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# **Review** article

# In out-of-hospital cardiac arrest patients, does the description of any specific symptoms to the emergency medical dispatcher improve the accuracy of the diagnosis of cardiac arrest: A systematic review of the literature<sup> $\star$ </sup>

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## ABSTRACT

*Aim:* We sought to determine if, in patients with out-of-hospital cardiac arrest (OHCA), the description of any specific symptoms to the emergency medical dispatcher (EMD) improved the accuracy of the diagnosis of cardiac arrest.

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*Methods*: For this systematic review, we searched MEDLINE, EMBASE and the Cochrane Library with no restrictions, and hand-searched the gray literature. Eligible studies included dispatcher interaction with callers reporting OHCA, and reported diagnosis of cardiac arrest. Two independent reviewers used standardized forms and procedures to review papers for inclusion, quality, and to extract data from eligible studies. Findings were peer-reviewed by the International Liaison Committee on Resuscitation. *Results*: We identified 494 citations; 74 were selected for full evaluation (kappa = 0.70) and 23 were included (kappa = 0.68), including six before–after, two case-control, and 15 descriptive studies. One before–after study and ten descriptive studies report that inquiring about consciousness and breathing status can help dispatchers recognize cardiac arrest with moderate sensitivity [ranging from 38% to 97%], and high specificity [ranging from 95% to 99%]. One case-control study, three before–after studies, and four observational studies report that abnormal breathing is a significant barrier to cardiac arrest recognition. One before–after study and two descriptive studies report that seizure activity can be a manifestation of cardiac arrest.

*Conclusion:* Dispatchers should recognize cardiac arrest when a victim is described as unconscious and not breathing or not breathing normally, and consider cardiac arrest when generalized seizure is described. They should receive specific instructions on how to best recognize the presence of abnormal breathing. © 2011 Elsevier Ireland Ltd. All rights reserved.

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## 1. Introduction

Bystander cardiopulmonary resuscitation (CPR) can significantly improve the likelihood of survival for out-of-hospital cardiac arrest victims (OHCA).<sup>1</sup> Unfortunately, bystander CPR rates remain low and vary significantly from one region to another.<sup>2,3</sup> Sixty-five percent of all cardiac arrests occur outside the hospital setting,<sup>4</sup> where the overall rate of survival to hospital discharge rarely exceeds 8%.<sup>2,5</sup> Various attempts have been made to improve bystander CPR rates on a large scale, including the organization of large group CPR training events, promotional CPR videos, and CPR training of high school students.<sup>5</sup> Unfortunately, none of these initiatives have succeeded in significantly improving bystander CPR or survival rates for cardiac arrest thus far. Other experts have proposed targeting CPR training for family members of patients suffering from heart disease, but more than 40% of all deaths from heart disease occur suddenly and often constitute the victim's first manifestation of heart disease.<sup>6</sup>

Emergency medical dispatcher-assisted CPR instructions have been shown to significantly improve community bystander CPR rates.<sup>7-11</sup> This intervention combines the benefits of training a large number of citizens with the highly targeted approach of providing CPR teaching or reminders to callers reporting a victim in cardiac arrest. In order to recognize cardiac arrest over the phone, most emergency medical dispatchers (EMDs) ask a number of standardized questions including information on the victims' consciousness, absence of breathing, or presence of abnormal breathing. Using this strategy, their ability to recognize cardiac arrest over the telephone ranges from 70% to 90%.<sup>12,13</sup> Agonal or abnormal breathing is often seen in the initial minutes of cardiac arrest, and may be misinterpreted as a sign of life.<sup>7</sup> In addition to abnormal breathing, other factors may be involved and limit the ability of EMDs to make a diagnosis of cardiac arrest.<sup>14–19</sup> The correct identification of cardiac arrest has been associated with increased survival.<sup>19,20</sup>

For adult and pediatric patients with OHCA, we sought to determine if the description of any specific symptoms to the EMD by the caller (compared with the absence of any specific description) improves the accuracy of the diagnosis of cardiac arrest.

#### 2. Methods

This systematic review was completed as part of the C2010 Consensus on Science and Treatment Recommendations process, managed by the International Liaison Committee on Resuscitation (ILCOR).<sup>21</sup>

# 2.1. Study design, population, intervention, and outcome measures

We systematically reviewed interventional and observational human studies meeting *a priori* defined inclusion and exclusion criteria. Eligible studies included a population of adult or pediatric patients experiencing OHCA, an intervention where real or simulated interactions between a caller and an EMD took place, and where diagnosis of cardiac arrest was the outcome, reported as either a percentage of correctly identified confirmed cases or using some other convention. We excluded manuscripts if they were comments, letters, editorials, or if they were only available in abstract form.

### 2.2. Information sources and search strategy

The original literature search took place in June, 2008 and included the following databases: MEDLINE (Ovid; 1950 to June week 2 of 2008), EMBASE (Ovid; 1980 to week 25 of 2008), and Cochrane Library (including the database of systematic reviews, the controlled clinical trials registry, and the database of abstracts of reviews of effectiveness; 2nd quarter of 2008). As part of the peerreview process specified by ILCOR,<sup>21</sup> we repeated the electronic searches in August, 2009, and again in January, 2010 for MEDLINE (to December week 5 of 2009), EMBASE (to week 1 of 2010) and the Cochrane Library (4th quarter of 2009).

We searched MEDLINE using a combination of Medical Subject Headings (MeSH) and text words for cardiac arrest (Appendix A). The strategy was limited to human studies, with no additional limits for publication year, study design, or language of publication. This search strategy was subsequently adapted for EMBASE, modifying subject headings where required, but maintaining the same text words.

In addition to the electronic search strategy, we searched a reference database compiled by the American Heart Association, reviewed the reference lists of all selected articles to identify any additional papers meeting the inclusion criteria that were not located in the electronic literature searches, and hand-searched key resuscitation and emergency medicine journals for potentially eligible studies not yet indexed in the electronic databases.

#### 2.3. Study selection and data collection process

We imported the titles and abstracts of identified studies into a bibliographical database library using Endnote<sup>®</sup> version X (Thomson Scientific, Carlsbad, CA). Duplicate citations were removed manually. Two reviewers (CV, MLC) independently assessed the titles and abstracts using the inclusion criteria previously described. Any citation selected by at least one of the reviewers was retrieved for full review. Those papers were independently assessed by the same two reviewers for inclusion in the systematic review. We calculated inter-rater agreement using kappa statistics and resolved all disagreements by way of consensus.

Data extraction was initially performed by a single reviewer (MLC) using a standardized data collection tool; this information was subsequently assessed and verified by two additional reviewers (CV, MC). Data extracted from eligible studies included Esta mensagem, incluindo os seus anexos, contém informações confidenciais destinadas a indivíduo e propósito específicos, e é protegida por lei É proibida a utilização, acesso, cópia ou divulgação não autorizada das informações presentes nesta mensagem.

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Fig. 1. Study flow diagram.

information on year, country and language of publication, in addition to information on study design, study participants, study interventions, and diagnosis (recognition) of cardiac arrest, the primary outcome of interest.

#### 2.4. Quality assessment and data synthesis

We assessed the level of evidence of the eligible diagnostic studies using criteria defined by ILCOR.<sup>21</sup> These criteria consist of five levels of quality of evidence ranging from: level (D1) validating cohort studies, or meta-analyses of validating cohort studies, or validation of a clinical decision rule; level (D2) exploratory cohort study, or meta-analyses of follow-up studies, or derivation of a clinical decision rule, or a clinical decision rule validated on a splitsample only; level (D3) diagnostic case control study; level (D4) study of diagnostic yield with no reference standard; to level (D5) studies not directly related to the specific patient/population.

Each study was then assigned a rating for methodological quality – either "good", "fair" or "poor". "Good" studies had most or all of the relevant quality items identified as important for a particular level of evidence, "Fair" studies had some of the relevant quality items, while "poor" studies had few of the relevant quality items, but were felt to have sufficient value to be included in the review. The quality items defined as important are those that have been shown to minimize the potential effects of spectrum bias (e.g., evaluating the test in an appropriate group of patients), review bias (e.g., including an independent, blind comparison with a reference standard) and verification bias (e.g., application of the reference standard regardless of the test result) in diagnostic studies.<sup>21</sup>

#### 3. Results

## 3.1. Literature search results

Our systematic review of the literature identified 714 potentially relevant citations. After manually removing duplicates, there remained 494 unique citations to review. Using standardized predetermined selection criteria, we excluded 420 citations based on manuscript title and abstract (kappa = 0.70; 95% confidence interval 0.59–0.80). We used the same criteria to review full-text copies of the remaining 74 manuscripts. Characteristics of the 51 papers rejected at this stage are presented in Fig. 1. Our systematic review included 23 papers (kappa = 0.68; 95% confidence interval 0.49–0.86), none of which shared design characteristics clinically homogeneous enough to be considered for meta-analysis.

The recall rate of our electronic search strategy, defined as the number of included papers found by the electronic search strategy divided by those found by the entire search strategy, was 95.7%. In other words, one included manuscript was only identified during the review of the gray literature. The precision of the electronic search strategy, defined as the number of included papers found by the electronic search strategy was 4.5%. In other words, we had to review a large number of irrelevant electronic citations in order to identify all relevant manuscripts.

| Table |  |
|-------|--|
| Table |  |
|       |  |

Characteristics of the included studies.

| Characteristic  | Number of papers (%), N=23 |
|---|----------------------------|
| Median year of publication [range]<br>Country of publication <sup>a</sup> | 2006 [1985-2009]           |
| United States   | 8 (34 8)                   |
| Europe (three different countries)  | 7 (30.4)                   |
| United Kingdom  | 5 (21.7)                   |
| Australia   | 1 (4.3)                    |
| Canada  | 1 (4.3)                    |
| Taiwan  | 1 (4.3)                    |
| Language  |                            |
| English   | 23 (100.0)                 |
| Study design  |                            |
| Observational (prospective and retrospective)                             | 15 (65.2)                  |
| Before-after  | 6 (26.1)                   |
| Case-control  | 2 (8.7)                    |
| Study level of evidence   |                            |
| D1  | 0(0.0)                     |
| D2  | 0 (0.0)                    |
| D3  | 8 (34.8)                   |
| D4  | 15 (65.2)                  |
| D5  | 0 (0.0)                    |
| Study quality   |                            |
| Good  | 6 (26.1)                   |
| Fair  | 16 (69.6)                  |
| Poor  | 1 (4.3)                    |

<sup>a</sup> Numbers do not add to 100% because of rounding.

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#### 3.2. Study characteristics

Key characteristics of the 23 studies included in this systematic review are reported in Table 1. All 23 studies were published in English, and most originated from the United States (35%). We identified six before–after studies<sup>7,22–26</sup> and two case-control studies.<sup>19,27</sup> The remaining studies were observational in design, with no intervention.<sup>12,13,15,17,18,20,28–36</sup> Most studies were of "Fair" quality (70%), the most common level of evidence was D4 (65%), and the highest level of evidence identified was D3. We found no systematic reviews, meta-analyses, or randomized controlled trials on this topic.

# 3.3. Main study results

Detailed characteristics on the population, interventions, and outcome measures used by the selected studies are presented in Table 2. Findings are synthesized and presented by themes in the following sections.

# 3.3.1. Diagnosis of cardiac arrest by emergency medical dispatchers

The symptoms most commonly used by EMDs to diagnose/recognize cardiac arrest over the phone are a combination of "unconsciousness" and "absence of breathing" or "presence of abnormal breathing". In one before–after trial, the ability of EMDs to recognize cardiac arrest improved from 15% to 50% after the implementation of such a protocol.<sup>25</sup> Many descriptive studies using a similar protocol report sensitivity for the recognition of cardiac arrest in the order of 70%<sup>12,13,15,20,26,29,32,33,35,36</sup> ranging from 38%<sup>37</sup> to 97%<sup>32</sup>, and a specificity ranging from 95%<sup>36</sup> to 99%.<sup>33</sup>

# 3.3.2. The impact of abnormal breathing on the ability to diagnose cardiac arrest

One case-control trial,<sup>19</sup> one before-after trial,<sup>7</sup> and four observational studies<sup>18,28,31,34</sup> describe agonal or abnormal breathing as a significant barrier or facilitator to cardiac arrest recognition by EMDs over the phone. Abnormal breathing was reported to be initially present in 37% of all cardiac arrest victims, and can be a barrier responsible for as many as 50% of all unrecognized cardiac arrest cases.<sup>7</sup> On the other hand, two before-after trials successfully facilitated the recognition of abnormal breathing using counting of breaths and/or education.<sup>22,23</sup> In the first study, failure to recognize cardiac arrest decreased from 28.0% to 18.8% (p=0.0012) after the implementation of a protocol asking EMDs to count the number of seconds between breaths when the presence of abnormal breathing was unclear.<sup>23</sup> In the second study, dispatch-assisted CPR instructions were offered to 56% of callers reporting a cardiac arrest victim with abnormal breathing compared to only 23% (*p*=0.006) before EMDs were educated about the significance of abnormal breathing.<sup>22</sup>

# 3.3.3. Strategies to improve cardiac arrest diagnosis among patients presenting with "seizure"

In a descriptive study, confirming the presence of a past medical history of seizure decreased the likelihood of erroneously diagnosing cardiac arrest among victims presenting with seizure activity (reported risk reduction of -0.0025; 95% confidence interval of -0.0044 to -0.0005, p = 0.016).<sup>17</sup> Similarly, in a before–after study by the same author, adding assessment of quality of breathing to the seizure assessment protocol doubled the likelihood of appropriately diagnosing cardiac arrest in this population (Odds ratio 2.10; 95% confidence interval of 1.30–3.40, p = 0.002).<sup>24</sup> In another descriptive study, seizure activity was independently associated with erroneous diagnosis of cardiac arrest.<sup>18</sup> However, only 25

patients (5.2%) had seizures in their study cohort, and no further analyses were performed in this patient group.

# 3.3.4. Other strategies proposed to improve cardiac arrest recognition

The authors of a large case-control study performed multivariate regression analyses to determine which descriptors spontaneously provided by callers were significantly associated with the presence of cardiac arrest.<sup>19</sup> Absence of breathing, abnormal breathing, and descriptions of abnormal facial color were all identified as significant predictors, but a spontaneous statement by the caller that the victim "is dead" was most significantly associated with the presence of real cardiac arrest.<sup>19</sup> Two other authors also found information spontaneously provided by the caller about the quality of breathing to be useful in identifying cardiac arrest.<sup>22,23</sup> One descriptive study included "response to painful stimuli" as part of their dispatcher assessment instructions, but did not evaluate the individual impact of that line of questioning on the ability of dispatchers to recognize cardiac arrest.<sup>20</sup> One descriptive study suggested that, in cases where the victim's problem is "unknown" to the dispatcher, asking about the victim's level of activity (standing, sitting, moving, or talking) helped to identify cases of non-cardiac arrest.<sup>30</sup> One older case-control study suggests that a combination of the victim's age (>50 years old) with the emotional status of the caller (>2 on a 1–5 scale) may yield a 96% cardiac arrest recognition rate.27

## 4. Discussion

Findings from this systematic review of the literature can be summarized in the following manner: (1) dispatchers should assume that cardiac arrest is present when a caller describes the victim as unconscious, not breathing, or not breathing normally; (2) additional instructions on the significance of abnormal breathing should be provided to EMDs in order to improve their ability to recognize cardiac arrest over the phone; (3) in addition, dispatch protocols could be modified to include tools to assess the quality of breathing; and (4) the correct identification of cardiac arrest can be improved with the introduction of focused questions for victims presenting with seizure activity. A number of studies examined the ability to predict cardiac arrest based on the information spontaneously provided by the callers.

The practice of assessing consciousness and quality of breathing in order to identify cardiac arrest over the phone appears to be widely adopted. This could potentially result in patients not truly in cardiac arrest receiving CPR. Two recent papers have provided data on the potential adverse effects of receiving CPR erroneously.<sup>34,38</sup> In a review of the Seattle experience, EMDs initiated CPR instructions after erroneously making the diagnosis of cardiac arrest in 14% of cases.<sup>34</sup> Since telephone CPR instructions do not always result in CPR being performed on the victim, only 4.3% of victims erroneously believed to be in cardiac arrest ultimately received bystander CPR.<sup>34</sup> No adverse event was reported in this small group receiving CPR erroneously. A similar study was recently conducted in King County, Washington with 1700 patients for whom CPR instructions were initiated by the dispatcher. Among those 1700 patients, 247 were not in cardiac arrest, received bystander chest compressions, and had complete outcomes for assessment.<sup>38</sup> Among those 247 patients, 29 experienced discomfort, and five suffered a fractured rib. No significant internal injury was identified.<sup>38</sup> These findings appear to support the safety of initiating CPR instruction in cases where the victim is not breathing normally.

Abnormal breathing appears to be a significant barrier to the recognition of cardiac arrest by EMDs.<sup>7</sup> We described two studies attempting to improve upon the recognition of abnormal breathing.

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# Table 2

Study results.

| 1st Author year  | Level of evidence              | # Of patients                                    | Main findings   | Additional information                                       |
|--|--------------------------------|--|---|--|
| ist Author, year   | and study quality <sup>a</sup> | " of patients                                    | Main Intenings  |  |
| Before-after studies $(n=6)$<br>Robm et al. $(2000)^{22}$  | D2 Fair                        | N= 152 (76 before                                | T CDP: 47% (before) y 68% (after).  | Intervention: training on recognition                        |
| Bolini et al. (2009)   | DS, Fall                       | 76 after)  | p = 0.01  | of AR  |
|  |                                |  | T-CPR with AR: 23% (before) v. 56%  |  |
| Roppolo et al $(2009)^{23}$  | D3 Cood                        | N-961 (599                                       | (after); $p = 0.0006$   | Intervention: new protocol to                                |
| Koppolo et al. (2009)  | D3, G000                       | before, $362 \text{ after}$                      | 81.2% (after); <i>p</i> =0.0012   | increase recognition of AR                                   |
|  |                                |  | Bystander CPR: 60.9% (before) v. 71.5%  |  |
| Clawson et al. $(2008)^{24}$   | D3 Good                        | Unclear  | (after); $p = 0.006$<br>OR (identification of CA) = 2.10 (95% CI                | -Intervention: new breathing regularly                       |
| chawson et ul. (2000)  | 55, 0000                       | oncicui  | 1.30-3.40; p=0.002) with new  | assessment question in AMPDS seizure                         |
| $V_{2}$ : $V_{2$ |                                | N 500 (005                                       | protocol question   | protocol   |
| Valliancourt et al. (2007)   | D3, G000                       | N = 529 (295<br>before, 234 after)               | AR: 37.0% (after): accounted for 50% of   | -Intervention: Introduction of I-CPR                         |
|  |                                | ,  | CA not identified   |  |
| Heward et al. (2004) <sup>25</sup>   | D3, Fair                       | Unclear  | Identification of CA: 15% (before) v.   | -Intervention: introduction of AMPDS                         |
| Eisenberg et al. (1985) <sup>26</sup>  | D3, Fair                       | N=446 (191                                       | Bystander CPR: 45% (before) v. 56%  | -Intervention: introduction of T-CPR                         |
|  |                                | before, 255 after)                               | (after)   |  |
| Case-control studies $(n=2)$   |                                |  | T-CPR: 38% (after)  |  |
| Berdowski et al. $(2009)^{19}$   | D3, Good                       | N=791 (285 cases,                                | Sensitivity = 71%   | -Main reason for missed CA not asking                        |
|  |                                | 506 controls)                                    | Specificity = 99%   | about breathing or not asking for                            |
|  |                                |  | recognized) v. 14% (recognized):  | description of breathing                                     |
|  |                                |  | <i>p</i> =0.04  |  |
| Eisenberg et al. (1986) <sup>27</sup>  | D3, Poor                       | N = 662 (516  cases, 146  controls)              | More CA calls reported patients >50,  | -Questions about consciousness and                           |
|  |                                | 140 controis)                                    | caller more emotional   | where patient >50 and caller emotional                       |
| Observational studies $(n = 15)$   | 5)                             |  |   |  |
| Bobrow et al. (2008) <sup>28</sup>   | D4, Good                       | N = 113 (Fire)                                   | OR (survival) = 5.1 (95% CI, 2.7–9.4)<br>with bystander CPR: increased survival | -Importance of recognition of AR<br>should be taught to EMDs |
|  |                                | N=1210 (END)                                     | when AR present v. no AR  | should be taught to EwiD3                                    |
| Cairns et al. (2008) <sup>29</sup>   | D4, Fair                       | N=238 presumed                                   | Sensitivity = 68.9%   | -MPDS system used  |
| Clawson et al. $(2008)^{30}$   | D4, Good                       | or actual CA<br>N=3947 calls<br>coded as unknown | MPDS unknown problem protocol able  | -MPDS unknown problem protocol                               |
| charroon et an (2000)  |                                |  | to differentiate CA patients when   |  |
|  |                                | problem  | patient's standing, sitting, moving or  |  |
| Bohm et al. (2007) <sup>31</sup>   | D4. Fair                       | N=313; 76 CA                                     | T-CPR: 47%  | -More intensified training for EMDs                          |
|  |                                | without ongoing                                  | T-CPR: 23% (breathing) v. 92% (not  | about AR suggested   |
| $(2007)^{17}$  | D4 Enir                        | CPR  | breathing)  | MPDS seizure protocol  |
| Clawson Ct al. (2007)  | D4, I dii                      | olicical   | confirming past medical history of  | -wir by scizure protocol                                     |
|  |                                |  | seizure/epilepsy increased recognition  |  |
| Ma et al. (2007) <sup>32</sup>   | D4 Fair                        | N=199  | of CA presenting with anoxic seizure<br>Sensitivity = 96.9%                     | Level of consciousness and breathing                         |
|  |                                |  | centrally control   | status most important to be asked to                         |
| Elump at al. $(2006)^{33}$   | D4 Fair                        | N - 729  | Soncitivity - 76 7%   | identify OHCA  |
| Fightil et al. (2006) <sup>22</sup>  | D4, Fall                       | 001 = 11   | Secificity = 99.2%  | MPDS to recognize CA   |
| Nurmi et al. (2006) <sup>18</sup>  | D4, Fair                       | N=776  | Identification of CA: 69% (breathing not  | 0  |
|  |                                |  | described); 80% (abnormal breathing);<br>89% (absent)                           |  |
|  |                                |  | Identification of CA: 80%   |  |
| X 1 (2007)20   |                                |  | (unconscious); 78% (not described)  |  |
| Kuisma et al. $(2005)^{20}$<br>Garza et al. $(2003)^{12}$  | D4, Fair<br>D4 Fair            | N = 373<br>N = 506                               | Identification of CA: 79.4%<br>Sensitivity = 68.4%                              |  |
| Hallstrom et al. (2003) <sup>34</sup>  | D4, Fair                       | N=3320   | T-CPR: 20.5%  | Secondary analysis of an RCT                                 |
|  |                                |  | Missed CA: 14.9%  |  |
| Hauff et al. (2003) <sup>15</sup>  | D4, Fair                       | N=404  | T-CPR: 34%  |  |
| · · · · · · · · · · · · · · · · · · ·  | ,                              | -  | No CPR: 41% (48% T-CPR not offered,   |  |
|  |                                |  | most often (64%) because CA not   |  |
| Castren et al. (2001) <sup>35</sup>  | D4, Fair                       | N=328  | Identification of CA: 72.9%   |  |
| Bang et al. (1999) <sup>13</sup>   | D4, Fair                       | N=473  | Identification of CA: 90.3%   |  |
| Clark et al. (1994) <sup>50</sup>  | D4, Fair                       | IN = 358   | I-CPK: /0%  |  |

Notes: AMPDS, Advanced Medical Priority Dispatch System; AR, agonal respirations; CA, cardiac arrest; CI, confidence interval; EMD, emergency medical dispatcher; *N*, number; OHCA, out-of-hospital cardiac arrest; OR, odds ratio; RCT, randomized controlled trial; T-CPR, dispatch-assisted cardiopulmonary resuscitation; v., versus.

<sup>a</sup> Studies were classified according to level of evidence. Level of evidence D3 indicates a diagnostic case control study, while level of evidence D4 indicates a study of diagnostic yield with no reference standard. Studies were also rated as good, fair or poor for methodological quality. Good studies had most or all of the relevant quality items for diagnostic studies; fair studies had some of the relevant quality items; poor studies had few of the relevant quality items.

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One study successfully improved the recognition of cardiac arrest after implementation of a protocol asking EMDs to count the number of seconds between breaths when the presence of abnormal breathing was unclear.<sup>23</sup> The other study showed improvement in the rate of dispatch-assisted CPR instructions being offered after EMDs received education about the significance of abnormal breathing.<sup>22</sup> In this last paper, EMDs attended a one-day course held by a physician and the person responsible for their education. The curriculum included a review of relevant airway anatomy, physiology, and symptomatology. They also listened to recorded caller–dispatcher interactions where various descriptions for abnormal breathing were used.

Other studies have evaluated the impact of asking additional questions about past medical history of seizure and about the pattern of breathing in patients reportedly having a seizure.<sup>17,18,24</sup> This strategy appears to have been successful in improving the accuracy with which cardiac arrest was determined. In addition to seizure activity, other conditions have the ability to mimic cardiac arrest over the phone.<sup>18</sup> Those can include transient ischemic attacks, strokes, intoxication, hypoglycemia, and syncope. Finally, a number of studies have explored the ability of information spontaneously provided by callers to predict cardiac arrest.<sup>19,22,23</sup> This approach may be challenging when considering that many EMDs are laymen, and do not have an extensive health care background or training. We did not find a study where cardiac arrest recognition was examined in relation to the health care training background (laymen, paramedic, nurse, or MD) of EMDs.

This systematic review of the literature has several strengths, and followed a rigorous process developed by the International Liaison Committee on Resuscitation.<sup>21</sup> This process included a strict policy on the monitoring and disclosure of conflicts of interests, clear guidelines for the evaluative process and classification of evidence, and several opportunities for the work in progress to be peer-reviewed during international meetings and webinars.

This review also has a number of limitations. First, it is remarkable that, despite an extensive and thorough review of the world's literature, we could only find 23 studies pertaining to the recognition of cardiac arrest by EMDs. Moreover, the overall quality of the studies included in this review was mostly "Fair", and the highest level of evidence found came from before-after and case-control studies. There were no randomized-controlled trials or published meta-analyses on this topic. These factors may affect the strength of the recommendations made based on the quantity and quality of the available science. Second, because this review is linked with the scientific review process determined by ILCOR, our search strategy was last conducted immediately preceding the last international consensus on science meeting that took place in Dallas in February, 2010. Pertinent studies that may have been published in the interim time, and have not been included in this review. Third, because of lack of clinical homogeneity, we could not combine any of the studies included in this review using meta-analysis. Finally, this systematic review is narrow in scope and is limited to studies reporting on the identification of cardiac arrest by emergency medical dispatchers. It does not include any review on the actual efficacy of CPR instructions or the process of delivery CPR instructions.

## 5. Conclusions

Emergency medical dispatchers should assume that cardiac arrest is present when a caller describes the victim as unconscious, not breathing, or not breathing normally. They should be educated about the significance of abnormal breathing in the context of cardiac arrest, and they should consider the introduction of focused questions when victims present with seizure activity. The quality of most studies included in this systematic review was classified as "Fair".

## **Conflicts of interest**

Dr. Christian Vaillancourt received funding from the Canadian Institutes of Health Research (CIHR) and the Heart and Stroke Foundation of Ontario (HSFO) to study dispatch-assisted CPR instructions.

Manya Charette has no conflicts of interest to declare.

Katarina Bohm has no conflicts of interest to declare.

Dr. James Dunford has no conflicts of interest to declare.

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#### Appendix A. Medline Search Strategy

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| Heart arrest.mp. or exp Heart Arrest/                |
|--|
| Exp death, sudden, cardiac/                          |
| Cardiac.mp.  |
| Cardio:.mp.  |
| Heart.mp.  |
| Arrest:.mp.  |
| 3 or 4 or 5  |
| 6 and 7  |
| 1 or 2 or 8  |
| Exp emergency medical service communication systems/ |
| Exp telemedicine/                                    |
| 9?1?1.mp.  |
| "911".mp.  |
| 9-1-1.mp.  |
| Dispat:.mp.  |
| (Call: and taker).mp.                                |
| Call-taker.mp.                                       |
| Emd.mp.  |
| (Emerg: and med: and dispat:).mp.                    |
| 9?9?9?.mp.   |
| Clawson.mp.  |
| Mpds.mp.   |
| (Medical: and prior: and dispat: and sys:).mp.       |
| Or/10-23   |
| 9 and 24   |
| Limit 25 to humans                                   |

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#### References

- 1. Stiell IG, Wells GA, Field B, et al. Advanced cardiac life support in out-of-hospital cardiac arrest. N Engl | Med 2004;351:647-56.
- Nichol G, Thomas E, Callaway CW, et al. Regional variation in out-of-hospital cardiac arrest incidence and outcome. JAMA 2008;300:1423-31.
- Vaillancourt C, Stiell IG, Brien S. Cardiac arrest care and emergency medical 3. services in Canada. Can J Cardiol 2004;20:1081-90.
- Zheng ZJ, Croft JB, Giles WH, Mensah GA. Sudden cardiac death in the United 4. States, 1989-1998. Circulation 2001;104:2158-63.
- Vaillancourt C, Stiell IG, Wells GA. Understanding and improving low 5. bystander CPR rates: a systematic review of the literature. CJEM, Can 2008;10: 51-65.
- 6. Messner T, Lundberg V. Trends in sudden cardiac death in the northern Sweden MONICA area 1985-99. J Intern Med 2003;253:320-8.
- 7 Vaillancourt C. Verma A. Trickett J. et al. Evaluating the effectiveness of dispatch-assisted cardiopulmonary resuscitation instructions. Acad Emerg Med 2007;14:877-83.
- Rea TD, Eisenberg MS, Culley LL, et al. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. Circulation 2001;104:2513-6.
- 9 Hallstrom A, Cobb L, Johnson E, et al. Cardiopulmonary resuscitation by chest compression alone or with mouth-to-mouth ventilation. [see comment]. N Engl I Med 2000:342:1546-53.
- Culley LL, Clark JJ, Eisenberg MS, Larsen MP. Dispatcher-assisted telephone 10. CPR: common delays and time standards for delivery. Ann Emerg Med 1991;20:362-6.
- Calle PA, Lagaert L, Vanhaute O, et al. Do victims of an out-of-hospital car-11 diac arrest benefit from a training program for emergency medical dispatchers? Resuscitation 1997:35:213-8.
- 12. Garza AG, Gratton MC, Chen JJ, et al. The accuracy of predicting cardiac arrest by emergency medical services dispatchers: the calling party effect. Acad Emerg Med 2003;10:955-60.
- 13. Bang A, Biber B, Isaksson L, et al. Evaluation of dispatcher-assisted cardiopulmonary resuscitation. Eur J Emerg Med 1999;6:175-83.
- 14. Bang A, Herlitz J, Martinell S, Bang A, Herlitz J, Martinell S. 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. Resuscitation 2003;56:25-34.
- 15. Hauff SR, Rea TD, Culley LL, et al. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. [see comment]. Ann Emerg Med 2003.42.731-7
- Vaillancourt C, Charette M, Wells GA, Stiell IG. Effectiveness of dispatch 16. assisted CPR instructions: design and methodology. BMC Emerg Med 2008;8, doi:10.1186/1471-1227X-1188-1112.
- Clawson J, Olola C, Heward A, et al. Cardiac arrest predictability in seizure 17 patients based on emergency medical dispatcher identification of previous seizure or epilepsy history. Resuscitation 2007;75:298-304
- 18. Nurmi J, Pettila V, Biber B, et al. Effect of protocol compliance to cardiac arrest identification by emergency medical dispatchers. Resuscitation 2006;70: 463-9.

- 19. Berdowski J, Beekhuis F, Zwinderman AH, Tijssen JGP, Koster RW. Importance of the first link: description and recognition of an out-of-hospital cardiac arrest in an emergency call. Circulation 2009;119:2096-102.
- Kuisma M, Boyd J, Vayrynen T, et al. Emergency call processing and survival from 20 out-of-hospital ventricular fibrillation. Resuscitation 2005;67:89-93.
- Morley PT, Atkins DL, Billi JE, et al. Part 3: Evidence evaluation process 2010 International consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. Resuscitation 2010;81s:e32-40.
- 22. Bohm K, Stalhandske B, Rosenqvist M, Ulfvarson J, Hollenberg J, Svensson L. Tuition of emergency medical dispatchers in the recognition of agonal respiration increases the use of telephone assisted CPR. Resuscitation 2009;80:1025-8.
- Roppolo LP, Westfall A, Pepe PE, et al. Dispatcher assessments for agonal breathing improve detection of cardiac arrest. Resuscitation 2009;80:769-72.
- lawson J, Olola C, Scott G, Heward A, Patterson B. Effect of a medical priority dispatch system key question addition in the seizure/convulsion/fitting protocol to improve recognition of ineffective (agonal) breathing. Resuscitation 2008;79:257-64.
- 25. Heward A, Damiani M, Hartley-Sharpe C, Heward A, Damiani M, Hartley-Sharpe C. Does the use of the advanced medical priority dispatch system affect cardiac arrest detection? Emerg Med J 2004;21:115-8.
- Eisenberg MS, Hallstrom AP, Carter WB, et al. Emergency CPR instruction via telephone. Am J Public Health 1985;75:47–50. Eisenberg MS, Carter W, Hallstrom A, et al. Identification of cardiac arrest by 26.
- 27. emergency dispatchers. Am J Emerg Med 1986;4:299-301.
- Bobrow BJ, Zuercher M, Ewy GA, et al. Gasping during cardiac arrest in humans is 28 frequent and associated with improved survival. Circulation 2008;118:2550-4.
- 29. Cairns KJ, Hamilton AJ, Marshall AH, Moore MJ, Adgey AAJ, Kee F. The obstacles to maximising the impact of public access defibrillation: an assessment of the dispatch mechanism for out-of-hospital cardiac arrest. Heart 2008;94:349–53.
- Clawson J, Olola C, Heward A, Patterson B, Scott G. Ability of the medical priority 30. dispatch system protocol to predict the acuity of "unknown problem" dispatch response levels. Prehosp Emerg Care 2008;12:290-6.
- 31 Bohm K, Rosenqvist M, Hollenberg J, et al. Dispatcher-assisted telephone-guided cardiopulmonary resuscitation: an underused lifesaving system. Eur J Emerg Med 2007;14:256-9
- Ma MHM, Lu TC, Ng JCS, et al. Evaluation of emergency medical dispatch in out-of-hospital cardiac arrest in Taipei. Resuscitation 2007;73:236-45
- Flynn J, Archer F, Morgans A, et al. Dispatcher assisted CPR: implementation and potential benefit A 12-year study. Resuscitation 2003;57:123-9.
- Hallstrom AP, Cobb LA, Johnson E, et al. Dispatcher assisted CPR: implementation and potential benefit. A 12-year study. Resuscitation 2003;57:123-9.
- 35. Castren M, Kuisma M, Serlachius J, et al. Do health care professionals report sudden cardiac arrest better than laymen? Resuscitation 2001;51:265-8. Clark JJ, Culley L, Eisenberg M, et al. Accuracy of determining cardiac arrest by 36
- emergency medical dispatchers. Ann Emerg Med 1994;23:1022-6. 37. Eisenberg MS, Cummins RO, Litwin P, et al. Dispatcher cardiopulmonary resus-
- citation instruction via telephone. Crit Care Med 1985;13:923-4. White L, Rogers J, Bloomingdale M, et al. Dispatcher-assisted cardiopulmonary 38. resuscitation: risks for patients not in cardiac arrest. Circulation 2010;121:91-7.