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

**Worksheet author(s)**

Tyler F. Vadeboncoeur MD

**Date Submitted for review:** July 11, 2008, revision submitted October 2, 2008, revision after final literature search submitted September 8, 2009

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**Clinical question.**

BLS-003B "In adult and pediatric patients with presumed cardiac arrest (prehospital or in-hospital) (P), are there any factors (eg. on clinical exam) (I) as opposed to standard care (C), that increase the likelihood of diagnosing cardiac arrest (as opposed to non-arrest conditions (eg post-seizure, hypoglycemia, intoxication) (O)?"

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

**State if this is a proposed new topic or revision of existing worksheet:** Revision of 2005 worksheets 142a and 142b

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

The Ovid databases of MEDLINE (1996-September 2, 2009), EMBASE (1996-Week 35, 2009) and the Cochrane Database of Systematic Reviews (3rd Quarter, 2009) were searched. The MeSH Headings "Heart Arrest" "Cardiopulmonary Resuscitation" or the textwords "cardiac arrest" "cardiopulmonary arrest" "cardiorespiratory arrest" or "circulatory arrest" or "bls" or "basic life support" or "cpr" or "cardiopulmonary resuscitation" were searched against the textwords "signs of life" "signs of circulation" "absence of pulse/breathing" "agonal/disorganized/spontaneous/simultaneous/sequential breathing or respirations" "gaspering" "shaking" "dispatch" "early diagnosis".

A clinical query was performed in PubMed using diagnosis as a filter with the key words CPR (and variants) cardiac arrest and heart arrest. (1996-September 2, 2009)

The AHA Endnote Master Library was reviewed one-by-one on July 10, 2008. As of September 2, 2009 it had not been updated.

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**State inclusion and exclusion criteria**

Only articles in English or with English abstracts were included. Translations of guidelines into other languages were excluded. Articles were excluded that did not pertain to the worksheet question – signs of the need for resuscitation. Articles that were duplicates of previously published literature were excluded. Commentaries and reviews were excluded.

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

727 references were identified in the MEDLINE database using our main search, 31 of those were considered relevant. 86 unique references were found in EMBASE, of which zero were considered relevant. 17 articles were reviewed from the Cochrane database, from which zero considered relevant. 16 articles were found in the AHA Endnote Master Library all of which were found in the MEDLINE search. 435 articles were discovered from the PubMed clinical query, none of which were both unique and relevant. See 31 proposed articles for further review below.
# Summary of evidence

## Evidence Supporting Clinical Question

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**Level of evidence**

- **A** = Return of spontaneous circulation
- **B** = Survival of event
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other endpoint
- **Italics** = Animal studies
- **P** = Pulse
- **Br** = Breathing
- **S** = “signs of life”
### Evidence Neutral to Clinical question

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### Evidence Opposing Clinical Question

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Question BLS-003 essentially asks if there is a way for responders to diagnose cardiac arrest and the subsequent need for CPR. Prior to the 2000 guidelines, the carotid pulse check was the primary means of determining the need for CPR. In the 2000 guidelines, however, the poor sensitivity and specificity of the carotid pulse check led to its deletion from the training of lay rescuers and its de-emphasis for health care providers. The deletion of the pulse check for lay rescuers was carried forward to the 2005 guidelines, and healthcare providers were advised to proceed with chest compressions if a pulse was not definitively palpated within 10 seconds. (IIa)

Since 1996, 16 articles have evaluated the pulse check in either lay or professional rescuers. Seven have been manikin studies and nine have used live human models. Five of the eight studies using human models have been on infants/children. There have been no studies on real cardiac arrest victims and, as such, all of the evidence is LOE D5 with limited external validity. Prior to the 2005 guidelines Chamberlain, Brennan, and Bahr had demonstrated that lay rescuers are unable to accurately assess the carotid pulse in a timely manner. Lapostalle, Moule, Eberle and Nyman had demonstrated that healthcare providers also have a difficult time accurately assessing the carotid pulse. Inagawa and Owen had demonstrated similar difficulties for healthcare providers palpating the pulses of infants and newborns respectively.

Also prior to 2005, there had been two positive and one neutral study evaluating the assessment of the carotid pulse. Ochoa et al. (neutral) evaluated the ability of emergency and ICU doctors and nurses to assess the carotid pulse of a healthy volunteer. These healthcare providers were very fast and accurate but the presence of a pulse was known, pulselessness was not evaluated, and there are significant concerns regarding the external validity of this study. Graham et al. was considered a positive study. It demonstrated a new technique for detecting the carotid pulse which performed better than the traditional technique. This finding is limited by the fact that it used a human model of non-obese healthy males (with known pulses). As such, the study did not evaluate for pulselessness and in this model of thin healthy males the traditional technique also performed well. The aforementioned study by Inagawa was also considered a positive study. While nurses performed poorly in evaluating the pulses of anesthetized infants they performed well using direct ear to chest auscultation. While this study is promising, it did not evaluate for pulselessness.

Four studies have evaluated the pulse check since the 2005 guidelines. All of which evaluated health care providers. In 2005 Sarti et al. evaluated 14 pediatric BLS trained health care professionals assessing the pulses of 56 normotensive sedated infants aged 1-12 months in a PACU. Direct ear to apex auscultation and brachial; carotid; and femoral pulse checks were evaluated. Like Inagawa, Sarti et al. found that direct ear to apex auscultation was rapid (median 4 seconds) and accurate (98%). Palpation of pulses performed poorly without significant differences between the three methods of pulse checks. All palpation methods required a median of 10 seconds to detection and the accuracy ranged from 59-68%. This study was limited as a simulation using living infants in a non-arrest scenario and thus lacks external validity and did not evaluate for pulselessness. In a similar although opposing study Sarti et al. 2006 evaluated the ability of healthcare providers to palpate the pulse of hypotensive anesthetized infants. While the femoral performed better than the carotid or brachial, the pulse was detected within 10 seconds just 65% of the time. Direct ear to apex auscultation was not evaluated. In 2006, Albarran et al. performed a simulation study on the Sim-Man with neutral results. They compared the accuracy of the recommended sequential pulse and breathing check to an alternative simultaneous method. 119 registered health professionals with BLS training were evaluated immediately after brief training. The sensitivity for detecting an absent pulse was 99% for both methods. The specificity was 48.9% for the simultaneous method and 61.9% for the sequential method. As a manikin study, Albarran et al. does little to show that pulse checks are accurate on real arrest victims. While consistent with previous studies for evaluating a present pulse this study is inconsistent with previous findings assessing pulselessness. Finally, in 2009, Tibballs et al. assessed the ability of doctors and nurses to assess the pulse of 16 infants/children (average age 1.8 years) who were either on ECMO or ventricular assist. This study is
unique in that the model allows for an assessment of pulselessness. The accuracy of pulse detection was 78% demonstrating that the pulse check is even difficult for healthcare providers in a controlled environment.

In summary, there is no high level evidence to date either for or against the pulse check. That being said, there is evidence that even in controlled settings the pulse check is a difficult skill to master and retain. No studies since 2005 should overturn the current recommendations. The findings of Inagawa which have been reproduced by Sarti et al. 2005 suggest that direct ear to chest auscultation might be the best way to determine a pulse in infants. It is important to note that neither Inagawa nor Sarti were able to evaluate for pulselessness with their human model.

The 2005 guidelines recognize that there is no evidence that checking for breathing, coughing, or movement are better than the pulse check for determination of circulation. In 2003, Haugh et al. (LOE D4) reviewed dispatch audio recordings to evaluate the factors that impede the performance of dispatcher-assisted CPR. In 51/80 cardiac arrest cases CPR instructions were not given because the victim showed “signs of life”.

The 2005 guidelines recommend that lay rescuers should begin CPR on an unresponsive victim if they do not detect normal breathing within 10 seconds and healthcare providers should begin CPR if they do not detect adequate breathing with 10 seconds. Prior to the creation of the 2005 guidelines there had been three manikin studies (LOE D5) evaluating the ability to assess breathing. Brennan and Chamberlain evaluated lay rescuers and Ruppert evaluated a combination of lay and trained providers. Brennan showed that immediately after a public CPR course just 50% evaluated breathing adequately and Chamberlain demonstrated that just 35% performed an adequate breathing assessment 6 months out from training. Ruppert et al. (LOE D5) performed a dichotomous assessment of breathing and not-breathing by lay and trained rescuers on both a manikin and a breath holding human model. Lay people achieved the correct diagnosis 72% of the time and physicians and EMS providers achieved the correct diagnosis 85% and 90% of the time respectively. The authors concluded that all levels of providers performed poorly since with no knowledge there would have been a 50% chance of a correct diagnosis. This studied is limited as a simulation with limited external validity and it also does not assess for abnormal breathing such as agonal respirations.

There has been one manikin study which evaluated the assessment of breathing since the 2005 guidelines. As previously discussed, in 2006 Albarran et al. (LOE D5) evaluated a simultaneous breathing and pulse check and compared it to the recommended sequential breathing and pulse check. The sequential check performed better with a sensitivity of 99.6% (able to detect the absence of breathing), specificity of 70.6%, and accuracy of 88%. This study suggests that health care providers are able to detect the absence of breathing, but are less able to detect the presence of breathing. Again, this study has limited external validity to the real arrest scenario and did not evaluate the ability to detect abnormal breathing.

The 2005 guidelines recommend that both professional and lay providers treat the victim with occasional gasps as though he or she is not breathing (I) and that CPR training should emphasize how to recognize occasional gasps and to advise rescuers to provide CPR when the victim demonstrates occasional gasps. (Ila) Prior to the publication of the guidelines Menegazzi et al. 1995 had shown a high rate of agonal respirations after VF arrest in a porcine model and Bang et al 2003 (LOE D4) had reviewed dispatch tapes and demonstrated a 30% incidence of agonal respirations. Bang et al. suggested that agonal respirations were a major obstacle to the performance of CPR. This study was limited by its retrospective nature and subsequent inability to confirm agonal respirations. Since the publication of the 2005 guidelines, numerous studies have reviewed dispatch tapes to assess for the prevalence of agonal respirations and their potential negative impact on the performance of CPR. Bohm et al. 2007 (LOE D4) performed a similar study to Bang et al. They also retrospectively evaluated tapes of cardiac arrest dispatch calls and found that in 45% signs of breathing were present. Telephone-guided CPR (T-CPR) was offered in 23% of cases with signs of breathing and in 92% of cases without signs of breathing. Bobrow et al. 2008 (LOE D4) reviewed dispatch tapes and EMS first-reports in a two-armed study. The 113 dispatch tapes revealed a 39% prevalence of gasping. The EMS run reports revealed a 20% prevalence of gasping when the response was < 7 minutes. Gasping was associated with survival and its prevalence decreased rapidly with prolonged response times. Berdowski et al. 2009 (LOE D4) reviewed 285 calls and found that in 82 (29%) cardiac arrest was not detected. In 42/82 breathing was not
assessed by the dispatcher and in 16/82 the character of the breathing was not assessed. The authors concluded that if the dispatchers considered all unconscious victims who were not breathing normally to be cardiac arrests no cardiac arrests would have been missed. Finally, Ropollo et al. 2009 (LOE D4) and Bohm et al. 2009 (LOE D4) went a step further and assessed whether specific tuition/protocols in the detection agonal respirations would improve the ability of dispatchers to diagnose cardiac arrest and subsequently increase the use of T-CPR. In Bohm et al. T-CPR was offered to 47% of cardiac arrest cases prior to tuition and 68% after tuition (p=0.01). In cases with agonal respirations T-CPR was offered in 23% prior to tuition and 56% after tuition (p=0.006). The authors conclude that teaching dispatchers to recognize bystander descriptions of agonal respirations in patients with OHCA resulted in a significant increase in offers of T-CPR. In Ropollo et al. the percentage of patients who did not meet dispatch criteria for cardiac arrest, but actually were arrests shrunk from 28% (168/599) prior to the new protocol to 19% (68/362) (p=0.0012) after the protocol. Bystanders started CPR more frequently after the new protocol 71.5% versus 60.9% p=0.006.

In 2008 Bang et al. (LOE D5 – different population) attempted to evaluate whether recommending the initiation of CPR on unconscious victims with abnormal breathing might have negative unintended consequences. Again, using dispatch recordings they attempted to determine whether this recommendation would lead to the performance of CPR in cases that might mimic cardiac arrest, but do not require CPR. They reviewed cases that were GCS 3 and were transported by ambulance, but that did not meet criteria for cardiac arrest. During the study period 299 patients were GCS 3 of which 250 met criteria for cardiac arrest. The remaining 49 were the group of interest. Of the 49 intoxication and seizures were the most common diagnoses. 45 had information available about their breathing and 24 had some form of abnormal breathing. The authors conclude that abnormal breathing is present in a high percentage of comatose non-cardiac arrest cases and that, as such, current guideline recommendations could lead to harm associated with the unnecessary performance of CPR. This study is limited by its retrospective nature. Just 8% (24/299) of the comatose victims had abnormal breathing AND were presumed not to be cardiac arrest victims. It is unknown whether CPR would have been initiated if responders were aware of a seizure or intoxication. It is also unknown whether the particular character of abnormal breathing would have led to the performance of CPR. Given its limitations, this study does little to impact the current recommendation to initiate CPR on comatose patients with abnormal breathing. Of note, in 1994 Clark et al. (LOE D4) retrospectively reviewed dispatch calls specifically to evaluate how often CPR was being unnecessarily performed based on dispatcher-assisted CPR protocols. They found that CPR was offered in 57/68 cardiac arrest cases when appropriate and possible. It was offered in 4/19 respiratory arrest cases and in 8/154 cases that might mimic cardiac arrest. Chest compressions were only actually performed in 1.2% (2/173) of the cases in which they were not indicated. This study is again limited by its retrospective nature.

Finally, there have been two studies by Perkins et al. (LOE D5) since the 2005 guidelines both of which use a live human model. In 2006, Perkins et al. evaluated the ability of first year medical students to determine agonal respirations. He had an intervention group which received standard CPR training plus specific tuition in assessing agonal respirations and a control group that had standard CPR training. Two weeks later the students assessed a live human simulation of cardiac arrest with normal, agonal, or absent breathing. The intervention group had greater diagnostic accuracy for cardiac arrest than the control group (90% vs. 78%) largely because the intervention group was more likely to recognize agonal respirations as a sign of cardiac arrest and the need for CPR (75% vs. 44%). This study, while well done and showing a positive beneficial effect of specific tuition on agonal breathing, is limited by selection bias, lack of external validity to a real arrest situation, and the fact that testing was performed just 2 weeks after training. In 2005, Perkins et al. evaluated the ability of 48 second year medical students to discriminate between simulated normal and abnormal breathing. The simulation was of a live human on video. Students were asked, “Is the patient breathing?” and responded: yes-normal breathing; yes-abnormal breathing; or not breathing. Students identified normal breathing as normal 61% of the time, abnormal 33% of the time and absent 6% of the time. They identified abnormal breathing as normal 29%, abnormal 61% and absent 10%. They identified absent breathing as normal 8%, abnormal 6% and absent 85%. The authors concluded that medical students were unable to discriminate between normal and abnormal breathing and infer that using breathing as a key sign of
circulation could lead to both the unnecessary performance and non-performance of CPR. This study is limited by its use of video clips as a simulation rather than assessing real cardiac arrest victims. It suggests, however, that it would be difficult for lay bystanders (2\textsuperscript{nd} year medical students studied) to evaluate breathing status which could have a negative impact on determining the need for CPR.

In summary there is no high level evidence to suggest that responders are either unable or able to accurately assess breathing. The work by Brennan, Chamberlain, Ruppert, and Perkins (2005) (all LOE D5) suggest that both lay and trained responders have difficulties assessing breathing. There have been no studies published since 2005 which should change the current guideline recommendations in terms of the assessment of breathing. The studies by Bang (2003), Bohm (2007), Bobrow (2008) and Berdowski (2009) (LOE D4) demonstrate that agonal respirations occur frequently after cardiac arrest and that they deter the initiation of CPR. The studies by Bohm (2009) and Ropollo (2009) suggest that specific tuition in the detection of agonal respirations can increase the ability of dispatchers to detect cardiac arrest. Perkins (2006) demonstrates that agonal respirations can be taught to health care providers. The work by Bang (2008) (LOE D5) which suggests that using the current recommendations to initiate CPR in unconscious victims with abnormal breathing might cause unnecessary harm is limited by the study design and is contrary to the findings of Clark and, as such, should not alter the current guideline recommendations.

**Acknowledgements:** I would like to acknowledge Ann Farrell, the Mayo Clinic Florida librarian, who was amazingly helpful and available in regards to both the literature search and the use of Endnote.

**Citation List**


LOE D5, Good, Neutral, No industry funding

Reviewer’s Comments: This is a simulation study using the Sim-Man and comparing whether the guideline recommended sequential breathing and pulse checks (requires 20 seconds) are more or less accurate than simultaneous breathing and pulse checks (require 10 seconds). The 119 participants were registered health professionals who had taken BLS. Participants watched a short video demonstrating the two techniques and were allowed hands-on practice. They performed 10 case scenarios. There were more correct diagnoses (e.g. pulse present, breathing absent) with the sequential assessment than the simultaneous assessment; 48.2\% vs. 33.5\%. Sensitivity for the pulse check was 99\% for both assessments (i.e. in 700/708 scenarios an absent pulse was detected accurately). The specificity was 48.9\% for simultaneous assessment and 61.9\% for sequential. The sensitivity of breathing checks was also quite high in both groups. The specificities were 50.4\% for the simultaneous method and 70.6\% for the sequential method. The authors concluded that a sequential assessment of breathing and pulse by healthcare professionals has a greater diagnostic accuracy. This study is limited by the fact that it is a simulation study and that testing was performed immediately after training. While it suggests that the sequential method is more accurate than the simultaneous method, it does little to demonstrate that pulse and breathing checks are accurate in actual arrest victims.

LOE D5, Fair, Opposing, No industry funding

Reviewer Comments: This study assesses the ability of 449 lay people, most trained in first aid, to detect the carotid pulse in a young healthy non-obese person. The average time to detection was 9.46 s. 73.7% of people were able to detect the pulse by 10 s and it took 35 s for 95% of volunteers to detect the pulse correctly. The authors suggest that the value of the pulse check needs to be reconsidered. This study is limited by the fact that the “victim” is alive and well in a training scenario and thus lacks external validity for a real arrest scenario. Despite knowing that a pulse exists (patient is a living volunteer), greater than 25% of the participants were not able to detect the carotid pulse within 10 s. The results of this study question the ability of lay bystanders to accurately detect a carotid pulse.


LOE D4, Fair, Neutral, No industry funding

Reviewer Comments: The purpose of this study was to evaluate the ability of emergency medical dispatchers (EMDs) to accurately diagnose cardiac arrest and to determine the frequency of agonal respirations. The authors reviewed 100 tape recorded EMD calls of out-of-hospital cardiac arrest. Dispatcher CPR was offered in 14 cases, attempted in 11, and completed in 8. The incidence of suspected agonal respirations (witness acknowledged that the patient was not breathing normally) was 30%. The authors conclude that dispatcher assisted bystander CPR is offered in just a fraction of potential cases and that agonal breathing is a major obstacle. They suggest that patients with a combination of unconsciousness and agonal respirations should be offered dispatcher-assisted CPR instruction. This study is limited by its retrospective nature. The question of whether the victim was breathing normally was asked in just 41% of cases. Additionally, there is no verification that agonal respirations were truly present. Despite its limitations, this study does suggest a potentially significant incidence of agonal respirations which could deter the performance of CPR in a real arrest victim.


LOE D5, Poor, Opposing, No industry funding

Reviewer Comments: Current guidelines, acknowledging agonal respirations, suggest performing CPR on patients who are deeply unconscious and are not breathing normally. The authors of this study attempt to determine how often abnormal breathing occurs in patients who have not suffered a cardiac arrest and therefore do not require CPR. All cases in a municipality of Sweden in 2005 who were transported by ambulance and were GCS 3, but who did not meet criteria for cardiac arrest were reviewed. 299 patients were found deeply unconscious, 250 of which were presumed to have suffered a cardiac arrest and 49 (16%) who were without suspicion of cardiac arrest. Of the 49 intoxication (23) and seizures (6) were the most common diagnoses. Information about breathing was available in 45 (92%). 24 (53%) were reported as having some kind of abnormal breathing. The authors conclude that signs of abnormal breathing are common in comatose victims who have not suffered from a cardiac arrest which increases the risk of unnecessarily initiating CPR. This study is limited by its retrospective nature. Just 8% (24/299) of the comatose victims had abnormal breathing AND were presumed not to be cardiac
arrest victims. It is unknown whether CPR would have been initiated if responders were aware of a seizure or intoxication. It is also unknown whether the particular character of abnormal breathing would have led to the performance of CPR. Given its limitations, this study does little to impact the current recommendation to initiate CPR on comatose patients with abnormal breathing.


LOE D4, Good, Opposing, No industry funding

Reviewer Comments: The purpose of this study was to assess whether dispatchers recognize cardiac arrest and whether or not this recognition impacts outcomes. Included calls were placed by laypersons and did not involve trauma. 349 calls met study criteria. Of 285 cardiac arrests (determined by EMS reports) 82 (29%) were not recognized and 64 (24%) were considered cardiac arrests by the dispatchers, but ultimately were not. Three month survival was 5% when cardiac arrest was not recognized and 14% when it was. The main reason for not recognizing cardiac arrest was not asking about breathing 42/82 and not asking about the quality of breathing 16/82. The authors conclude that if the dispatchers had considered all unconscious patients who were not breathing normally cardiac arrests then no arrests would have been missed. While this study is considered prospective observational it is limited by a retrospective review of dispatch tapes. The dispatchers did not routinely use a structured dialogue with the caller and as such it does not evaluate how effective a structured approach asking for breathing assessment and using specific “trigger” words would perform. In summary, this study suggests that a more thorough assessment of breathing and recognition of abnormal breathing would result in fewer missed cardiac arrests.


LOE D4, Good, Neutral, No industry funding

Reviewer Comments: This analysis attempted to determine the incidence of gasping after out-of-hospital cardiac arrest. Two methods were used: 1) Review of dispatch calls for evidence of gasping and 2) Review of EMS reports for evidence of gasping. The review of dispatch calls revealed a 39% (44/113) prevalence of gasping. The review of EMS first-reports revealed a gasping prevalence of 20% if EMS arrival was within 7 mintues of arrest. The prevalence fell with longer response times. Survival was higher in patients who were found to be gasping. The authors conclude that gasping (or abnormal breathing) is common after cardiac arrest but that it decreases with time and that gasping is associated with improved survival. They stress the importance of recognition of gasping by dispatch and bystanders. This study only goes as far as to say that gasping is common after cardiac arrest and that it appears to be a marker of early arrest and thus an increased chance of survival. It does not evaluate whether dispatchers and bystanders are capable of recognizing abnormal breathing. This study is also limited in that the arm reviewing EMS first-reports relies on EMS documentation to determine the presence or absence of gasping.

LOE D4, Fair, Neutral, No industry funding

Reviewer Comments: The purpose of this study was to evaluate how often dispatcher-assisted CPR is offered in Stockholm and how often it is performed. It also sought to determine factors that could mislead the dispatcher from recognizing a cardiac arrest. The investigators retrospectively reviewed 76 consecutive tape-recorded dispatcher calls of witnessed cardiac arrest victims in whom CPR was not already being performed. Dispatchers offered CPR instructions in 36 cases and the instructions were actually given in 25. Signs of suspected agonal breathing were described in 45% of cases. CPR was offered to 23% of patients with signs of breathing versus 92% of those who were not breathing. This study was limited by its retrospective nature. Breathing information was available on 69/76 patients and whether or not the abnormal breathing was agonal could not be confirmed. Of the 44 victims reported to be breathing, 34 were described as having breathing which was not normal. Despite its limitations this study is suggestive that a potentially significant percentage of cardiac arrest patients have agonal respirations. It also reveals that signs of breathing resulted on victims being less likely to receive timely CPR.


LOE D4, Good, Supporting, No industry funding

Reviewer Comments: This was a review of dispatch calls before and after tuition in agonal respirations to assess whether the 1-day training increased the recognition of cardiac arrest and subsequent offering of telephone assisted CPR (T-CPR) instructions. Only witnessed arrests were reviewed. T-CPR was offered to 47% of cardiac arrest cases prior to tuition and 68% after tuition (p=0.01). In cases with agonal respirations T-CPR was offered in 23% prior to tuition and 56% after tuition (p=.006). The authors conclude that teaching dispatchers to recognize bystander descriptions of agonal respirations in patients with OHCA resulted in a significant increase in offers of T-CPR. The study is limited in that it does not assess the ability of bystanders to assess for agonal respirations – i.e. are agonal respirations really happening when the dispatchers conclude that they are. It is also limited by the inherent weakness of a before and after study design.


LOE D4, Fair, Opposing, No industry funding.

Reviewer comments: In this study bystander responders to out-of-hospital cardiac arrest (OHCA) were surveyed in a “semi-structured” manner between 1-4 days after the arrest in an attempt to determine why bystander resuscitation only occurs “15-50%” of cases. Interviews were obtained in 69% (138/201) of eligible cases. Bystanders did not detect cardiac arrest in 45.3% of cases. 26% of bystanders spontaneously reported “bluish color”. 28.1% reported abnormal breathing. When present, agonal respirations interfered with a diagnosis of cardiac arrest in 54%. This study again shows how difficult it is for bystanders to diagnose cardiac arrest and how agonal respirations can be misleading. It also suggests that adding cyanosis to education might be beneficial. Based on the study design it is difficult to make broader conclusions based on this study.

LOE D5, Fair, Opposing, Supported by Laerdal Medical Corporation

Reviewer Comments: This is a manikin study evaluating the performance of CPR skills by 226 lay people immediately after training in public CPR classes. 45% failed to open the airway prior to a breathing check, 50% failed to adequately assess breathing and 53% did not perform an adequate pulse check. The authors conclude that trainee performance was poor and that CPR training programs must be developed with attention to learner outcomes. This study is limited by being a manikin study lacking external validity to actual performance in a real cardiac arrest situation. The fact, however, that immediately after training and in a controlled environment just 50% of participants performed an adequate breathing check and 47% performed an adequate pulse check suggests that these skills are not easily acquired by CPR course participants and are unlikely to be performed correctly in a real arrest situation which occurs further removed from the time of training.


LOE D5, Good, Opposing, No industry funding

Reviewer Comments: This is a manikin trial of laypersons which attempted to assess the value of staged training (compared to single training) on skill retention. CPR skills were evaluated immediately after training and 6-9 months later. Immediately after training 68% performed an effective assessment of breathing and 61% performed an adequate carotid pulse check. At reassessment just 35% performed an effective assessment of breathing and 29% performed an adequate pulse check. This is a manikin study with little external validity to a real cardiac arrest scenario. Despite its limitations, the fact that under 70% of participants could perform adequate breathing and pulse checks immediately after training and that this number fell to 35% and 29% respectively at 6-9 months (despite some having retraining) suggests that these skills are difficult to acquire and even more difficult to retain.


LOE D4, Fair, Supporting, No industry funding

Reviewer Comments: In this study the authors attempted to determine the number of times CPR was instructed by dispatchers and ultimately performed on patients who did not need CPR (false positive diagnosis of cardiac arrest). To do this they retrospectively reviewed tapes of dispatch calls. They found that CPR instructions were offered in 57/68 cardiac arrest cases when appropriate and possible. They found that CPR was offered in 4/19 respiratory arrest cases and in 8/154 potential cardiac arrest cases which were cases that might resemble cardiac arrest, but were not. These included 44 with respiratory difficulty, 31 with syncope, 24 with stroke, and 45 with seizure. The false positive rate for performance of chest compressions on cases that were not cardiac arrest (the authors implied that chest compressions were not appropriate for respiratory arrest) was just 1.2% (2/173). The authors conclude that there is a low rate of performance of telephone CPR in cases that mimic cardiac arrest. The authors did not focus on the reasons for not offering CPR when appropriate. This study is limited by its retrospective nature and
subsequent lack of detail on what deterred providing CPR instructions. This study does suggest that chest compressions are rarely performed inappropriately.


LOE D5, Fair, Supporting, Unclear if industry funding, but remarkable COI

Reviewer comments: This is a complicated before-and-after study comparing the ability of an updated dispatch protocol for seizure to better detect cases of seizure that are not from typical CNS causes, but rather other causes such as anoxic brain injury (i.e. cardiac arrest or other low flow states). The fear is that EMS responders will see a seizure and assume that the condition is less severe. The updated protocol added the question: Is s/he breathing regularly? as a follow-up to the question is s/he breathing now?. With the addition of the question: Is s/he breathing regularly? more cardiac arrest patients were appropriately categorized in the higher acuity level. This study suggests that when dispatchers attempt to characterize breathing they are better able to determine the acuity of the patient and are better able to appropriately treat/triage cardiac arrest. It should be noted that this study reviews a seizure dispatch protocol and so does not specifically address the cardiac arrest population.


LOE D5, Fair, Opposing, No industry funding

Reviewer Comments: In this study the authors used a human model of simulated cardiac arrest (16 cardiopulmonary bypass patients) to determine the ability of 206 prehospital providers of varying levels of training to detect the presence or absence of a pulse. The providers were randomly assigned to assess for a pulse during spontaneous circulation or during non-pulsatile cardiopulmonary bypass. While 53/59 (90%) were able to detect the absence of a pulse, the median time to detection was 30 seconds. Only 1/59 providers recognized pulselessness within 10 seconds. In 66/147 (45%) a pulse was not detected when it was in fact present. The authors conclude that the recognition of pulselessness by rescuers with CPR training is both time-consuming and inaccurate. The external validity of this study for real cardiac arrest scenarios is limited. Despite this limitation, the fact that nearly half of providers determined pulselessness when there was a pulse and that the determination of pulselessness required a median of 30 seconds suggests a limited role of the pulse check in the diagnosis and treatment of cardiac arrest by EMS providers.

Frederick, K., E. Bixby, et al. (2002). "Will changing the emphasis from 'pulseless' to 'no signs of circulation' improve the recall scores for effective life support skills in children?" Resuscitation 55(3): 255-261.

LOE D5, Fair, Opposing, No industry funding

Reviewer Comments: In this study the authors retrospectively analyzed an existing data set to evaluate whether removing the pulse check would improve the performance of CPR by 10-11 year-old children. The initial study was a prospective matched control study evaluating the performance of CPR on a manikin 5 months after BLS training. Adequate BLS skills (the minimum to be effective) were performed by
4.1% in the initial study and 24% when the pulse check was removed. While this was initially an
elegant prospective study, this particular analysis is limited by the fact that removal of the pulse check
was done retrospectively and was not an initial aim of the study. It also has limited external validity
being a manikin study. Adequate performance of BLS increased with removal of the pulse check, but
only to 24%. Additionally, less than 7% of children adequately performed a pulse check. This
suggests that at least child bystanders would have difficulty performing a pulse check.


LOE D5, Good, Supporting, No industry funding

Reviewer Comments: Recognizing the importance of the pulse check for healthcare providers and the
difficulty with the traditional technique of carotid pulse check, the authors evaluate a new technique
(also manual). 67 undergraduate dental students performed pulse checks on non-obese healthy males
with their necks in varying positions. For 3 of 4 neck positions the detection of the pulse was quicker
with the new method. This study has limited external validity because it was performed on healthy
males known to have a pulse. The model also did not allow for an evaluation of pulselessness. While
the new technique was faster, the old technique also resulted in fast and accurate detections of the
carotid pulse.


LOE D4, Fair, Opposing, No industry funding

Reviewer Comments: The authors attempt to determine the factors that impede the implementation of
telephone assisted CPR. They reviewed dispatcher audio recordings and EMS reports of 404 cardiac
arrests evaluating whether instructions were not offered, offered but declined, or offered and accepted
but CPR not performed. 99/404 received CPR without dispatch assistance. Of the remaining 305, 139
received telephone CPR and 166 did not receive CPR. Of the 166, instructions were not offered in 80
(48%), were offered and declined in 52 (31%), and were offered and accepted and CPR was not
performed in 34 (21%). Telephone instructions were not given in 51/80 (64%) because the patient
showed “signs of life”. The authors conclude that “signs of life” might significantly impede the
performance of CPR. The analysis is limited by its retrospective nature and the inability to determine
the nature of the “signs of life”.

infants." Paediatr Anaesth 13(2): 141-146.

LOE D5, Good, Supporting, No industry funding

Reviewer Comments: In this analysis the authors evaluated 28 nurses detecting the pulse of 13 anaesthetized
infants ages 1-12 months who were scheduled for outpatient surgery. Each nurse evaluated by palpation
of the brachial, carotid, femoral and apical pulses and auscultation of the apical pulse in random order.
They found that auscultation was significantly faster and that with this technique the pulse was detected
within 10 seconds every time. They also found that just 50% of nurses were able to detect a carotid
pulse within 10 seconds. This study has limited external validity in that it is on infants who are not in an arrest state. It also does not evaluate for pulselessness. It is, however, consistent with the literature in regards to carotid pulse checks and suggests that direct ear to chest auscultation of the chest in infants might be a viable alternative for the pulse check by healthcare providers.


LOE D5, Good, Opposing, Used a Laerdal manikin – no comment on industry funding

Reviewer Comments: The authors perform a manikin study to evaluate the ability of 64 healthcare providers to perform the carotid pulse check. Pulselessness was only detected accurately 58% (37/64) of the time at 10 seconds. A weak pulse was detected correctly 83% (53/64) of the time at 10 seconds and a normal pulse was detected 92% and 84% of the time at 10 seconds (evaluated twice). The authors conclude that these results should question the ability of healthcare providers to accurately perform pulse checks. These results have limited external validity for a real arrest situation, but do question the ability of healthcare providers to accurately perform a pulse check.


LOE D5 (Animal), Fair, Neutral, No comment on industry funding

Reviewer Comments: In this animal model 12 female mechanically ventilated and sedated swine had VF induced electrically. 11/12 (92%) animals had agonal respirations for the first three minutes after cardiac arrest. This study is clearly limited as an animal model, but it suggests a high rate of agonal respirations immediately following VF cardiac arrest. This has implications as the presence of agonal respirations could initially impede the performance of CPR.


LOE D5, Fair, Opposing, No industry funding

Reviewer Comments: The authors evaluated the ability of 105 students of healthcare professions to detect the presence or absence of a carotid pulse in a manikin. 44/56 detected a carotid pulse when it was present, but just 31 did so in 10 seconds. This is consistent with other published literature which suggests that about 50% can detect a carotid pulse within 10 seconds. 44/49 detected the absence of a pulse, but just 9/49 did so within 10 seconds. This study is again limited by selection bias and a lack of external validity as it is a manikin study. It does support that the carotid pulse check is a difficult skill to attain even in students of the health professions.


LOE D5, Fair, Opposing, No industry funding reported
Reviewer Comments: The authors evaluated the BLS skills of 298 either nurses or final term nursing students on a manikin. 53% had taken a CPR course during the prior 6 months, and 93% had taken a CPR course sometime previously. Only 3% correctly determined pulselessness before trying to resuscitate. The authors conclude that the skills of the participants were inadequate in terms of evaluating the need for resuscitation. This study is limited by selection bias and external validity as it is a manikin study. It nonetheless suggests that the skill of pulse check is both difficult to attain and retain and questions its role in the assessment of need for CPR.


LOE D5, Fair, Neutral, No industry funding reported

Reviewer Comments: The authors assess the ability if Emergency and ICU doctors and nurses to accurately detect the carotid pulse. 80% had CPR training. This was a simulation study on a healthy volunteer. Only 3/72 (4.2%) required more than 10 seconds to detect the pulse. With previous training you were 10 time more likely to detect a carotid pulse. This study is limited by the fact that the model used a healthy volunteer with known pulses. External validity is limited and the detection of pulselessness was not evaluated.


LOE D5, Fair, Opposing, No industry funding reported

Reviewer Comments: This study randomized 60 healthy term newborn babies to femoral, brachial and cord pulse assessments within 5 minutes of birth. The participants were midwives and senior house officers. Pulses were not palpable within 30 seconds in 7/20 (35%) using a femoral pulse check, 12/20 (60%) using a brachial pulse check, and 5/20 (25%) using a cord pulse check. In the cord pulse group, which performed the best, the pulse check was accurate in just 55%. The authors conclude that pulse checks in a newborn should be done with a stethoscope. They state that umbilical pulse checks are the next best option, but that they are limited. This study is limited by the fact that it evaluated newborns with known pulses. It says little about older infants and does not evaluate for pulselessness. Despite its limitations it suggests that there is little value to brachial and femoral pulse checks in newborns.


LOE D5, Good, Opposing, No industry funding reported

Reviewer Comments: This study evaluates the ability of 48 second-year medical students to discriminate between simulated normal and abnormal breathing. Six video clips of simulated normal, abnormal, shallow, rapid, agonal, and absent breathing were shown to each student in random order. Students were asked, “Is the patient breathing?” and responded: yes-normal breathing; yes-abnormal breathing; or not breathing. Students identified normal breathing as normal 61% of the time, abnormal 33% of the time and absent 6% of the time. They identified abnormal breathing as normal 29%, abnormal 61% and
absent 10%. They identified absent breathing as normal 8%, abnormal 6% and absent 85%. The authors conclude that medical students were unable to identify normal breathing from abnormal breathing and infer that using breathing as a key sign of circulation could lead to unnecessary treatment and lack of treatment. This study is limited by its use of video clips as a simulation rather than assessing real cardiac arrest victims. It suggests, however, that it would be difficult for lay bystanders (2nd year medical students studied) to evaluate breathing status which could have a negative impact on determining the need for CPR.


LOE D5, Good, Supporting, No industry funding

Reviewer Comments: The authors hypothesize that teaching agonal breathing as a sign of cardiac arrest will improve the diagnostic accuracy of checking for “signs of circulation”. 64 first-year medical students were randomized to standard CPR training or standard CPR training plus specific tuition in agonal breathing. Two weeks later their ability to diagnose cardiac arrest was evaluated on a simulated victim (a live person trained in breath holding and agonal respirations). The intervention group had greater diagnostic accuracy for cardiac arrest than the control group (90% vs. 78%) largely because the intervention group was more likely to recognize as agonal respirations as a sign of cardiac arrest and the need for CPR (75% vs. 44%). This study, while well done, is limited by selection bias, lack of external validity to a real arrest situation, and the fact that testing was performed just 2 weeks after training.


LOE D4, Good, Supporting, No industry funding

Reviewer comments: This is a before-and-after study assessing the impact of a new dispatch protocol designed to better detect agonal respirations. During the 8 months prior to the new protocol no patients had agonal respirations detected compared to 22 patients in the 4 months after the institution of the protocol. The percentage of patients who did not meet dispatch criteria for cardiac arrest, but actually were arrests shrunk from 28% (168/599) prior to the new protocol to 19% (68/362) (p=0.0012) after the protocol. Bystanders started CPR more frequently after the new protocol 71.5% versus 60.9% p=0.006. Survival to ED admission was similar in the two groups. This study suggests that dispatchers can be trained to ask questions regarding breathing and subsequently to detect cardiac arrest and suggest the initiation of bystander CPR. Dispatchers describe the method of having the bystander say “now” after each breath to be an effective way to assess for breathing. Lying the phone on the floor or putting the phone by the victim were not deemed helpful. This study is limited by the Hawthorne effect (particularly with the short duration of study after the implementation of the new protocol). The study design in unable to identify cases in which agonal respirations were present, but were not detected.

LOE D5, Good, Neutral, No industry funding reported

Reviewer Comments: This study evaluated the ability of 261 EMS personnel, physicians, medical students, and laypersons to determine breathlessness. Each participant evaluated an unresponsive breathing or not-breathing test person and a manikin with simulated respiratory function. For all participants, the correct diagnosis was achieved in 81% (423/522) and the median time to diagnosis was 12 seconds. Of the 19% (99) that had misdiagnoses 69 (13.2%) determined breathlessness when breathing was present and 30 (5.8%) detected breathing when it was absent. In laypersons the correct diagnosis was achieved in 72% (93/130) and was determined in a median of 13 seconds. EMS providers were accurate 90% of the time and physicians were accurate 85% of the time. The authors conclude that checking for breathing was mostly inaccurate and unreliable. Of note, only 56% of assessments were done using the recommended look, listen, feel technique which was much more effective than other methods. This study is limited as a simulation study with limited external validity. The 5.8% false negative rate (missed breathlessness and the subsequent need for CPR needed) is perhaps not as dismal as suggested by the authors.


LOE D5, Fair, Supporting, No industry funding

Reviewer Comments: In this study 14 pediatric BLS trained health care professionals evaluated the pulses of 56 normotensive sedated infants aged 1-12 months in a PACU. Direct ear to apex auscultation and brachial; carotid; and femoral pulse checks were evaluated. Apex auscultation was more rapid (median 4 seconds) and accurate (98%) than the palpation methods. No significant differences were found when comparing the three methods of pulse checks. All palpation methods required a median of 10 seconds to detection and the accuracy ranged from 59-68%. This study is limited as a simulation using living infants in a non-arrest scenario and thus lacks external validity. It also did not evaluate for pulselessness. The study, however, suggests that direct ear to chest auscultation might be the best means of a pulse check in infants. It also shows that standard pulse checks are inaccurate even on live infants with known pulses.


LOE D5, Fair, Opposing, No industry funding

Reviewer Comments: Two doctors and two nurses performed brachial, carotid and femoral pulse checks in 40 anesthetized hypotensive infants prior to surgery. The mean time to detection of HR was less than 10 seconds in each group. Accurate detection of a pulse within 10 seconds occurred in 65% for femoral, 52% for carotid, and 41% for brachial. This study is limited by being a simulation on live infants, and, as such, the external validity for a real cardiac arrest scenario is limited. Additionally, pulselessness was not evaluated. Despite these limitations, this analysis suggests that femoral, carotid, and brachial pulse checks perform poorly even in the hands of healthcare professionals evaluating live infants with known pulses.

Reviewer comments: This study was designed to determine the reliability of pulse palpation to diagnose pediatric cardiac arrest. It evaluated doctors and nurses and used simulated arrests in the form of 16 children aged 1 week – 13 years (average 1.8 years) who were either on ECMO or left ventricular assistance. Rescuer accuracy was 78%. Sensitivity was 0.86 and specificity was 0.64. Accuracy was 89% when the pulse pressure was zero. Brachial palpation was slightly more accurate than femoral palpation. This study is limited as a simulation, but is a very thoughtful simulation especially in that it allows for the assessment of pulselessness. Again, the pulse check proves difficult even in the hands of health professionals in a relatively controlled environment.