE4).

Definitions:
ROSC: return of spontaneous circulation
ECC: external chest compression

Citation List

   LOE 4, fair (1 case), supportive Letter to editor Case report of external compression for 15 min.
   ROSC (return of spontaneous circulation), ECC, then spontaneous respirations but eventual death.

   LOE4, good, supportive. 3 cases mechanically ventilated with BVM after intubation developed PEA, hard to ventilate and all responded with ROSC, hemodynamic stability, and 1 discharged from the hospital neurologically intact.

   LOE 5, Good, Supportive

   LOE 4, fair (one case) supportive Routine ECC no pulse, then thoracotomy with int. cardiac compression resulted in easier ventilation but then ventricular fibrillation resulting in internal cardioversion with then ROSC. ROSC but then the patient died. Hyperinflated lungs preclude adequate external cardiac compression and ejection.

   LOE 4, fair (1 case), supportive. Respiratory arrest, 100 cm H20 peak pressure pack to give 5 ml/kg for tidal volume, hypercapnia, ECC, 15-20 sec squeeze, no breaths except after these for 10 min. Then peak pressure 45 cm H2O with 10 ml/kg of air. Full recovery.

LOE 5. fair (anecdotal), supportive. Patients in intensive care with severe acute asthma usually 5-10 cm drop in peak airway pressure and cardiac output is maintained. Sometimes technique applied for almost 2 hrs.


LOE 4, fair (case series), supportive, 31 patients in respiratory or cardiopulmonary arrest, 23/31 improved. 24/31 medics felt it was lifesaving. They did ECC for a mean of 20 min.


LOE 4, fair (case series), supportive, 1 case with addition of ECC to standard therapy. Unclear whether ECC added any benefit. Technique of hands on sides of ribs at end exhalation and end inspiration in mechanically ventilated. Anecdotally medics in Australia spontaneous breathing patients, ECC caused easier breathing. 31 patients – 23 with respiratory arrest, 8 cardiac arrest – ECC made ventilation possible. Doctors feel same in patients that have been nearly impossible to ventilate.. Lifesaving under extreme conditions.


LOE 5, fair, supportive, prospective observational study. Results show a decrease of hyperinflation when expiratory time is prolonged. This is less effective if VE is < 10l/min. This does not, however, directly address the question of increasing joules for defibrillation in cardiac arrest and asthma.


LOE 4, fair (1 case), supportive. 13 year old patient with cardiac arrest due to acute asthma and asystole and occasional rhythm given 8 mg epinephrine by the ET tube with sustained blood pressure of 180 systolic and heart rate of 144 beats/min. GCS though of 3 persisted but stable. Died of pneumonia 9 months later.


LOE 5, good, supportive. 1 case of tension pneumothorax in a 16 year old asthmatic that had needle tube thoracostomy with dramatic improvement. Not a cardiac arrest case.


LOE 5, good. supportive. This article could be used in lieu of Worksheet on tension pneumothorax. Review incidence pathophysiology, animal and human studies, signs, chest x-ray, limitations of needle decompression with short 4.4 cm needle, and urges finger and tube thoracotomy as definitive.

LOE4, good, supportive. Veno-arterial bypass used in a 20 year old asthmatic with cardiac arrest secondary to asthma. No spontaneous rhythm during CPR for 30 min. Minutes after bypass spontaneous rhythm and pulse. On bypass for 36 hr, then mechanical ventilation for 14 days, 4 days later discharged neurologically intact. PMID: 10149097 [PubMed - indexed for MEDLINE]


LOE 4, good, supportive. Cardiopulmonary bypass for 27 year old patient with acute asthma and bilateral tension pneumothoraces and cardiac arrest unresponsive to ACLS for 10 min, had ROSC. Although not specified which patients, 8 of 10 patients in this case series of cardiac arrest patients receiving cardiopulmonary bypass in the ED had some neurologic and sustained purposeful movements despite arrest times of over 25 minutes.


LOE 4, fair (1 case), supportive Total bronchospasm – Inability to move air intraoperatively. Cardiac arrest followed by thoracotomy. Severely over expanded lungs were found, difficult to ventilate, ET replaced, no success, then ET disconnected x 30 sec, no success in ventilation. Manually decompressed lungs as much as possible and immediate complete ease of ventilation. Followed by 35 min internal massage, 0.8 mg intracardiac epi and 0.2 intracardiac calcium yielded ROSC but death 54 hours later.


LOE 4, fair (1 case), negative, ECC started in acidotic (pH 6.9) hypercarbic (PCO2 150 mm Hg) child. 2 min ECC resulted in cardiac arrest and compressed sternum. Resuscitated then 1 min of ECC again resulted in cardiac arrest. Resuscitated again then gentle ECC resulted in hypotension. ECC may increase intrathoracic pressure and decrease venous return.


LOE 5, fair (groups different in age), supportive. Prevention of fatal asthma by following international GINA and probably NAEPP guidelines from 15% to 0% at 4 yr (p=0.005)

LOE 4, fair (1 case), supportive Mitral commissurotomy in December/1958. Total bronchospasm, thoracotomy, cardiac and lung massaged. Within minutes there was easier ventilation.


LOE5, good, supportive. The role of ECMO in asthma may need to be analyzed separately with ELSO registry. 25 had pneumonia or respiratory failure with 6 survivors to hospital discharge (24%), not different than overall high survival for ECMO (27%). Role of ECMO in cardiac arrest needs to be clarified but seems encouraging.


LOE 5, good, supportive, retrospective study indicating that higher minute and tidal volumes in patients with asthma are associated with barotraumas and circulatory side effects. This does not, however, directly address the question of increasing joules for defibrillation in cardiac arrest and asthma.


LOE 5, good, supportive, bench model study using a test lung. States that high respiratory rates and tidal volumes increase auto PEEP in patients with high airway resistance and low compliance as occurs in asthma. This is an animal model.


LOE5, good, supportive. Systematic review of the treatment of near respiratory arrest, intubation, peri-intubation period, and cardiac arrest, and initial mechanical ventilation of the severe asthmatic. 40 search terms used in the review. Level of evidence was used to describe the recommendations. The methodology, criteria for evidence categories, and summary recommendations are reported in the introduction to the supplement. Schatz M, Kazzi AA, Krishnan JA, Brenner B, Camargo CA Jr, Corbridge T, Nowak R, Rachelefsky G. Joint task force report. Supplemental recommendations for the management and follow-up of asthma exacerbations. Proc Am Thorac Soc 2009: 6:353-356