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

**Worksheet author(s)**

<table>
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<tr>
<th>Jensen, Jan L</th>
<th>Date Submitted for review: February 7, 2010</th>
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Clinical question.

BLS-017B  "In adult and pediatric patients in cardiac arrest (prehospital [OHCA], in-hospital [IHCA]) (P), does the use of alternative methods of manual CPR (i.e. cough CPR, precordial (chest) thump, fist-pacing (percussion pacing)) (I) compared with standard CPR (C), improve any outcomes (eg. ROSC, 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. Existing worksheets: 2005 W58 and W59

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).

A search was conducted of the following electronic databases: MedLine (PUBMed), the Cochrane Library (including the Cochrane Database of Systematic Reviews and the Cochrane Clinical Trials Register), EMBASE and the AHA EndNote Database. This search was initially conducted in June 2008, repeated on October 12, 2008 and again on May 26, 2009; in an effort to locate any recently published relevant papers. A hand-search was done, using all reference lists of included studies, position statements and review papers on the topic, as well as the 2005 ILCOR Worksheets W58 (Fist pacing in ventricular tachycardia or cardiac arrest, by Dr. Eich) and W59 (Precordial Thump in cardiac arrest, by Dr. Eich). The electronic search strategy and number of hits are listed:

- **Pubmed:** `((fist-pacing) OR (fist pacing) OR (precordial thump) OR ("cough CPR") OR ("cough-CPR")) AND (("Heart Arrest"[MeSH - Majr]) OR "cardiac arrest")` = **30 hits**

- **Cochrane Database:** fist pacing OR fist-pacing = **1 hit**; precordial thump = **6 hits**; cough CPR OR cough-CPR = **4 hits**

- **Embase:** `('fist pacing') OR (fist AND pacing) OR (precordial AND thump) OR ('cough cpr') OR ('cough-cpr')) AND (('heart arrest'/exp/mj OR 'heart arrest') OR ('cardiac arrest'/exp/mj OR 'cardiac arrest'))` = **30 hits**

- **AHA EndNote:** fist pacing OR fist-pacing = **1 hit**; precordial thump = **4 hits**; cough CPR OR cough-CPR = **0 hits**

Hand-searching: **9 hits**

- **State inclusion and exclusion criteria**

Only peer-reviewed articles were included. There were no limitations based on age or language. Papers were reviewed for relevance based on available title and abstract. Papers were reviewed for inclusion based on full article review. There was single author review for relevance and inclusion.

Excluded: Abstract-only articles were excluded (the corresponding full text article was searched for), as were reviews, editorials, guidelines and current opinion articles. The following were also reasons for exclusion: not true cardiac arrest models (e.g. brain dead organ donors, heart failure patients, cardiopulmonary bypass etc.), post resuscitation measures, chest compression only CPR (this is addressed in another worksheet question),

Similar to the worksheets prepared for C2005 by Eich (fist-pacing and precordial thump), case reports will be included in the Summary of Evidence tables (as LOE 4). Eich included case reports in his worksheet due to a paucity of higher evidence. This holds true for this worksheet, particularly with FP and c-CPR.

- **Number of articles/sources meeting criteria for further review: 76**
- **12 articles excluded:** 1 abstract; 7 review articles; 1 editorial; 1 position statement; 1 case report that discussed PT, but it was not actually part of case; 1 foreign language
- **NUMBER OF ARTICLES INCLUDED IN THIS WORKSHEET: 57 (7 articles not found)**
### Summary of evidence: PRECORDIAL THUMP (PT)

#### Evidence Supporting Clinical Question

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<tr>
<th>Good</th>
<th>Evidence Supporting Clinical Question</th>
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<tbody>
<tr>
<td></td>
<td>Bierfeld (1979) E (PT) (1)</td>
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<td>Antonelli (1986) B, E (PT) (3)</td>
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<td>Bademan (1965) B, E (PT) (4)</td>
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<td>Brandenberg (1959) A, B C (PT) (5)</td>
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<td>Conner (1978) B, E (PT) (6)</td>
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<td></td>
<td>Zeh (1978) (human - dissimilar population) E (PT &amp; FP) (9)</td>
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#### Relevant Outcomes

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Termination of fatal rhythm
- **F** = Initiation of fatal rhythm

#### Legend for Intervention

- **FP**: fist pacing
- **c-CPR**: cough CPR
- **PT**: precordial thump

*Italics = Animal studies or dissimilar study populations*
## Summary of evidence: PRECORDIAL THUMP (PT)

### Evidence Neutral to Clinical question

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<th>Level of evidence</th>
<th>Relevant Outcomes</th>
<th>Legend for Intervention</th>
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<tr>
<td></td>
<td><strong>Li (2006) (animal) E (PT)</strong> (22)</td>
<td><strong>Befeler (1977) E (PT)</strong> (23)</td>
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Summary of evidence: PRECORDIAL THUMP (PT)

Evidence Opposing Clinical Question

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<td>Cayla (2007) F (PT) (36)</td>
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<td>Rieser (1992) E (PT &amp; c-CPR) (37)</td>
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Level of evidence

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Relevant Outcomes

A = Return of spontaneous circulation  
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Legend for Intervention

FP: fist pacing  
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### Summary of evidence: COUGH-CPR (c-CPR)

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<tr>
<td><strong>Good</strong></td>
<td>B. Miller (1994) A, E (c-CPR) (39)</td>
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<tr>
<td><strong>Fair</strong></td>
<td>Criley (1976) A (c-CPR) (40)</td>
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<td>Keeble (2008) G (c-CPR) (41)</td>
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<td>Niemann (1980) B, G (c-CPR) (42)</td>
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<tr>
<td><strong>Poor</strong></td>
<td>Petelenz (1998) G, B (c-CPR) (43)</td>
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<td>Saba (1996) C, B (c-CPR) (44)</td>
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<td>Wei (1980) E (c-CPR) (45)</td>
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- **G** = Avoid syncope/maintain consciousness

**Italics** = Animal studies or dissimilar study populations

#### Legend for Intervention

- **FP**: Fist pacing
- **c-CPR**: Cough CPR
- **PT**: Precordial thump
### Summary of evidence: COUGH-CPR (c-CPR)

**Evidence Neutral to Clinical question**

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**Legend for Intervention**
- FP: fist pacing
- c-CPR: cough CPR
- PT: precordial thump

**Caldwell (1985) A,B,C,E (PT and c-CPR) (15)**


**B. Miller (1989) (human - dissimilar population) B (c-CPR) (47)**

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### Summary of evidence: FIST PACING (FP)

#### Evidence Supporting Clinical Question

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<td>Chan (2002) B (FP)</td>
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<td>Chester (1988) B (FP)</td>
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<td>Don Michael (1963) B, C, D (FP)</td>
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<td>Dowdle (1996) B, C, D (FP)</td>
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<td>Eich (2005) A, B, C, D (FP)</td>
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<td>Iseri (1987) B, C, E (FP)</td>
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<td>Tucker (1995) A (FP)</td>
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<td>Zoll (1976) B (FP)</td>
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<td>Zurcher (1972) E (PT, FP)</td>
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<td>Zeh (1978) (human – dissimilar population) E (PT and FP)</td>
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Summary of evidence: FIST PACING (FP)

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<tr>
<td>Scherf (1960) E (FP) (38)</td>
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<td>Weston (1997) B, E (FP) (57)</td>
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**Legend for Intervention**

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*Italics = Animal studies or dissimilar study populations*
Evidence for the following question was located and appraised: In adult and pediatric patients in cardiac arrest (out-of-hospital (OHCA), in-hospital (IHCA)), does the use of alternative methods of manual CPR (i.e. cough CPR (c-CPR), precordial thump (PT), fist-pacing (FP)) compared with standard CPR, improve any outcomes (e.g. ROSC, survival)?

To clarify the population, patients in included studies must have been in cardiac arrest or unstable condition (‘pre-arrest’, as a result of their rhythm). Patients who were stable were considered a dissimilar human population, and ranked LOE 5.

There was a paucity of controlled studies found of patients in cardiac arrest, or who had sudden deterioration in heart rhythm, and were treated with alternative methods of CPR, including PT, FP or c-CPR. In particular, there were no Level of Evidence (LOE) I (randomized control trials), or II (studies with concurrent controls) reports located for this question. The majority of evidence for this worksheet came from case reports.

Evidence pertinent to each intervention is described separately here.

**PRECORDIAL THUMP**

For this worksheet, there were 38 reports found on PT. There was one study with a control group found on PT (LOE 2). There were 29 case reports and case series included (LOE 4). There were seven reports on dissimilar populations included, three on animal populations (LOE 5) and three on dissimilar human populations (LOE 5). Of these, twelve reports provided supportive evidence of the usefulness of PT, fifteen were neutral and eleven were opposing.

**Evidence of benefit for the Precordial Thump**

Several reports demonstrated the effectiveness of PT in terminating ventricular rhythms (LOE 4). In a case series, twenty patients (101 episodes) were treated with PT for VT, all of whom converted, except one, who deteriorated to VF (LOE 4). There were some case reports of PT converting slow atrial-ventricular blocks or bradycardic rhythms (LOE 4), and a single report of PT converting a paroxysmal supraventricular tachycardia (LOE 4).

**Neutral evidence for the Precordial Thump**

Several reports demonstrated only moderate success of the PT in converting ventricular rhythms. The one study with a comparison group included in this worksheet was an out-of-hospital study in which cardiac arrest patients who treated with PT were compared to those who were not (LOE 2). A significant difference was not found in ROSC (PT = 31/144, 21.5%, non-PT = 43/219, 19.6%) or in survival to discharge (PT = 8/144, 5.6%, non-PT = 14/219, 6.4%). No adverse events were noted in any case as a result of PT. All other neutral reports included patients in ventricular dysrhythmias (LOE 4). In the largest case series of in-hospital and out-of-hospital patients, 316 patients were treated with PT or c-CPR (86 out-of-hospital) (LOE 4). PT was successful in 26 incidents (in 23/316 patients),
with 15 patients surviving to discharge. Another case series reported on 17 patients who had 45 episodes of VT treated with PT as the first-line intervention and was successful in rhythm conversion in approximately 50% of cases (LOE 4\(^{17}\)). The authors did not report any poor outcomes from the intervention. Another case series reports on 47 cases of VT, VF and ventricular flutter: 20/37 cases of VT were successfully treated with PT, with increased rates of success found in slower rates (in rates less than 160, 17/22 were converted with PT or serial PTs, compared to 3/15 successes in rates above 160). PT was not successful in converting any case of VF or ventricular flutter (0/10 cases) (LOE 4\(^{16}\)).

**Serial PTs**

Two reports discuss using serial PTs (rapidly applied successive thumps) (LOE 4\(^{16,17}\)). The rate of conversion of ventricular rhythms was moderate: 13/19 episodes, and unsuccessful in six (LOE 4\(^{16}\)). In one patient, the rate of the VT accelerated as a result of PT, and in another, asystole resulted. This converted with more thumps. These authors warned against using serial PTs without a defibrillator present. One report demonstrated ROSC and return of consciousness from a witnessed cardiac arrest (the rhythm was not documented) using a series of three rapidly applied PTs (LOE 4\(^{5}\)).

**PT in patients receiving digitalis therapy**

A report of three patients receiving digitalis therapy had episodes of ventricular tachycardia while in-hospital were all treated with a PT, which accelerated the VT. All three were successfully treated with cardioversion (LOE 4\(^{16}\)). All patients had digitalis discontinued. All relapsed back into VT rhythms. In two patients, a single PT was effective in converting the VT to a sinus rhythm, and in the third patient the PT had no effective (did not speed up or slow the VRate). A case report of a 42-year-old female on digitalis therapy who received PT for VT was converted to a bradycardic rhythm. It is unclear if a pulse was found (LOE 4\(^{10}\)).

**PT in ischemic myocardium**

One animal study sought to determine the difference in success of PT in VT in ischemic or normal rabbit hearts (LOE 5\(^{22}\)). This study found PT to be less effective in ischemia, and provided some evidence for only using PT in witnessed cardiac arrest.

**Opposing evidence for the Precordial Thump**

Most of the reports that demonstrate PTs poorly effective are from patients with ventricular arrhythmias (LOE 4\(^{28-34,34,35,37}\)), except one in which PT was administered to a patient with an unstable bradycardia (LOE 4\(^{36}\)). The rhythm converted to VF (commotio cordis). An out-of-hospital case series included 50 patients who had PT administered by paramedics who witnessed rhythms deteriorate to either VF or VT (LOE 4\(^{29}\)). In 27 patients who received PT for VT, 3 converted to a supraventricular rhythm (one did not have a pulse, and died with pulseless electrical activity), 12 patients did not have a rhythm change, and 12 were thumped into a worse rhythm (3 = asystole, 8 = VF, 1 = PEA). 11/27 VT patients were successfully resuscitated with other measures. 0/23 VF patients who received PT had a rhythm change. There are case reports where PT converted VT to a worse rhythm: in one report the rhythm changed to a slow idioventricular rhythm and the patient died (LOE 4\(^{25}\)), and in the other report the VT sped up from 150 to 190 bpm after PT (LOE 4\(^{33}\)). Reports from patients undergoing electrophysiology studies demonstrate low rates of
conversion from ventricular rhythms with PT: 1/80 (LOE 4\textsuperscript{30}) and 0/9 patients (LOE 5\textsuperscript{34}). An adverse event occurred when a patient suffered a fractured sternum and osteomyelitis from a PT, which did not change the rhythm (LOE 4\textsuperscript{31}).

**COUGH CPR**

There were 11 reports found on c-CPR (2 of which were reports that included both PT and C-CPR (LOE 4\textsuperscript{15,37}). Nine of these were case reports or series (LOE 4\textsuperscript{15,37,39-41,41-45}) and 2 were from a dissimilar human population (LOE 5\textsuperscript{46,47}). Eight reports provided supportive evidence for c-CPR (LOE 4\textsuperscript{39-45} LOE 5\textsuperscript{46}) and 2 provided neutral evidence (LOE 4\textsuperscript{15,37} LOE 5\textsuperscript{47}). There were no reports of opposing evidence found. All cases in these reports were patients in the cardiac catheterization laboratory (LOE 4\textsuperscript{39,40,43,44} LOE 5\textsuperscript{47}), except for three papers (LOE 4\textsuperscript{15,37,45}).

**Evidence of benefit for Cough CPR**

Four papers reported c-CPR allowed patients to maintain consciousness for 30-62 sec during ventricular fibrillation rhythms (LOE 4\textsuperscript{39,41,42,44}). Five reports demonstrated c-CPR lead to higher aortic, left ventricular or arterial blood pressures compared to no c-CPR (i.e., pulselessness) (LOE 4\textsuperscript{40-43} LOE 5\textsuperscript{46}). Finally, one report provided evidence that c-CPR (forceful coughs) may be able to convert ventricular tachycardia rhythms to more stable rhythms (LOE 4\textsuperscript{45}).

**Neutral evidence for Cough CPR**

Three reports give some neutral evidence of survival of a lethal rhythm in patients who do c-CPR. In all three reports, other methods were used to cardiovert the patients' rhythms (ventricular tachycardia or fibrillation), but all survived (LOE 4\textsuperscript{15,37} LOE 5\textsuperscript{47}).

**FIST PACING**

Fourteen reports were found on fist pacing. Thirteen were case reports and series (LOE 4\textsuperscript{13,38,48-58}) and two were from dissimilar patient populations (LOE 5\textsuperscript{9,55}). Zoll contained two case series, one used humans and one used animals, so this article was ranked twice (LOE 4-5\textsuperscript{55}). Three articles referred to both FP and PT (LOE 4\textsuperscript{9,13,38}). Twelve articles provided supportive evidence for fist pacing (LOE 4\textsuperscript{13,38,48-54,56-58}, LOE 5\textsuperscript{9,55}) and three were neutral (LOE 4\textsuperscript{38,57,58}).

**Evidence of benefit for Fist Pacing**

Several articles reported that fist pacing was an effective form of mechanical pacing, producing a wide QRS complex, particularly in rhythms with p-waves (such as AV blocks with ventricular standstill) (LOE 4\textsuperscript{13,48,49,53,54,56,58}). Cardiac output was demonstrated in some reports (LOE 4\textsuperscript{52,56} LOE 5\textsuperscript{9,55}). One report demonstrated that stroke volumes were similar with FP as with transthoracic and transvenous pacing (LOE 4\textsuperscript{48}). Only one pediatric case report was found, which demonstrated the effectiveness in producing cardiac output in a 3-year old girl who suddenly became bradycardic and unstable during surgery (LOE 4\textsuperscript{52}). One study found that FP produced reliable output in 20 dogs and in 8/10 patients with varying cardiac rhythms (LOE 4-5\textsuperscript{55}). Some articles reported patient consciousness was maintained as long as FP continued for as long as 1.5 hours (LOE 4\textsuperscript{49-51,56}).

**Neutral evidence for Fist Pacing**
Three reports provided some evidence of the FP providing effective mechanical pacing, but no patient survived (LOE 4 38,57,58).

**Acknowledgements:** Dr. Andrew Travers for his guidance with the ILCOR worksheet process, and Dr. Tom Aufderheide for his collaboration on this worksheet topic.

**Comments from other reviewers:** Perhaps PT should be considered for next guidelines (comment from New Orleans)
Citation List
(Alphabetical with abstracts, LOE and field notes)

Italics = field notes


**LOE 4, Fair, Opposing (PT):** A case of a 78 year old male patient who received a PT from paramedics after a witnessed cardiac arrest. The PT did not change the rhythm or clinical condition. A subsequent countershock resulted in return of circulation. The patient was diagnosed with a fractured sternum and later developed osteomyelitis. No comment of industry funding.


**LOE 4, Good, Opposing (PT):** A prospective cohort study where patients who were undergoing electrophysiological studies or defibrillator implantations were administered a PT after observation or induction of a ventricular rhythm. PT was only successful in converting 1/80 ventricular (monophasic ventricular tachycardia) to a more stable rhythm. No comment of industry funding.


**LOE 4, Fair, Supporting (PT):** A case report of a single PT which changed the rhythm from asystole, which had lasted 15s to a bradycardia in the low 30s. Atropine further raised the heart rate, and the patient became stable. It is unknown if the patient had a palpable pulse after the PT. No comment on industry funding.


**LOE 4, Fair, Supporting (PT):** A case report of a 75-year old female who had two witnessed episodes of unstable ventricular tachycardia, both corrected with a single PT. No comment on industry funding.


**LOE 4, Poor, Neutral (PT):** Case report of two patients with ventricular aneurysms who were treated with PT for VT. The PT was unsuccessful, unless applied directed to area of maximum paradoxical pulsation. Both patients were successfully converted from VTs with PTs. No comment on industry funding.


**LOE 5, Fair, Neutral (PT):** A prospective cohort study, which included 68 patients suffering from tachydyrsrhythms and/or undergoing cardiac diagnostic procedures. Dysrhythmias were treated with either PT or stimulation of the right or left ventricle using an intraventricular wire. The type of treatment was decided based on which was most accessible at the time of the dysrhythmia. 19/68 patients were successfully treated, 8 with PT (10 episodes, all VT except 1 VF). No patients treated with PT responded, and all were subsequently treated with electrical cardioversion or medication. It is unknown if any patient received more than one PT. Results were reported descriptively. This study was evaluated as a LOE 5, as it was considered a dissimilar sample from the intent of this worksheet question. No comment on industry funding.

LOE 4, Good, Supporting (PT): A case report of a 41 year old male undergoing angiography for chest pain with a history of repaired atrial septal defect. He developed VT, which quickly disintegrated into VF. A single PT was administered, which immediately converted the rhythm to sinus with a first degree AV block, without loss of consciousness. No comment on industry funding.


LOE 4, Poor, Neutral (PT): A case of a 42 year old female who entered into ventricular tachycardia from atrial fibrillation. A single PT converted the VT to bradycardic “automatic beats”. Unclear patient outcome, vague reference to autopsy. No comment of industry funding.


LOE 4, Fair, Supporting (PT): A case report of a 64 year old male witnessed to loose consciousness and a pulse after complaining of chest pain. No ECG provided. Three PTs were administered. Immediately after an irregular radial pulse was felt, which became regular. The patient regained consciousness. No comment on industry funding.


LOE 4, Fair, Neutral (PT and c-CPR): A prospective cohort study where all unconscious cardiac arrest patients in and out-of-hospital were initially treated with a PT. No control group was used in this study, and outcomes were reported descriptively. A total of 316 patients were treated with PT or c-CPR (86 OHCA). PT was successful in 26 incidents (in 23 patients), with 15 patients surviving to discharge. c-CPR was instructed in six patients with ventricular tachycardia VT. The authors did not describe the frequency of unsuccessful PT and C-CPR. No comment on industry funding.


LOE 4, Poor, Opposing (PT): A case report demonstrating a poor outcome from PT administered to a patient who developed complete heart block during angiography. The PT was administered during repolarization of a ventricular escape beat, and VF immediately developed. This case is an example of the potential harmful effects of the PT (i.e. commotio cordis). No comment on industry funding.


LOE 4, Fair, Supporting (FP): A case report of a 55- year old female patient who developed asystole with persistent p-waves on ECG, during surgery. She was treated with percussion pacing at a rate of 52 bpm, until transthoracic pacing was started 4 minutes later. Subsequently, transvenous cardiac pacing was initiated. The authors compared stroke volumes across all three pacing techniques, which were comparable. No comment on industry funding.


LOE 4, Fair, Supporting (FP): A case report of a 32-year old male undergoing spinal blockade for surgery, who became unconscious with a complete heart block, with p-waves and no associated QRS complexes. FP was started, and the patient quickly woke. Atropine was administered at the same time as the FP. The FP was stopped, and again the patient lost consciousness. FP was resumed, and the rhythm changed to sinus bradycardia and then normal sinus rhythm. The entire resuscitation lasted three minutes, and the patient was discharged without complication. No comment on industry funding.

LOE 4, Fair, Supporting (PT): A case report of a 53-year old male who self-reported he terminated ventricular tachycardia episodes many times with a self-administered blow to the chest. The author documented this while the patient was admitted in-hospital and was under ECG monitoring. No comment on industry funding.


LOE 4, Poor, Neutral (PT): Case reports of 14 patients (6 in VT, 8 in A block with ventricular standstill). PT lead to ROSC in all patients. Few ECGs in report. No comment on industry funding.


LOE 4, Poor, Neutral (PT): A case report of PT successfully converting VT. No comment on industry funding.


LOE 4, Fair, Supporting (c-CPR): Case reports of eight patients who lapsed into VF in the cardiac catherization laboratory during angiography and were instructed on cough-CPR. Three patients were able to cough on command, and maintained higher aortic pressures while coughing when compared to during CPR (comparison made within same patient), and in comparison to the other five patients who only received CPR. All patients had a successful rhythm change with defibrillation. Authors recommend training patients in cough-CPR prior to entering the catheritization laboratory, where gaining access to the patient and conducting high quality CPR is difficult, and further recommends this can be extrapolated to other settings, such as the cardiac/intensive care unit. No comment on industry funding.


LOE 4, Poor, Supporting (PT): A sub-study from the Ontario Prehospital Advanced Life Support (OPALS) study. The primary outcome was survival from cardiac arrest where the only treatment was CPR or PT. There was only one patient who was considered to be in true cardiac arrest who received PT for ventricular tachycardia (VT), which converted to sinus rhythm and the patient survived to discharge. The paper states there were 12 patients who received PT who were not considered to be in cardiac arrest, but their outcomes are not reported. As there was only one patient who received PT and had a reported outcome, this cohort study was downgraded to LOE 4, poor, and was considered a case report. No comment on industry funding.


LOE 4, Fair, Supporting (FP): A case report of a 68 year old male who deteriorated from a heart block to asystole, and was treated with fist pacing of approximately 60 strikes per minute for 1.5 hours until a pacemaker was inserted. The patient maintained consciousness during this time, but quickly lost consciousness when FP was withheld. The authors recorded cardiac output on ECG. No comment on industry funding.


LOE 4, Fair, Supporting (FP): A case report of a 20 year old male patient who had a pacing wire inserted after a period of unconsciousness due to heart block and cardiomyopathy. The pacing was interrupted, and the author administered fist pacing for over 15 minutes until radiography was available to assist in re-placing the pacing wires. This patient maintained consciousness during FP.


LOE 4, Fair, Supporting (FP): A report of a three year old patient undergoing surgical repair of an atrial septal defect where damage caused complete heart block and asystole. The authors treated the patient with FP at 80 bpm, striking the lower left edge of the sternum. Wide ECG complexes were associated with each FP, along with deflections in the oximetry signal and mechanical output. After administration of IV atropine and epinephrine and 3
minutes of FP, the rhythm switched to sinus tachycardia. The authors report the patient underwent successful surgical repair and ECGs were normal in follow up several months later. No comment on industry funding.


LOE 4, Fair, Supporting (FP): Case reports of two patients with AV block with ventricular standstill, post cardiac surgery. One patient regained consciousness when FP was administered, and lost consciousness when FP was stopped. In the second patient, FP increased mean arterial pressure. Both patients responded to electrical pacing. No comment on industry funding.


LOE 4, Fair, Supporting (PT): Case reports on two patients (a 60 year old male and 82 year old male), both of whom were admitted to cardiac care units after myocardial infarctions, and had witnessed cardiac arrests. One author treated each patient with PT and states that ROSC occurred immediately without any other intervention required. The authors report both patients survived and were discharged. No comment on industry funding.


LOE 5, Fair, Neutral: Animal study which evaluated PT and serial PTs in 20 induced episodes of VT in pigs. A single PT converted 6/20 VTs, 0/20 were converted with a second PT. 7/20 were converted with serial PT (five thumps in rapid succession), and an additional 6/20 VTs were converted with multiple serial PTs (more than 1 round of five thumps, range 2-7 rounds). All pigs had induced myocardial infarction one-week prior.


LOE 4, Good, Neutral: A prospective study in three hospitals on coronary care unit patients who lapsed into VT rhythms. 14 patients had 19 episodes and received serial PTs (a series of approximately five thumps). PTs were successful in terminating the rhythm in 13 episodes, and unsuccessful in six. In one patient, the rate of the VT accelerated as a result of PT, and in another, asystole resulted. This converted with more thumps. No comment on industry funding.


LOE 5, Poor, Supporting (c-CPR): A case report of a 64 year old male undergoing testing of his implantable cardioverter-defibrillator. He spontaneously began coughing when VF was induced. The authors report his arterial pressure was a mean of 98mmHg, and without coughing was 27mmHg (pulseless). No comment on industry funding.


LOE 4, Good, Opposing (PT): A case series of patients undergoing electrophysiology study with programmed ventricular stimulation. Patients with non-tolerated ventricular arrhythmias (i.e., the arrhythmia induced unresponsiveness) were administered one PT, while external cardioversion was prepared. PT only changed the rhythm in 2/155 patients, both in polymorphic ventricular tachycardia. PT was delivered at 13s and 14s after the onset of arrhythmia. All other patients (153/155) were immediately cardioverted, all successfully. The authors noted no adverse effects of administering the PTs. The only potential confounder identified in this study is the authors can not be sure the PT caused the rhythm cardioversion, as opposed to spontaneous cardioversion. Similarly, it is not published how much time elapsed between PT and cardioversion. Otherwise, the outcomes were well defined and follow-up was sufficient. No comment on industry funding.

LOE 4, Fair, Supporting (FP): Five patient case reports and four animal cases (dogs with induced complete heart block). FP produced increased cardiac output compared to CPR. No comment on industry funding.


LOE 4, Fair, Opposing (PT): Case report of a 70 year old male admitted to hospital for cardiac investigation, who suddenly lost consciousness with a ventricular tachycardia. A PT was immediately applied, which converted the rhythm to a complete heart block with no ventricular response for 8 seconds. The rhythm then changed to an idioventricular rhythm and then back to VT. Again, a PT was applied, and the same rhythm sequence occurred. The patient died after an unsuccessful resuscitative effort. The authors warn that PT can cause complete heart block. No comment on industry funding.


LOE 4, Fair, Supporting (c-CPR): No comment on industry funding.


LOE 4, Fair, Opposing (PT): A case report of a 71-year old male with VT with a pulse at 150 bpm. A PT was administered, and the VT sped up to 190 bpm and the patient lost consciousness. Electrical cardioversion was administered to convert the rhythm to sinus. The authors warn against the use of PT in ventricular rhythms without a defibrillator present. No comment on industry funding.


LOE 5, Fair, Neutral (PT): A simulation study using rabbit hearts to determine the difference in success of PT in VT in ischemic or normal hearts. This study found PT to be less effective in ischemia, and provided some evidence for only using PT in witnessed cardiac arrest. No comment on industry funding.


LOE 4, Fair, Supporting (PT): A case report of 56 year old athletic male with marked sinus bradycardia. During monitored evaluation, the patient’s heart rate dropped to 11 bpm while sleeping. While a temporary pacemaker was inserted, the rhythm became asystolic for 30 sec. He was treated with one PT, which converted the rhythm to sinus. The pacemaker was inserted, the patient survived and was discharged. No ECG provided in report. No comment on industry funding.


LOE 5, Poor, Neutral: A case report of three patients (2 with VT, 1 with VF) instructed to do c-CPR during cardiac intervention. The authors describe higher blood pressures observed during the coughing than when coughing ceased. One patient required regular CPR after a loss of consciousness, the next patient required electrical pacing and the third required cardioversion. Each patient was coached on coughing prior to the interventions, and all survived the events. Miller's report shows the potential to sustain blood pressure for short periods of time, but difficult to generalize to patients who cannot be coached on the technique. No comment on industry funding.


LOE 4, Good, Supporting (c-CPR): A case report of a 43-year old woman undergoing coronary angiography who developed a rapid Torsades de Pointes, lasting over 62 seconds. She was immediately instructed to cough. ECG and central aortic pressure monitoring continued throughout the dysrhythmia. The authors note the patient maintained consciousness and coughing throughout the episode, which included two cardioversion attempts and
**administration of IV lidocaine. ROSC occurred 4s after the second cardioversion of 360J, and 80msec after the strongest cough, measured by the aortic systolic pressure of 128mmHg. The aortic diastolic pressure stayed above 50mmHg throughout the episode, with an average of 63 mmHg. No comment on industry funding.**


**LOE 4, Fair, Opposing (PT):** An out-of-hospital case series where fifty cardiac arrest patients had PT administered by paramedics who witnessed rhythms deteriorate to either VF or VT. In 27 patients who received PT for VT, three converted to a supraventricular rhythm (although one did not have a pulse, and died with pulseless electrical activity). 12 patients did not have a rhythm change and 12 were thumped into a worse rhythm (3 = asystole, 8 = VF, 1 = PEA). 11 of the 27 VT patients were successfully resuscitated with other measures. Of the 23 patients who were in ventricular fibrillation (VF) and received PT, none had a rhythm change. 12/23 patients in this group were successfully resuscitated with other measures. No comment on industry funding.


**LOE 5, Fair, Opposing (PT):** A cohort study of nine patients undergoing electrophysiology who had induced VT. PT did not convert any of the patients from the rhythm. No comment on industry funding.


**LOE 4, Fair, Neutral (PT):** A cohort of 17 patients who had 45 episodes of VT, PT was the first-line treatment. PT converted the rhythm in about 50% of the episodes. The authors did not report any poor outcomes from the intervention. They did describe an alternative PT technique that was used in patients with refractory malignant rhythms. They rapidly applied many successive thumps. They state five episodes of VT were successfully converted with this mechanical overdrive pacing method. No comment on industry funding.


**LOE 4, Fair, Supporting (c-CPR):** Case reports of seven patients (3 previously reported) in cath lab and cardiac care unit setting. All patients maintained consciousness with c-CPR. No comment on industry funding.

Patros RJ, Goren CC. The precordial thump: An adjunct to emergency medicine. HEART LUNG J.CRIT.CARE 1983;12(1):61-64

**LOE 4, Poor, Neutral (PT):** Case reports of four patients attached to cardiac monitoring in a cardiac care unit who all had sudden rhythm deterioration. In three of the four cases, VT was converted to sinus rhythm after a single PT. In the last case, a PT was administered to a patient who had a sudden onset of asystole, which resulted in VT. Sinus rhythm was restored after regular CPR. In the same patient, a second period of asystole was treated with a single PT, which converted the patient to sinus rhythm. No comment on industry funding.


**LOE 2, Good, Neutral (PT):** A prospective cohort study in Italy, including all OOHCA patients. Patients who were found to be in CA by EMS, and whom a decision was made to attempt CPR were eligible. EMS staff were instructed to administer one PT after defibrillation pads were attached, and before all other interventions (including CPR). This sequence was followed in 39.7% of OOHCA patients (114/363). The remaining patients formed the control (non-PT) group. A significant difference was not found in ROSC (PT = 31/144, 21.5%, non-PT = 43/219, 19.6%, p > 0.05) or in survival to discharge (PT = 8/144, 5.6%, non-PT = 14/219, 6.4%). The authors noted that ROSC was induced by PT in 3 patients, all of whom were EMS-witness asystolic cardiac arrest patients (compared to 28 ROSC in the non-PT group). No events as a result of PT were noted in any case. The authors conclude they were unable to show a ROSC or survival benefit of PT, but because it is a 'low-cost' intervention, in terms of time to perform and adverse effects, that it should be considered for OOHCA.

**LOE 4, Poor, Supporting (PT):** A report of 12 episodes of VT in five men suffering from ischemic cardiac disease had their dysrhythmias converted with PT. No comment on industry funding.


**LOE 3, Fair, Supporting (c-CPR):** This three phase study evaluated c-CPR. In the first phase, 10 participants had BP measured in the aorta and left ventricle during catheterization. A difference was not found in pressure during normal heart contraction and during coughing. In the second phase, 31 participants underwent echocardiography to determine blood flow differences in the brachial artery during rest and coughing. No significant differences were found. Of most relevance to this worksheet, in the third phase, 115 participants who had a history of syncope associated with dysrhythmia were trained in c-CPR while admitted to a cardiology unit. They were followed by clinic visits. Participants reported on events and success of c-CPR. The evaluation was subjective, and self-reported by the patients. 66/115 participants stated they used c-CPR, which a success rate of ‘approximately 80%’. The intervention was considered successful if syncope was avoided. The authors report in the remaining 20% of cases where c-CPR was attempted, the intervention was considered ‘less effective, but all were able to avoid fainting’ (p. 330). It is unknown how many of these patients needed to seek medical help. All who attempted to use c-CPR survived, although length of follow-up was not reported. The outcomes of the 49 who did report to use c-CPR was not published. This study was ranked LOE 4, quality poor, because confounding was not well controlled, follow-up was not well described and the outcomes were not objective. No comment on industry funding.


**LOE 4, Poor, Supporting (PT):** A cohort of patients in VT treated with PT. They reported on 101 incidents in 20 patients. PT successfully converted the rhythm in all patients, except one, who deteriorated to VF. The authors did not report on the unsuccessful cases. No comment on industry funding.


**LOE 4, Poor, Neutral (c-CPR):** A report of a single male patient who presented to the ED with acute anterior MI. The patient had a physician-witnessed episode of dizziness and corresponding VF. The physician instructed the patient to cough repeatedly, and the patient maintained consciousness. The physician administered one PT, without change in rhythm or condition. Quickly following, electrical cardioversion was performed, and the rhythm converted to rapid atrial fibrillation. This case report was given a level of quality of poor, as it is not possible to be sure the cardioversion was not due to the PT, and the report did not include survival and disposition of the patient (i.e. length of follow-up was not long enough). No comment on industry funding.


**LOE 4, Poor, Supporting (c-CPR):** A case report of a 54-year old male undergoing angiography who went into VF. He was instructed to do c-CPR and maintained consciousness for 30 sec until a single defibrillation cardioverted the rhythm. No comment on industry funding.


**LOE 4, Poor, Neutral (FP):** Case reports of eleven patients who were treated with multiple precordial thumping during episodes of ventricular standstill, fibrillation or tachycardia. None of the patients in the series survived, and it was unclear what additional treatments were administered. No comment of industry funding.

**LOE 4, Fair, Neutral (PT):** Case reports of three male patients, all receiving digitalis therapy who had episodes of ventricular tachycardia while in-hospital. All were administered IV lidocaine, which was not effective in any case. Each received a PT, which accelerated the VT. All three were successfully treated with cardioversion. All patients had digitalis discontinued. All relapsed back into VT rhythms. In two patients, a single PT was effective in converting the VT to a sinus rhythm, and in the third patient the PT had no effective (did not sped up or slow the VT rate). This article provides some evidence that PT should be used with caution in patients known to be on digitalis therapy. No comment on industry funding.


**LOE 4, Poor, Neutral (PT):** A case series in which 4/20 cases of bradycardia secondary to suxmethonium received either PT or CPR. All patients reported to have survived. Little other detail about the PT. No comment on industry funding.


**LOE 4, Poor, Supporting (FP):** Case report of a patient who developed atrial fibrillation with ventricular pauses. FP administered until electrical pacing was started. No comment on industry funding.


**LOE 4, Fair, Neutral (PT):** A cohort of 47 consecutive cases of VT, VF and ventricular flutter treated with PT. 20/37 cases of VT were successfully treated with PT, with increased rates of success found in slower rates (in rates less than 160, 17/22 were converted with PT or serial PTs, compared to 3/15 successes in rates above 160). No comment on industry funding.


**LOE 4, Poor, Supporting (c-CPR):** A case report of a patient who converted over 30 episodes of VT with forceful coughs. Cardioversion required during episodes when coughing did not convert VT quickly. No comment of industry funding.


**LOE 4, Poor, Neutral (FP):** A report of an elderly male patient (age not provided) who developed cardiac arrest while in the cardiac care unit. He was in a ventricular standstill with p-waves present. FP (2-3 blows) was administered, which produced a short-lived idioventricular rhythm. When the complexes slowed, FP was resumed, followed by external pacing. The patient died shortly after. The author noted that the FP was able to produce QRS complexes, as the patient was not truly asystolic, but rather had some p-wave activity. No comment of industry funding.


**LOE 4, Poor, Neutral (FP):** A report of three patients who had FP administered for asystole. The first was a 60 year old woman who lapsed into VF repeatedly after her pacemaker wires were damaged. She was treated once successfully with cardioversion, and subsequent episodes of asystole were treated with FP, for about 30 minutes, until a temporary pacemaker was inserted. The authors state she survived. The second patient was an 83 year old female treated with FP by a nurse after becoming asystolic, for an unknown period of time while a pacemaker was inserted. She initially responded well with the pacemaker, but then died the next day. The authors do not state that ROSC was achieved with the FP. The third patient was a 77 year old male who developed third degree heart block and subsequent unconsciousness while in-hospital. He was initially treated with CPR, which was then switched to FP. The authors provided an ECG tracing which shows mechanical capture after FP. It appears FP was not started for at least 45 minutes after the heart block began. A pacemaker was inserted and the patient survived. The authors
recommend that cases of asystole be treated with a PT, then FP if the thump is not successful, and if FP does not cause mechanical depolarization, to resort to CPR. No comment on industry funding.


LOE 5, Fair, Opposing (PT): An animal study of PT in dogs that were asphyxiated into cardiac arrest. In all events of VT, PT resulted in VF as often as it slowed the VT. No comment on industry funding.


LOE 5, Fair, Supporting (PT and FP): 50 patients who were a mix of healthy patients and patients with implanted pacemakers who had PT or FP administered. In all cases, cardiac electrical stimulation occurred with PT or FP. No adverse events from the intervention were reported (Zeh & Rahner, 1978). They describe delivering PTs from a height of 20-30cm. No comment on industry funding.


LOE 4, Poor, Supporting (FP) and LOE 5, Fair, Supporting (FP): Two case series were reported. The first used 20 dogs with normal sinus rhythm or AV block. They found that a ventricular response was recorded at 40msec after each thump with a hammer device. The lowest required stimuli to produce a response was 0.4 – 0.7J of a 250g weight. In a case series of 10 human patients, FP was applied to a patient in asystole, two in atrial fibrillation, 6 in AV block and 1 in normal sinus rhythm (to provote PVCs for hemodynamic study). The FP was effective in producing ventricular response in 8 of these 10 patients (although the report does not describe which patients). No comment on industry funding.


LOE 4, Poor, Supporting (FP): A report of a patient who was administered a PT while in asystole, which lead to ROSC. The ECG provided indicates PT was administered, followed by FP, but the text does not adequately describe this, or any patient characteristics. No comment on industry funding.
References
(Ordered as appeared in worksheet)


