

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

### Worksheet author(s)

Koen Monsieurs

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### Clinical question.

"In adult and pediatric patients who are unresponsive (out-of-hospital and in-hospital) (P), are there any specific factors (or Clinical Decision Rules) (I) as opposed to standard assessment? (C), that increase the likelihood of diagnosing cardiac arrest (as opposed to non-arrest conditions (eg post-seizure, hypoglycemia, intoxication) (O))?"

>>> In order to have a working question that allows to approach the problem, I have asked myself for every study "would this study change the current recommended methods of diagnosing cardiac arrest". Studies that would not alter the current methods were classified as "neutral". Studies that WOULD alter the current methods were classified as "supporting".

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

**State if this is a proposed new topic or revision of existing worksheet:** new topic, but including C2005 topics on the diagnostic value of the pulse check (W5A\_Zaritsky.doc, W5B\_Fiedor.doc, W142A\_Tang.doc, W142B\_Jacobs.doc).

### Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?

I am a consultant in Intensive Care and Emergency Medicine. Honorary Secretary of the European Resuscitation Council. Co-authors of two studies on detection of agonal breathing, included in this worksheet.

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

Pubmed accessed online 25 January 2010

Search key words/MESH adapted from all four related 2005 worksheets.

"Heart arrest" [Mesh] AND "recognition": 268 hits.

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh]: 11429 hits (not further investigated)

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "apnea"[Mesh]:90 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "pulse"[Mesh]: 142 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "respiration"[Mesh]: 185 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "telephone"[Mesh]: 16 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "agonal": 27 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "gaspings": 18 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "shaking": 2 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "signs of life": 1183 hits (not further investigated)

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "signs of life" AND "lay": 21 hits

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "signs of circulation": 1590 (not further investigated)

"Heart arrest" [Mesh] AND "Diagnosis"[Mesh] AND "signs of circulation" AND "lay": 12 hits

"Heart arrest" [Mesh] AND "apnea"[Mesh]: 166 hits

"Heart arrest" [Mesh] AND "pulse"[Mesh]: 142 hits

"Heart arrest" [Mesh] AND "respiration"[Mesh]: 262 hits (not further investigated)

"Heart arrest" [Mesh] AND "telephone"[Mesh]: 61 hits

"Heart arrest" [Mesh] AND "agonal": 44 hits

"Heart arrest" [Mesh] AND "shaking": 4 hits

"Heart arrest" [Mesh] AND "signs of life" AND "lay": 27 hits

"Heart arrest" [Mesh] AND "signs of circulation" AND "lay": 16 hits

"Heart arrest" [Mesh] AND "pulse check": 19 hits

Cochrane Library

AHA EndNote Master library version 23 March 2008:

The following search terms were used:

Diagnosis AND apnea  
Diagnosis AND respiration  
Diagnosis AND telephone  
Diagnosis AND agonal

Diagnosis AND shaking  
Diagnosis AND signs of life  
Diagnosis AND signs of circulation  
pulse check

Current Controlled Trials

Forward searching via Web of Science

review of references from articles

Embase: accessed 25 January 2010

• **State inclusion and exclusion criteria**

**Inclusion criteria:** studies describing technical solutions to aid in the diagnosis of cardiac and/or respiratory arrest were included.  
**Exclusion criteria:** Letters and abstracts were excluded.

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

49 articles were included in the review. All articles were studied in relation to their potential to alter the current 2005 recommendations for assessing the need for CPR (=for diagnosing cardiac arrest).  
15 studies were judged not to have an influence on the current recommendations.  
34 studies were judged to have the potential to alter the current recommendations.

Because the worksheet question included both adults and children, and any possible technique to diagnose cardiac arrest without technical adjuncts, I have grouped the studies in the "summary of evidence" grids in the following categories:

- Pulse check adults
- Pulse check infants
- Pulse check newborn
- Breathing
- Seizures
- Dispatching
- Technology: echocardiography – mobile phones – thoracic impedance

## Summary of evidence

### Evidence Supporting Clinical Question (change in guidelines)

Good					
Fair	<p><u>Dispatching</u> Bohm, 2009 Clawson, 2008 Flynn, 2006 Heward, 2004 Roppolo, 2009</p> <p><u>Seizures</u> Clawson, 2007</p>	<p><u>Dispatching</u> Berdowski, 2009 Bohm, 2007</p>		<p><u>Breathing</u> Poets, 1999</p> <p><u>Dispatching</u> Hauff, 2003 Vaillancourt, 2007</p> <p><u>Technology thoracic impedance</u> Johnston, 1998 (cardiac)</p>	<p><u>Pulse check adults</u> Albarran, 2006 Graham, 2002</p> <p><u>Pulse check infants</u> Inagawa, 2003 Sarti, 2006 Tanner, 2000 Lee, 1991</p> <p><u>Breathing</u> Bang, 2008 Breckwoldt, 2009 Brennan, 1998 Chamberlain, 2002 Perkins, 2005 Perkins, 2006 Ruppert, 1999</p> <p><u>Seizures</u> Ghearing, 2007 Schuele, 2007</p> <p><u>Dispatching</u> Bach 2007 Bang, 2003</p> <p>Technologie thoracic impedance <i>Cromie, 2008 (cardiac)</i> <i>Pellis, 2002 (cardiac and breathing)</i> Johnston, 1998 (cardiac)</p>
Poor	<p><u>Technology echocardiography</u> Tsung, 2008 (children)</p>				<p><u>Technology echocardiography</u> Blaiwas, 2008 Niendorff, 2005</p>
	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*

## Evidence Neutral to Clinical question

<b>Good</b>					<u>Pulse check adults</u> Eberle, 1996  <u>Pulse check newborn</u> Owen, 2004
<b>Fair</b>	<u>Dispatching</u> Feldman, 2006				<u>Pulse check adults</u> Lapostolle, 2004 Frederick, 2002 Moule, 2000 Ochoa, 1998 Bahr, 1997 Mather, 1996  <u>Pulse check infants</u> Tibballs, 2009 Cavalarro, 1983  <u>Technology</u> <u>mobile phones</u> Bolle, 2009 Choa, 2008 Yang, 2009 Yang, 2008
<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 (no change in guidelines)

<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:**

The pulse check to assess the need for resuscitation was abandoned for lay rescuers in 2000, after evidence that this technique generated a type II error in 10%. During the 2005 CoSTR process, an update of the pulse check worksheets did not reveal studies that would alter the recommendation. The current recommendation is that lay rescuers should start CPR in victims that are unresponsive and not breathing normally. I have updated the literature review with a search strategy including the 2005 search strategies from the relevant worksheets. The studies supporting a change in recommendation were grouped.

Pulse check in adults:

One LOE D5 manikin study (Albarran, 2006, 243) showed that the technique of simultaneous pulse check and breathing check by professional rescuers increased the diagnostic accuracy. One LOE D5 study (Graham, 2002, 37) on healthy volunteers showed that an alternative technique of carotid pulse check was superior than the standard technique.

*Conclusion: a change in technique of pulse check, and adopting the technique of sequential check pulse and check breathing may improve diagnostic accuracy for professional rescuers. However, the evidence based on one manikin study and one study on healthy volunteers appears insufficient to recommend a change in current practice.*

Pulse check in infants

Three LOE D5 studies (Inagawa, 2003, 141; Tanner, 2000, 429; Lee, 1991, 190) showed that direct auscultation with the naked ear of the apical pulse in infants was superior than all other (standard) techniques. This evidence was considered insufficient to change the recommendation during CoSTR 2005. A more recent LOE D5 study (Sarti, 2006, 394) in hypotensive infants shows that the femoral pulse was superior than the standard brachial pulse technique.

*Conclusion: feeling for the femoral pulse in infants, or direct auscultation of the apical pulse may increase diagnostic accuracy (for both lay and professionals).*

Breathing

Five LOE D5 studies provide evidence that lay rescuers do not master the techniques of breathing assessment and that are unable to recognize agonal breathing (Breckwoldt, 2009, 1108; Brennan, 1998, 653; Chamberlain, 2002, 179; Perkins, 2005, 109; Ruppert, 1999, 720). One LOE D4 study demonstrated that gasping is also present in monitored infants experiencing SID early after they developed bradycardia (Poets, 1999, 350). One LOE D5 study (Perkins, 2006, 432) showed that teaching recognition of agonal breathing using a video clip improved the accuracy of rescuers in diagnosing cardiac arrest. One LOE D5 observational study (Bang, 2008, 116) showed that "abnormal breathing" was present in 53% of comatose patients. The authors suggest that "abnormal breathing" may cause erroneous initiation of CPR in these cases.

*Conclusion: lay rescuers should learn to recognize agonal breathing. On the other hand, "abnormal breathing" is present in comatose patients and may cause wrongful initiation of CPR. There is no evidence that the use of "abnormal breathing" as a sign of cardiac arrest actually causes initiation of wrongful CPR.*

Seizures

Two LOE D5 studies (Ghearing, 2007, 221; Schuele, 2007, 434) show that asystolic epileptic seizures are associated with prolonged absent muscle tone. This feature may distinguish uncomplicated epileptic seizure from asystolic seizure (which is thought to be related with sudden death during epilepsy). One LOE D1 study (Clawson, 2007, 298) showed that prediction of cardiac arrest during seizures by EMS dispatchers was improved using knowledge of the history of seizures.

*Conclusion: absent muscle tone after seizure may be a sign of asystole associated with the seizure.*

Dispatching

One LOE D1 study (Flynn, 2006, 72) showed that cardiac arrest was detected by MPDS with a sensitivity of 77% only. Three LOE D1 studies (Bohm, 2009, 1025; Heward, 2004, 115; Roppolo, 2009, 769) showed improved detection of cardiac arrest cases after specific training of dispatchers and implementation of protocols aiming at recognising agonal breathing. One LOE D1 study (Clawson, 2008, 257) studied detection of cardiac arrest cases before and after introduction of a question "is he breathing regularly?" in a seizure protocol for EMS dispatchers. Use of this question improved the identification of true cardiac arrests. One LOE D2 study (Bohm, 2007, 256) found that in 67 confirmed cardiac arrest cases, telephone CPR guidance was offered in only 23% of cases with "signs of breathing". One LOE D2 study (Berdowski, 2009, 2023) showed that 29% of cardiac arrest calls were not recognised by EMS dispatchers, and that this was due to the dispatcher not enquiring about presence of breathing and type of breathing. Non-recognition was associated with decreased survival. In addition, certain spontaneous words mentioned by the caller such as skin colour were more prevalent in cardiac arrest cases and may therefore help dispatcher to identify cardiac arrest better. One LOE D4 study (Vaillancourt, 2007, 877) showed that agonal breathing was present in 37% of cardiac arrest cases, and accounted for 50% of missed diagnoses. One LOE D4 study (Hauff, 2003, 731) showed that CPR guidance was impeded by callers mentioning "signs of life". One LOE D5 study (Bang, 2003, 25) showed the inability of EMS

dispatchers to detect agonal breathing. One LOE D5 study (Bach, 2007, 742) showed that a policy dispatcher system had a sensitivity to diagnose unconsciousness of 82%..

*Conclusion: studies from EMS dispatchers show that a significant number of false negative cardiac arrest diagnoses are being made. Misinterpretation of agonal breathing, the presence of “signs of breathing” and of “signs of life” are the main causes. Also, certain words (e.g. about skin colour) may help dispatchers to detect cardiac arrest cases. Training of dispatchers to recognise agonal breathing has shown to improve the detection and recognition of individuals needing CPR.*

Technology

Echocardiography

Two LOE D5 small case series (Niendorff, 2005, 81;; Blaivas, 2008, 135) and one LOE D1 study (Tsung, 2008, 264) show the application of echocardiography during cardiac arrest both in children and adults, but the use for diagnosis of cardiac arrest (rather than the cause of the arrest) needs further evidence before a recommendation can be made.

Mobile phones

Three LOE D5 manikin studies (Choa, 2008, 87; Yang, 2009, 490; Yang, 2008, 327) show that video through mobile phones may improve the quality of ventilations and compressions delivered by rescuers. However, one LOE D5 manikin study (Bolte, 2009, 116) did not show this benefit. In any case, the use of mobile phones for improving the diagnosis of cardiac arrest has not been studied.

Thoracic impedance

Three LOE D5 studies (Chromie, 2008, 1677; Johnston, 1998, 1879; Pellis, 2002, S176) of which two were small pig studies and one human study showed the potential to detect spontaneous ventilation and circulation using chest impedance measurements. This technology is currently under development and cannot be recommended for clinical use yet.

**Acknowledgements:**

none

***Citation List***

Number	Citation marker	Citation
1	Albarran, 2006  LOE D5, fair. Supporting change in guidelines	<b>Author:</b> Albarran, J. W.; Moule, P.; Gilchrist, M.; Soar, J. <b>Year:</b> 2006 <b>Title:</b> Comparison of sequential and simultaneous breathing and pulse check by healthcare professionals during simulated scenarios <b>Journal:</b> Resuscitation <b>Volume:</b> 68 <b>Issue:</b> 2 <b>Pages:</b> 243-249  <i>Notes: LOE D5, fair quality. Health care professionals assessed breathing on a manikin. (study actually assessed simultaneous assessment of checking pulse and breathing versus sequential check). Participants had been shown a video on the methods of assessment and they were allowed to practice. The sensitivity to detect absence of breathing using sequential assessment was 100%, the specificity was 71%. Specificity was only 50% for simultaneous assessment of pulse and breathing. Study indicates a lack of specificity to detect apnea (leading to inadvertent CPR). Also highlights that the method of checking influences the specificity.</i>  <i>Usually the simultaneous check is recommended and taught, therefore this study argues for a change in practice.</i>
2	Bahr, 1997  LOE D5, fair. Neutral (change in	Bahr, J., H. Klingler, et al. (1997). “Skills of lay people in checking the carotid pulse.” <u>Resuscitation</u> <b>35</b> (1): 23-6.  Notes: LOE D5 since not in a cardiac arrest population. Lay

	old guidelines for pulse check from 5 to 10 s)	rescuers need more than 5 s for a pulse check.
3	Bang, 2003  LOE D5, fair. Supporting change in guidelines	Bang, A., J. Herlitz, et al. (2003). "Interaction between emergency medical dispatcher and caller in suspected out-of-hospital cardiac arrest calls with focus on agonal breathing. A review of 100 tape recordings of true cardiac arrest cases." <i>Resuscitation</i> <b>56</b> (1): 25-34.  <i>Notes: LOED5, fair quality study. This study demonstrates the inability of EMS dispatchers to detect agonal breathing (and to offer CPR guidance). May lead to change in recommendation: better detection of agonal breathing by EMS dispatchers needed.</i>
4	Bang, 2008  Fair, LOE D5, supporting	<a href="#">Resuscitation</a> . 2008 Aug;78(2):116-8. <b>Are patients who are found deeply unconscious, without having suffered a cardiac arrest, always breathing normally?</b> <b><a href="#">Bång A</a>, <a href="#">Gustavsson M</a>, <a href="#">Larsson C</a>, <a href="#">Holmberg S</a>, <a href="#">Herlitz J</a>.</b> University College of Borås, School of Health Sciences, SE-501 90 Borås, Sweden.  <i>Observational study showing that comatose patients are often (53%) not breathing normally. Claims that this may cause inappropriate starting of CPR.</i>
5	Bach A, 2007  LOE D5, fair.  Supportive of change: EMS dispatch to diagnose unconsciousness can do better.	<a href="#">Bach A</a> , <a href="#">Christensen EF</a> . Accuracy in identifying patients with loss of consciousness in a police-operated emergency call centre - first step in the chain of survival. <i>Acta Anaesthesiol Scand</i> . 2007 Jul;51(6):742-6. Epub 2007 Apr 26  <i>LOE D5. Showing that policy operated dispatch that the sensitivity to diagnose unconscious patients was 82%.</i>
6	Berdowski, 2009  LOE D2 Supportive	<a href="#">Circulation</a> . 2009 Apr 21;119(15):2096-102. <a href="#">Circulation</a> . 2009 Apr 21;119(15):2023-5. <b>Importance of the first link: description and recognition of an out-of-hospital cardiac arrest in an emergency call.</b> <b><a href="#">Berdowski J</a>, <a href="#">Beekhuis F</a>, <a href="#">Zwinderman AH</a>, <a href="#">Tijssen JG</a>, <a href="#">Koster RW</a>.</b> Department of Cardiology, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands. J.Berdowski@amc.nl  <i>Fair LOE D2 study showing that 29% of cardiac arrest calls were not recognised by EMS dispatchers, and that this was due to the dispatcher not enquiring about presence of breathing and type of breathing. Non-recognition was associated with decreased survival. In addition, certain spontaneous words mentioned by the caller such as skin colour were more prevalent in cardiac arrest cases and may therefore help dispatcher to identify cardiac arrest better.</i>
7	Blaivas, 2008  LOE D5, supportive, poor	<a href="#">Resuscitation</a> . 2008 Aug;78(2):135-40. <b>Transesophageal echocardiography during cardiopulmonary arrest in the emergency department.</b> <b><a href="#">Blaivas M</a>.</b>  <i>Six adult cases where the use of echography appears to have been beneficial</i>

		<i>during diagnosis of the cause of arrest (not for recognition of the actual arrest).</i>
8	Bohm, 2007  LOE D2, fair.  Supportive, signs of breathing lead to a high number of cases not offered CPR guidance.	<a href="#">Bohm K</a> , <a href="#">Rosenqvist M</a> , <a href="#">Hollenberg J</a> , <a href="#">Biber B</a> , <a href="#">Engerström L</a> , <a href="#">Svensson L</a> . <b>Dispatcher-assisted telephone-guided cardiopulmonary resuscitation: an underused lifesaving system.</b> <a href="#">Eur J Emerg Med.</a> 2007 Oct;14(5):256-9.  <i>LOE DD2, fair. In a series of 67 cardiac arrest cases, only 23% of patients with “signs of breathing” telephone CPR was offered. This means that “signs of breathing” are an inadequate term and should not be used to guide decisions during telephone CPR.</i>
9	Bohm, 2009 Fair, LOED1, supportive	<a href="#">Resuscitation.</a> 2009 Sep;80(9):1025-8. Epub 2009 Jul 5.  <b>Tuition of emergency medical dispatchers in the recognition of agonal respiration increases the use of telephone assisted CPR.</b>  <a href="#">Bohm K</a> , <a href="#">Stålhandske B</a> , <a href="#">Rosenqvist M</a> , <a href="#">Ulfvarson J</a> , <a href="#">Hollenberg J</a> , <a href="#">Svensson L</a> .  Department of Clinical Science and Education, Section of Cardiology, Karolinska Institutet, SE 118 83 Södersjukhuset, Stockholm, Sweden. katarina.bohm@sodersjukhuset.se
10	Bolle, 2009  Fair, LOED5, neutral (not about diagnosis but about quality of CPR)	<a href="#">Acta Anaesthesiol Scand.</a> 2009 Jan;53(1):116-20. <b>Can video mobile phones improve CPR quality when used for dispatcher assistance during simulated cardiac arrest?</b>  <a href="#">Bolle SR</a> , <a href="#">Scholl J</a> , <a href="#">Gilbert M</a> .  Norwegian Centre for Telemedicine, University Hospital of North Norway, Tromsø, Norway. stein.roald.bolle@telem.no  <i>Manikin study comparing audio and video call guided CPR in highschool students. No benefit in skills was shown.</i>
11	Breckwoldt, 2009  Fair, LOE D5, supportive	<a href="#">Resuscitation.</a> 2009 Oct;80(10):1108-13. Epub 2009 Jul 25.  <b>Perceptions of collapse and assessment of cardiac arrest by bystanders of out-of-hospital cardiac arrest (OOHCA).</b>  <a href="#">Breckwoldt J</a> , <a href="#">Schloesser S</a> , <a href="#">Arntz HR</a> .  Department of Anesthesiology and Perioperative Intensive Care, Charité - University Medicine Berlin, Campus Benjamin Franklin, Hindenburgdamm 30, 12200 Berlin, Germany. jan.breckwoldt@charite.de
12	Brennan, 1998  LOE D5, fair Supporting change (study contributed to abandon the pulse check, but the data would also cause to abandon check breathing!)	Brennan, R. T. and A. Braslow (1998). “Skill mastery in public CPR classes.” <a href="#">American Journal of Emergency Medicine</a> <b>16</b> (7): 653-7.  <i>Notes: LOE D5. Study showing that lay rescuers are often unable to perform adequate check of pulse and check of breathing. Argument in favor of abandoning the pulse check (but also of check breathing, or better training).</i>

13	Cavallaro, 1983  LOE D5, fair. Neutral (does not change current guidelines because the brachial pulse is recommended in infants).	Cavallaro, D. L. and R. J. Melker (1983). "Comparison of two techniques for detecting cardiac activity in infants." <u>Crit Care Med</u> <b>11</b> : 189-190.  <i>Notes: parents who had undergone training were better in palpating the brachial pulse than the apical impulse in their healthy infants within 10 s.</i>
14	Chamberlain 2002  LOE D5, fair. Supporting a change in practice since retention of ventilation check was poor.	Chamberlain, D., A. Smith, et al. (2002). "Trials of teaching methods in basic life support (3): comparison of simulated CPR performance after first training and at 6 months, with a note on the value of re-training." <u>Resuscitation</u> <b>53</b> (2): 179-87.  Notes: LOE D5 study demonstrating poor skill retention of community volunteers, both regarding pulse check and breathing check.
15	Choa, 2008  Fair, LOE D5,	<u>Resuscitation</u> . 2008 Apr;77(1):87-94. Epub 2007 Dec 27. <b>The effectiveness of cardiopulmonary resuscitation instruction: animation versus dispatcher through a cellular phone.</b> <b><u>Choa M, Park I, Chung HS, Yoo SK, Shim H, Kim S.</u></b> Department of Emergency Medicine, Yonsei University College of Medicine, 134 Sinchon-dong, Seodaemun-gu, Seoul 120-752, Republic of Korea.
16	Clawson J, 2007  LOE D1, fair.  Supportive	<u>Clawson J, Olola C, Heward A, Patterson B. Cardiac arrest predictability in seizure patients based on emergency medical dispatcher identification of previous seizure or epilepsy history.</u> <u>Resuscitation</u> . 2007 Nov;75(2):298-304. Epub 2007 Jul 5  <i>LOEO D1: information on seizure history helps EMS dispatchers in the differentiation between seizure by epilepsy or by anoxic arrest.</i>
17	Clawson, 2008  LOE D1, fair	<u>Resuscitation</u> . 2008 Nov;79(2):257-64. <b>Effect of a Medical Priority Dispatch System key question addition in the seizure/convulsion/fitting protocol to improve recognition of ineffective (agonal) breathing.</b> <b><u>Clawson J, Olola C, Scott G, Heward A, Patterson B.</u></b> International Academies of Emergency Dispatch, 139 East South Temple, Suite 200, Salt Lake City, UT 84111, USA. jeff.clawson@emergencydispatch.org  <i>Study of datasets before and after introduction of a question "is he breathing regularly?" in a seizure protocol for EMS dispatchers. Use of this question improved the identification of true cardiac arrests. This finding may have also have implications for assessment of breathing by rescuers (use "regular breathing" in stead of "normal breathing")</i>
18	Cromie, 2008  Fair, LOE D5, supportive	<u>Crit Care Med</u> . 2008 May;36(5):1578-84. Comment in: <u>Crit Care Med</u> . 2008 May;36(5):1677-8. <b>The impedance cardiogram recorded through two electrocardiogram/defibrillator pads as a determinant of cardiac arrest during experimental studies.</b> <b><u>Cromie NA, Allen JD, Turner C, Anderson JM, Adgey AA.</u></b>

		<p>Regional Medical Cardiology Centre, Royal Victoria Hospital, Belfast, Northern Ireland. <a href="mailto:nacromie@doctors.org.uk">nacromie@doctors.org.uk</a></p> <p><i>Study in swine using impedance measurement to detect presence/absence of circulation. Promising.</i></p>
19	<p>Eberle, 1996</p> <p>LOE D5, Good Neutral (the pulse check is abandoned)</p>	<p>Eberle, B., W. F. Dick, et al. (1996). "Checking the carotid pulse check: diagnostic accuracy of first responders in patients with and without a pulse." <u>Resuscitation</u> <b>33</b>(2): 107-116.</p> <p><i>Notes: study on anesthetized individuals showing poor diagnostic value of the pulse check, causing abandoning of this technique in the 2000 guidelines. Does not cause a change in the current guidelines.</i></p>
20	<p>Feldman, 2006</p> <p>LOE D1, fair Neutral</p>	<p><a href="#">Feldman MJ</a>, <a href="#">Verbeek PR</a>, <a href="#">Lyons DG</a>, <a href="#">Chad SJ</a>, <a href="#">Craig AM</a>, <a href="#">Schwartz B</a>. <b>Comparison of the medical priority dispatch system to an out-of-hospital patient acuity score.</b> <u>Acad Emerg Med</u>. 2006 Sep;<b>13</b>(9):954-60. Epub 2006 Aug 7.</p> <p><i>LOE D1: assessment of MPDS protocol showed that the cardiac arrest protocol had a high PPT. But what about the NPV?.</i></p>
21	<p>Flynn, 2006</p> <p>LOE D1 fair.</p> <p>Supportive of change because missed CA cases by EMS dispatch.</p>	<p><a href="#">Flynn J</a>, <a href="#">Archer F</a>, <a href="#">Morgans A</a> Sensitivity and specificity of the medical priority dispatch system in detecting cardiac arrest emergency calls in Melbourne <u>Prehosp Disaster Med</u>. 2006 Mar-Apr;<b>21</b>(2 Suppl 2):72-6.</p> <p><i>LOE D1: MPDS had a sensitivity to detect cardiac arrest of only 77 %.</i></p>
22	<p>Frederick, 2002</p> <p>LOE D5, fair. Neutral (pulse check already abandoned)</p>	<p><b>Frederick K.</b> Bixby E. Orzel MN. Stewart-Brown S. Willett K. Will changing the emphasis from 'pulseless' to 'no signs of circulation' improve the recall scores for effective life support skills in children?. <u>Resuscitation</u>. 55(3):255-61, 2002 Dec.</p> <p><i>LOE D5, manikin study using 10-11 year old children. Argument in favor of abandoning the pulse check.</i></p>
23	<p>Ghearing GR, 2007</p> <p>LOE D5, fair.</p> <p>Supportive of a change because may distinguish between epilepsy and cardiac arrest.</p>	<p><a href="#">Ghearing GR</a>, <a href="#">Munger TM</a>, <a href="#">Jaffe AS</a>, <a href="#">Benarroch EE</a>, <a href="#">Britton JW</a>. <b>Clinical cues for detecting ictal asystole.</b> <u>Clin Auton Res</u>. 2007 Aug;<b>17</b>(4):221-6. Epub 2007 Jul 16.</p> <p><i>LOE D5. Observation that asystolic epileptic fit is associated with loss of muscle tone, whereas non-asystolic seizures had preserved muscle tone. The preservation of muscle tone may be a future clue to distinguish between "normal" epileptic fit and cardiac arrest needing CPR.</i></p>
24	<p>Graham, 2002</p> <p>LOE D5, fair Supporting change (new technique of pulse check)</p>	<p>Graham, C. A. and N. F. Lewis (2002). "Evaluation of a new method for the carotid pulse check in cardiopulmonary resuscitation." <u>Resuscitation</u> <b>53</b>(1): 37-40.</p> <p>LOE D5 study with students palpating a volunteer's carotid artery in different positions. Time to identification of pulse. Could be interpreted as in favor of a change in guidelines.</p>
25	<p>Hauff, 2003</p> <p>LOE D4, fair.</p> <p>Supporting a</p>	<p>Hauff, S. R., T. D. Rea, et al. (2003). "Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation." <u>Ann Emerg Med</u> <b>42</b>(6): 731-7.</p> <p><i>LOE D4: review of audio reportings of EMS calls for cardiac</i></p>

	change in guidelines because CPR was not offered because there were "signs of life"	<i>arrest cases. Telephone CPR was impeded because victims were reported by the caller to have "signs of life". The nature of the observed "signs of life" (moving, shaking, breathing) was not reported. The study does not say that bystanders would not initiate CPR when observing "signs of life", it does say that telephone CPR was not offered because "signs of life" were reported. Therefore we can only conclude that EMS dispatchers were misled but the reported "signs of life".</i>
26	Heward A, 2004  LOED1, fair.  Supportive	<a href="#">Heward A, Damiani M, Hartley-Sharpe C. Does the use of the Advanced Medical Priority Dispatch System affect cardiac arrest detection? <i>Emerg Med J.</i> 2004 Jan;21(1):115-8.</a>  <i>LOE D1: implementation of a specific dispatch system increased the accurate identification of CA patients.</i>
27	Inagawa, 2003  LOE D5, fair. Supporting change	Inagawa, G., N. Morimura, et al. (2003). "A comparison of five techniques for detecting cardiac activity in infants." <i>Paediatr Anaesth</i> 13(2): 141-6.  LOE D5: Direct auscultation of the apical impulse was better than other techniques when used by nurses (in anesthetized infants). Not related to lay rescuers.
28	Johnston, 1998  Fair, LOE D5, supportive	<a href="#">Eur Heart J.</a> 1998 Dec;19(12):1879-88.  Erratum in: Eur Heart J 1999 Mar;20(6):472. <b>The transthoracic impedance cardiogram is a potential haemodynamic sensor for an automated external defibrillator.</b> <a href="#">Johnston PW, Imam Z, Dempsey G, Anderson J, Adgey AA.</a>  Regional Medical Cardiology Centre, Royal Victoria Hospital, Belfast, Northern Ireland.  <i>Study of impedance cardiograms in 116 CA cases showing the potential value of this technique for the detection of spontaneous circulation.</i>
29	Lapostolle, 2004  LOE D5, fair. Neutral	Lapostolle, F., P. Le Toumelin, et al. (2004). "Basic Cardiac Life Support Providers Checking the Carotid Pulse: Performance, Degree of Conviction, and Influencing Factors." <i>Acad Emerg Med</i> 11(8): 878-80.  LOE D5, manikin study, health care providers. Shows difficulty of pulse check.
30	Lee, 1991  LOE D5, fair Supporting change.	Lee, C. J. and L. J. Bullock (1991). "Determining the pulse for infant CPR: time for a change?" <i>Mil Med</i> 156(4): 190-193.  LOE D5, advocating that apical pulse in children is better than brachial pulse.
31	Mather, 1996  LOE D5, fair Neutral.	Mather, C. and S. O'Kelly (1996). "The palpation of pulses." <i>Anaesthesia</i> 51(2): 189-191.  <i>LOE D5: showing that anaesthetist more rapidly detect the radial pulse than the carotid pulse in anaesthetized patients. Little relevance with cardiac arrest or low blood pressure states where the opposite may be true. The study indicates that even professionals have difficulty in feeling a carotid pulse.</i>
32	Moule, 2000  LOE D5, fair. Neutral.	Moule, P. (2000). "Checking the carotid pulse: diagnostic accuracy in students of the healthcare professions." <i>Resuscitation</i> 44(3 SU -): 195-201.

		<i>LOE D5, manikin study. Health care professionals. Supportive of the pulse check being difficult.</i>
33	Niendorff, 2005  LOE D5 Poor, supportive	<a href="#">Resuscitation</a> . 2005 Oct;67(1):81-7. <b>Rapid cardiac ultrasound of inpatients suffering PEA arrest performed by nonexpert sonographers.</b> <b><a href="#">Niendorff DF</a>, <a href="#">Rassias AJ</a>, <a href="#">Palac R</a>, <a href="#">Beach ML</a>, <a href="#">Costa S</a>, <a href="#">Greenberg M</a>.</b>  Department of Anesthesiology, Dartmouth Hitchcock Medical Center, USA. niendd@kadlemed.org  <i>Five adult PEA arrests where echography was used appropriately by minimally trained doctors. Feasibility.</i>
34	Ochoa, 1998  LOE D5, fair. Neutral.	Ochoa, F. J., E. Ramalle-Gomara, et al. (1998). "Competence of health professionals to check the carotid pulse." <a href="#">Resuscitation</a> <b>37</b> (3): 173-175.  <i>LOE D5. Doctors and nurses' ability to feel a pulse in a healthy volunteer in different positions. Shows difficulty of carotid pulse.</i>
35	Owen, 2004  LOE D5, good. Neutral to change in guidelines.	Owen, C. J. and J. P. Wyllie (2004). "Determination of heart rate in the baby at birth." <a href="#">Resuscitation</a> <b>60</b> (2): 213-17.  <i>LOE D5: in newborn babies the stethoscope method is more reliable than other methods.</i>
36	Pellis, 2002  Fair, LOE <u>D</u> 5, supportive	<a href="#">Crit Care Med</a> . 2002 Apr;30(4 Suppl):S176-8. <b>Expanding automatic external defibrillators to include automated detection of cardiac, respiratory, and cardiorespiratory arrest.</b> <b><a href="#">Pellis T</a>, <a href="#">Bisera J</a>, <a href="#">Tang W</a>, <a href="#">Weil MH</a>.</b>  Institute of Critical Care Medicine, Palm Springs, CA, USA.  <i>Swine study using chest impedance to detect breathing and cardiac contraction signals. Promising.</i>
37	Perkins, 2006  LOE D5, fair. Supporting change: teaching recognition of agonal breathing improves accuracy of diagnosing cardiac arrest.	<b>Author:</b> Perkins, G. D.; Walker, G.; Christensen, K.; Hulme, J.; Monsieurs, K. G. <b>Year:</b> 2006 <b>Title:</b> Teaching recognition of agonal breathing improves accuracy of diagnosing cardiac arrest <b>Journal:</b> Resuscitation <b>Volume:</b> 70 <b>Issue:</b> 3 <b>Pages:</b> 432-7  CONCLUSION: This study demonstrates improved diagnostic accuracy and sensitivity of "checking for signs of circulation" by teaching CPR providers to recognise agonal breathing as a sign of cardiac arrest.  <i>Notes: LOE D5, Fair quality study. Teaching recognition of agonal breathing improves decision to start CPR (assessed during a mock situation on a human simulated casualty). First year medical students. Evidence limited to short time effect (two weeks after training). Supporting of the concept that training can improve assessment of breathing.</i>
38	Perkins, 2005  LOE D5, fair Supporting change	<b>Author:</b> Perkins, G. D.; Stephenson, B.; Hulme, J.; Monsieurs, K. G. <b>Year:</b> 2005 <b>Title:</b> Birmingham assessment of breathing study (BABS)

	because showing inadequate diagnosis of agonal breathing by rescuers.	<p><b>Journal:</b> Resuscitation  <b>Volume:</b> 64  <b>Issue:</b> 1  <b>Pages:</b> 109-113</p> <p><i>Notes: LOED5. Fair quality. Second year medical students assessed 6 different breathing patterns on video clips of simulated casualties. Debatable how appraisal of video clips relates to assessment of real casualty. Correct decisions regarding initiation of CPR were made in 86% for absent breathing but in only 51% for abnormal breathing. Together with other study from Perkins only study simulating abnormal breathing and assessing correct decision making of rescuers.</i></p>
39	Poets, 1999  LOE D4, fair Supportive of change	<p>Poets, C. F., R. G. Meny, et al. (1999). "Gasping and other cardiorespiratory patterns during sudden infant deaths." <u>Paediatr Res</u> <b>45</b>(3): 350-354.</p> <p>Note: study showing that gasping is present in SID syndrome.</p>
40	Roppolo, 2009  Fair, LOE D1, supportive	<p><a href="#">Resuscitation</a>. 2009 Jul;80(7):769-72. Epub 2009 May 23.</p> <p style="text-align: center;"><b>Dispatcher assessments for agonal breathing improve detection of cardiac arrest.</b></p> <p><a href="#">Roppolo LP</a>, <a href="#">Westfall A</a>, <a href="#">Pepe PE</a>, <a href="#">Nobel LL</a>, <a href="#">Cowan J</a>, <a href="#">Kay JJ</a>, <a href="#">Idris AH</a>.</p> <p>University of Texas Southwestern, Dallas, 75390-8579, United States.</p>
41	Ruppert, 1999  LOE D5, fair.  Supporting change because showing missed diagnosis of apnea by lay people.	<p><b>Author:</b> Ruppert, M. ; Reith, M. W. ; Widmann, J. H. ; Lackner, C. K. ; Kerkmann, R. ; Schweiberer, L. ; Peter, K.  <b>Year:</b> 1999  <b>Title:</b> Checking for breathing: evaluation of the diagnostic capability of emergency medical services personnel, physicians, medical students, and medical laypersons.  <b>Journal:</b> Ann Emerg Med  <b>Volume:</b> 34  <b>Issue:</b> 6  <b>Pages:</b> 720-729</p> <p><i>Notes: LOE D5, fair quality study. Health care providers and laypeople assessed breathing (breathing or not breathing) on a manikin. Limited because of use of manikin. No simulation of agonal breathing. Correct diagnosis in 90% for EMS and 71% for laypeople. 10% false negative diagnosis (missed apnea) for EMS, 23% for laypeople. Study shows missed diagnosis of apnea is higher for lay than EMS.</i></p>
42	Sarti A, 2006  LOE D5 fair. Supportive: femoral pulse is better than brachial in hypotensive infants.	<p><a href="#">Sarti A</a>, <a href="#">Savron F</a>, <a href="#">Ronfani L</a>, <a href="#">Pelizzo G</a>, <a href="#">Barbi E</a>. <b>Comparison of three sites to check the pulse and count heart rate in hypotensive infants.</b> <u>Paediatr Anaesth</u>. 2006 Apr;16(4):394-8.</p> <p><i>LOE D5 good quality study in hypotensive infants. Femoral pulse was more reliable than brachial pulse.</i></p>
43	Schuele, 2007  LOE D5, fair.  Supportive of a change in recommendation	<p><a href="#">Schuele SU</a>, <a href="#">Bermeo AC</a>, <a href="#">Alexopoulos AV</a>, <a href="#">Locatelli ER</a>, <a href="#">Burgess RC</a>, <a href="#">Dinner DS</a>, <a href="#">Foldvary-Schaefer N</a>. <b>Video-electrographic and clinical features in patients with ictal asystole.</b> <u>Neurology</u>. 2007 Jul 31;69(5):434-41</p> <p><i>LOE D5. Prolonged loss of muscle tone may distinguish between</i></p>

	because may distinguish between cardiac arrest and epilepsy.	<i>cardiac arrest and epilepsy.</i>
44	Tanner, 2000  LOE D5, fair. Supporting a change of practice.	Tanner, M., S. Nagy, et al. (2000). "Detection of infant's heart beat/pulse by caregivers: a comparison of 4 methods." <u>J Pediatr</u> <b>137</b> (3): 429-30.  LOE D5. Again supporting apex listening as the most accurate method in infants by their parents.
45	Tibballs, 2009  Fair LOE D5 neutral	<u>Resuscitation</u> . 2009 Jan;80(1):61-4. <b>Reliability of pulse palpation by healthcare personnel to diagnose paediatric cardiac arrest.</b>  <u>Tibballs J, Russell P.</u>  Intensive Care Unit, Royal Children's Hospital, Melbourne, Victoria, Australia. james.tibballs@rch.org.au  <i>Study in doctors and nurses feeling for a pulse in infants and children during non-pulsatile conditions. Rescuers misdiagnosed in 22%. During cardiac arrest, sensitivity was 89%. This study shows the difficulty of professionals to feel for a pulse in infants and children.</i>
46	Tsung, 2008  Poor, D1, supportive	<u>Resuscitation</u> . 2008 May;77(2):264-9. <b>Feasibility of correlating the pulse check with focused point-of-care echocardiography during pediatric cardiac arrest: a case series.</b>  <u>Tsung JW, Blaiwas M.</u>  Departments of Emergency Medicine and Pediatrics, Bellevue Hospital Center/NYU School of Medicine, Emergency Care Institute, New York, NY 10016, United States. jtsung@gmail.com  <i>Report of 14 children in cardiac arrest where cardiac echography was used. Claiming the value of this technique.</i>
47	Vaillancourt, 2007  LOE D4, fair. Supporting change because missed diagnosis caused by agonal breathing.	Vaillancourt C, Verma A, Trickett J, Crete D, Beaudoin T, Nesbitt L, Wells GA, Stiell IG. Evaluating the effectiveness of dispatch-assisted cardiopulmonary resuscitation instructions. Acad Emerg Med. 2007 Oct;14(10):877-83. Epub 2007 Aug 29.  <i>Notes: LOED4 (before-after study, but designed to assess impact of introduction of dispatcher assisted CPR on the rate of bystander CPR), fair quality. Agonal breathing was present in 37% of all CA cases, and accounted for 50% of missed diagnoses.</i>
48	Yang, 2008  Fair, LOE D5, Neutral	<u>Resuscitation</u> . 2008 Sep;78(3):327-32. <b>Impact of adding video communication to dispatch instructions on the quality of rescue breathing in simulated cardiac arrests--a randomized controlled study.</b>  <u>Yang CW, Wang HC, Chiang WC, Chang WT, Yen ZS, Chen SY, Ko PC, Ma MH, Chen SC, Chang SC, Lin FY.</u>  Department of Emergency Medicine, National Taiwan University Hospital, Taipei, Taiwan; Department of Medical Education, National Taiwan University Hospital, Taipei, Taiwan.  <i>Randomised manikin study on quality of CPR using video calls, showing improved ventilation quality. However, initiation of rescue breaths was delayed.</i>

49	Yang, 2009  Fair, LOE D5, neutral (not about diagnosis but about quality of CPR)	<p><a href="#">Crit Care Med.</a> 2009 Feb;37(2):490-5.</p> <p>Comment in: <a href="#">Crit Care Med.</a> 2009 Feb;37(2):753-4.</p> <p><b>Interactive video instruction improves the quality of dispatcher-assisted chest compression-only cardiopulmonary resuscitation in simulated cardiac arrests.</b> <a href="#">Yang CW</a>, <a href="#">Wang HC</a>, <a href="#">Chiang WC</a>, <a href="#">Hsu CW</a>, <a href="#">Chang WT</a>, <a href="#">Yen ZS</a>, <a href="#">Ko PC</a>, <a href="#">Ma MH</a>, <a href="#">Chen SC</a>, <a href="#">Chang SC</a>.</p> <p>Department of Emergency Medicine, National Taiwan University Hospital, Taipei, Taiwan.</p> <p><i>Manikin study on video cell phone guidance delivering chest compressions only. Quality improved but compressions were started later in the video group.</i></p>
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