

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

### Worksheet author(s)

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### Clinical question.

BLS-045A "In adult and pediatric patients with cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does optimizing chest wall recoil (I) compared with standard care (C), improve outcome (eg. ROSC, survival) (O)? In patients with CA (P), does optimizing chest wall recoil (I), improve survival (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? No. I have performed research and published peer-reviewed articles on this topic. Consultant: Medtronic, JoLife, Take Heart America; President (volunteer position) of the Citizen CPR Foundation; Volunteer, National American Heart Association BLS Subcommittee

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

Electronic data bases:

OID MEDLINE

AMED

BIOSIS

Global Health

NASW Clinical Register

Google

Search terms included: Cardiopulmonary resuscitation, CPR, compression, decompression, chest recoil, chest wall recoil, complete chest recoil, incomplete recoil, incomplete chest recoil, incomplete chest wall recoil

#### • State inclusion and exclusion criteria

Included years 1997-2008

English language

Animal or human studies

Pediatric and adult

Exclusions: Abstract-only articles were excluded (the corresponding full text article was searched for), as were reviews, guidelines, current opinion articles, non-peer reviewed papers, and manuscripts not addressing complete chest recoil.

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

9

# Summary of evidence

## Evidence Supporting Clinical Question

<b>Good</b>				(Aufderheide, 2005,734; 4B) (Thayne, 2005,103; 4B) (Sutton,2009,494;4E) (Sutton, 2009, 1259;4E) (Niles,2009,553; 4E)	(Aufderheide, 2006,341; 5E) (Aufderheide, 2005,353; 4E, 5E) <i>(Yannopoulos, 2005,363; 5E)</i> (Wenzel,1997,129; 5E)
<b>Fair</b>					
<b>Poor</b>					
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Level of evidence</b>					

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

<b>Good</b>					
<b>Fair</b>					
<b>Poor</b>					
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Level of evidence</b>					

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

<b>Good</b>					
<b>Fair</b>					
<b>Poor</b>					
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Level of evidence</b>					

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:**

In a high quality, prospective, randomized animal study, Yannopoulos (Yannopoulos,2005,363) demonstrated significant reduction in coronary and cerebral perfusion pressures with one centimeter incomplete chest recoil during CPR. Using electronic recordings of intra-tracheal pressure in humans receiving CPR from professional rescuers following out-of-hospital cardiac arrest, Aufderheide (Aufderheide,2005,353) showed a 46% incidence of incomplete chest recoil with the AHA-recommended CPR technique. Sutton (Sutton, 2009,494) showed a 23.4% incidence of incomplete recoil (excessive residual leaning force (>or=2500 g) in pediatric in-hospital resuscitations. He also demonstrated that incomplete recoil was more likely to occur following pauses for a provider switch (Sutteen,2009,1259). Niles (Niles,2009,553) electronically recorded chest recoil during in-hospital pediatric cardiac arrests, and found that leaning on the chest (>2.5 kg; an adult feedback threshold) occurred in 50% of chest compression/decompressions and that the incidence of incomplete recoil was significantly reduced with real-time automated feedback. Aufderheide demonstrated significant improvement (in a manikin model) in complete chest recoil using a variety of simple techniques to remove the heel of the chest-compressing hand slightly, but completely off the chest following each compression in professional rescuers (Aufderheide,2005,353) and laypersons (Aufderheide, 2005,341). Wenzel (Wenzel,1997,129) showed that without specific training in complete chest recoil CPR technique, 22% of medical students leaned on the chest during CPR 6 months following training. There are no clinical trials specifically evaluating ROSC, intermediate survival, or survival to hospital discharge in patients receiving complete chest recoil versus not. Two high quality clinical trials using the Impedance Threshold Device (ITD) in out-of-hospital cardiac arrest reported significantly increased ROSC, survival to hospital admission, and survival to ICU admission with use of the ITD and complete chest wall recoil technique during CPR. (Aufderheide, 2005,734; Thayne, 2005,103) However, these studies (Aufderheide, 2005,734; Thayne, 2005,103) cannot attribute the improvement in ROSC, survival to hospital admission, or survival to ICU admission to complete chest recoil because a menu of interventions (including chest compression rate and depth, "hands-on" time, and proper ventilation rate and duration) were simultaneously implemented.

**Acknowledgements:*****Citation List***

1. Aufderheide TP, Pirrallo RG, Yannopoulos D, Klein JP, von Briesen C, Sparks CW, Deja KA, Kitscha DJ, Provo TA, Lurie KG. Incomplete chest wall decompression: a clinical evaluation of CPR performed by trained laypersons and an assessment of alternative manual chest compression-decompression techniques. *Resuscitation*. 2006 Dec;71(3):341-51.  
Good quality. Manikin studies performed in a prospective randomized manner comparing standard CPR technique to multiple different hand positions to optimize chest compression and chest decompression, performed by trained laypersons.
2. Aufderheide TP, Pirrallo RG, Yannopoulos D, Klein JP, von Briesen C, Sparks CW, Deja KA, Conrad CJ, Kitscha DJ, Provo TA, Lurie KG. Incomplete chest wall decompression: a clinical evaluation of CPR performance by EMS personnel and assessment of alternative manual chest compression-decompression techniques. *Resuscitation*. 2005 Mar;64(3):353-62.  
Good quality, LOE 4 and LOE 5, supportive. Two parts: a) Clinical case series demonstrating incomplete chest wall recoil in 46% of cases. b) manikin studies performed in a prospective randomized manner comparing multiple different hand positions to optimize chest compression and chest decompression, performed by professional EMS personnel.
3. Aufderheide TP, Pirrallo RG, Provo TA, Lurie KG. Clinical evaluation of an inspiratory impedance threshold device during standard cardiopulmonary resuscitation in patients with out-of-hospital cardiac arrest. *Crit Care Med*. 2005 Apr;33(4):734-40.  
Good Quality, LOE 4, supportive. Clinical trial using the ITD in out-of-hospital cardiac arrest demonstrating significant improvement in ROSC and survival to ICU admission. EMS

personnel were trained to allow the chest to completely recoil following each compression during this study.

4. Thayne RC, Thomas DC, Neville JD, Van Dellen A. Use of an impedance threshold device improves short-term outcomes following out-of-hospital cardiac arrest. *Resuscitation*. 2005 Oct;67(1):103-8. Good quality, LOE 4, supportive. Clinical trial using the ITD in out-of-hospital cardiac arrest demonstrating significant improvement in ROSC and survival to emergency department admission. EMS personnel were trained to allow the chest to completely recoil following each compression during this study.
5. Wenzel V, Lehmkuhl P, Kubilis P, Idris A, Pichlmayr I. Poor correlation of mouth-to-mouth ventilation skills after basic life support training and 6 months later. *Resuscitation* 35: 129-134 (1997) Good quality, LOE 5, supportive. Manikin study demonstrating that lack of specific teaching related to leaning on the chest after each compression resulted in poor retention skills as 22% of the subjects leaned on the chest 6 months after being taught CPR. This paper emphasizes the need to teach student specifically about the importance of full chest wall recoil and the correct hand position to accomplish this.
6. Yannopoulos D, McKnite S, Aufderheide TP, et al. Effects of incomplete chest wall decompression during cardiopulmonary resuscitation on coronary and cerebral perfusion pressures in a porcine model of cardiac arrest. *Resuscitation*.;64(3):363-372 (2005). Good quality, LOE 5, supportive. Animal (pig) study showing that 1 centimeter of incomplete chest wall recoil results in a significant reduction in mean arterial blood pressure ( $14.3 \pm 3.0$  vs  $7.0 \pm 2.9$ ,  $p=0.03$ ), CPP ( $23.3 \pm 1.9$  vs  $15.1 \pm 1.6$ ,  $p=0.003$ ), and CePP ( $313.8 \pm 104$  vs  $89.2 \pm 39$ ,  $p<0.03$ ) during standard CPR
7. Sutton RM, Niles D, Nysaether J, Abella BS, Arbogast KB, Nishisaki A, Maltese MR, Donoghue A, Bishnoi R, Helfaer MA, Myklebust H, Nadkarni V. Quantitative analysis of CPR quality during in-hospital resuscitation of older children and adolescents. *Pediatrics*. 2009 Aug;124(2):494-9. Good quality, LOE 4, supportive. Case series of 18 pediatric in-hospital cardiac arrests evaluating quality of CPR performed. There was excessive residual leaning force ( $\geq 2500$  g) in 23.4% of compressions (8611 of 36749 compressions).
8. Sutton RM, Maltese MR, Niles D, French B, Nishisaki A, Arbogast KB, Donoghue A, Berg RA, Helfaer MA, Nadkarni V. Quantitative analysis of chest compression interruptions during in-hospital resuscitation of older children and adolescents. *Resuscitation*. 2009 Nov;80(11):1259-63. Good quality, LOE 4, supportive. Case series analyzing CPR quality in pediatric ICU/ED cardiac arrests with attention to pauses in chest compressions. CPR epochs following pauses due to provider switch were more likely to have measurable residual leaning (OR: 5.52; CI(95): 2.94, 10.32;  $p<0.001$ )

9. Niles D, Nysaether J, Sutton R, Nishisaki A, Abella BS, Arbogast K, Maltese MR, Berg RA, Helfaer M, Nadkarni V. Leaning is common during in-hospital pediatric CPR, and decreased with automated corrective feedback. *Resuscitation*. 2009 May;80(5):553-7.

Good quality, LOE 4, supportive. Demonstrate leaning in 50% of chest compressions performed during in-hospital pediatric cardiac arrests. The incidence of leaning was significantly reduced with real-time automated feedback.