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

- **Worksheet author(s):** E. Brooke Lerner
- **Date Submitted for review:** 2/17/09

#### Clinical question.
In adult and pediatric patients with out-of-hospital cardiac arrest (including residential settings) (P), does implementation of a public access AED program (I) as opposed to traditional EMS response (C), improve successful outcomes (O) (eg. ROSC, survival)?

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

#### Conflict of interest specific to this question
- Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? no

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

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ECC endnote library searched for “public access” in any field – 57 references identified: 41 relevant.

- Cochrane Database search for "public access defibrillation" - 1 record found: preliminary report no abstract or report available

All reviewed articles had their reference sections hand reviewed and any relevant articles were obtained. The author also searched her personal reference library for relevant articles.
Search re-run 10/2/09 – One additional paper identified

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<tr>
<th>State inclusion and exclusion criteria</th>
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No exclusion criteria were applied to the search strategy. For the article review only studies that discussed research were considered for the evidence table. Further, that research had to directly answer the worksheets clinical question and relate to responders who are not part of the formal EMS system including police and firefighters. That is if responders were dispatched to the scene by emergency number (e.g., 911) dispatchers the study was excluded.

<table>
<thead>
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<th>Number of articles/sources meeting criteria for further review:</th>
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<td>A total of 93 articles were reviewed.</td>
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# Summary of evidence

## Evidence Supporting Clinical Question

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<thead>
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<th>Level of evidence</th>
<th>Evidence Supporting Clinical Question</th>
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<tr>
<td><strong>Good</strong></td>
<td>Peberdy, 2006 E</td>
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<tr>
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<td>Hallstrom, 2004 C</td>
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<tr>
<td></td>
<td>Colquhoun, 2008 C</td>
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<tr>
<td></td>
<td>Capucci, 2002 D</td>
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<td></td>
<td>Culley, 2004 C</td>
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<td>&amp;E Caffrey, 2002 D</td>
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<td></td>
<td>Page, 2000 D</td>
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<tr>
<td></td>
<td>Valenzuela, 2000 C</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>Sana, 2008 C</td>
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<td></td>
<td>Fleischhackl, 2007 C</td>
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<td></td>
<td>Davies, 2005 C</td>
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<td>O'Rourke, 1997 C</td>
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<td></td>
<td>Pell, 2002 E</td>
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<tr>
<td><strong>Poor</strong></td>
<td>Kuisma, 2002 E</td>
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<td>Jorgenson, 2003 C</td>
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**Level of evidence**

- **A** = Return of spontaneous circulation endpoint
- **B** = Survival of event studies
- **C** = Survival to hospital discharge
- **D** = Intact neurological survival
- **E** = Other

*Italics* = *Animal*
### Evidence Neutral to Clinical question

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<thead>
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<th>Level of evidence</th>
<th>Evidence Neutral to Clinical question</th>
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</thead>
<tbody>
<tr>
<td><strong>Good</strong></td>
<td>Bardy, 2008 B</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>Eisenberg, 1989 D</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
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### Evidence Opposing Clinical Question

<table>
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<th>Level of evidence</th>
<th>Evidence Opposing Clinical Question</th>
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<tbody>
<tr>
<td><strong>Good</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>Nanthakumar, 2006 E</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Evidence Neutral to Clinical question**

- **A =** Return of spontaneous circulation
- **B =** Survival of event
- **C =** Survival to hospital discharge
- **D =** Intact neurological survival
- **E =** Other

**Level of evidence**

**Evidence Opposing Clinical Question**

- **A =** Return of spontaneous circulation
- **B =** Survival of event
- **C =** Survival to hospital discharge
- **D =** Intact neurological survival
- **E =** Other

**Level of evidence**

*Italics = Animal*
REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

The AHA has previously defined 4 levels of public access defibrillation: level 1 traditional first responder (police/fire), level 2 nontraditional first-responder (security guard, flight attendant), level 3 citizen CPR (trained lay-providers), and level 4 minimally trained witness. (Nichol, Hallstrom et al. 1998 pg1309). This worksheet focused on response outside of the traditional EMS system, levels 2, 3, and 4. The key study is the PAD trial (LOE 1), which demonstrated that twice as many cardiac arrest patients survived when PAD was available (93% CI 1.07-3.77) (Hallstrom, Ornato et al. 2004 pg 637) and that PAD programs were generally safe for both the patient and the rescuer. (Peberdy, Ottingham et al. 2006 pg59). PAD is also supported by four LOE2 studies, one LOE3, and 7 LOE4 studies. There is a single case study that illustrates an inappropriate shock being advised by an AED device, which is considered a negative study. (Nanthakumar 2006 pg672) However, this single negative case is far outweighed by the numerous positive studies with much larger sample sizes.

While there are no documented cases of harm being caused by a lay-provider using an AED, the cost and most logical deployment strategies are not clear and may vary by site and circumstances. For a PAD program to be effective it must be integrated into the formal EMS system. However, evidence shows that this is not consistently being done (Myers, French et al. 2005 pg339).

Initiating PAD programs is not without challenges. A study found that attrition of volunteer responders was 36% and that some locations do not have a ready pool of volunteer responders. (Richardson, Guncels et al. 2005 pg688) Further, a large percent of lay-volunteers associated with a formal PAD program may not participate in retraining efforts, but the retention of CPR skills among lay volunteers may be high. (Riegel, Nafziger et al. 2006 pg254) (Cummins, Schubach et al. 1989pg143) (Christenson, Nafziger et al. 2007 pg52) But during an actual cardiac arrest event the number of CPR actions that are actually performed by lay responders may be low. (Hedges, Sehra et al. 2006 pg659)

The cost effectiveness of placing an AED in a given location must also be considered. Research has shown that they are cost-effective when placed on commercial airplanes (Groeneveld, Kwong et al. 2001pg1482) or other high incidence areas (Nichol, Hallstrom et al. 1998 pg15); Nichol 2003 pg697); (Cram, Vijan et al. 2003pg745); (Gold and Eisenberg 2007 pg1); (Folke, Lippert et al. 2009 pg510); but they may not be cost effective in low incidence areas. (Pell, Walker et al. 2007 pg5) Several studies have looked at the location of cardiac arrests to try to predict high incidence locations. (Becker, Eisenberg et al. 1998 pg2106); (Engdahl and Herlitz 2005 pg171); (Friedman, Dowler et al. 2006 pg407); (Muraoka, Ohishi et al. 2006 pg827) Prior to initiating a PAD program it is recommended that the likely incidence of cardiac arrest in that location be determined.

Use of AED's in the home by survivors of anterior-wall myocardial infarction showed that the presence of a home AED demonstrated no significant improvement in survival. (Bardy, Lee et al. 2008 pg1793) However, the event rate in this population was low. The study did find that use of the AED in the home by lay-providers was feasible; it terminated ventricular fibrillation and did not result in inappropriate shocks. Therefore, home use of an AED is not harmful and potentially helpful, but because of the low likelihood of its use distribution to those who survive an anterior-wall myocardial infarction is unlikely to be cost effective or improve overall survival rates.

Acknowledgements:
Citation List

Articles used as Evidence


**Reviewer’s Comment:** Use of AED’s in the home by survivors of anterior-wall myocardial infarction showed that the presence of a home AED had demonstrated no significant improvement in survival. However, the event rate in this population was low. The study did find that use of the AED in the home by lay-providers was feasible; it terminated ventricular fibrillation and did not result in inappropriate shocks. Therefore, home use of an AED is not harmful and potentially helpful, but because of the low likelihood of its use distribution to those who survive an anterior-wall myocardial infarction is unlikely to be cost effective or improve overall survival rates.


**Reviewer’s Comment:** This case series looked at the deployment of AED across all three Chicago airports (LOE 4). They had good follow-up and survival to one year (quality – good). 11 of 18 ventricular fibrillation patients survived to hospital discharge with good neurologic function. They estimate the cost of the program is $3,000 per patient or $7,000 per life saved.


**Reviewer’s Comment:** This non-randomized study recruited “lay-providers” who were taught to use an AED but were not taught CPR (LOE2 good quality). Thirty-nine AED’s were then placed at 12 fixed locations (main public squares), 15 police and fire vehicles, and 12 public assistance vehicles. The authors then compared cardiac arrests treated by these providers over a 22 month period to those treated by EMS. This deployment method resulted in 40% of the 354 cardiac arrests being treated by the AEDs and found improved survival to hospital discharge and a higher rate of neurologically intact survival.


**Reviewer’s Comment:** This non-randomized study compared static to mobile AED placement making it an LOE 2. There were 1,530 arrests studied and data was collected using a standardized report form making it a good quality study. Survival to hospital
discharge was the outcome and it was found to be higher in the group treated by the static devices.


**Reviewer’s Comment:** This is referred to as a cohort study but there is no control group (LOE 4). They report survival to hospital discharge for the 50 cases of cardiac arrest that were treated by one of the 475 PAD AED’s that are deployed within King County in a 4 year period. They identified patients who were treated by one of their registered AED’s as well as those treated by unregistered AED’s (quality good). They examined survival rates (76% admitted, 50% discharged from hospital alive), but their main focus was on device usage. They found that these devices had 5 uses per 100 years of AED exposure.


**Reviewer’s Comment:** This is a case series (no control) that describes a PAD program initiated in London LOE 4. They had difficulty obtaining hospital information, but were able to obtain survival to hospital discharge for all but 2 patients (quality – fair). The survival rate was 28.3% to hospital discharge. The program had 681 AEDs that were used 172 times or one AED use for every 120 defibrillator months. Note the same data is presented in Whitfield 2005 only the Davies article was included on the evidence grid so as not to double count a single study.


**Reviewer’s Comment:** This project had a non-randomized pilot phase, then a randomized phase, and then a phase where all participants were offered an AED. All of these phases were reported together because there were only 14 out-of-hospital cardiac arrests making it a fair quality LOE 2 study. There was only 1 survivor in each group, but given the small sample size it is not possible to draw any conclusions on survival. Although, it does indicate that home AEDs may be rarely used.


**Reviewer’s Comment:** This study used historical controls from 1996 making it a fair LOE 3 study. It reported that neurologic status was obtained but reports survival to hospital discharge.

**Reviewer's Comment:** This study was randomized at the community unit level (LOE 1). The number of actual arrests was far lower than what was expected. The program was detailed with good training for responders; therefore, the results only apply to programs with a training and response plan.


**Reviewer's Comment:** This survey asks AED owners about usage in the last year. The owners were identified though a single manufacturers customer database, the response rate was low (50-59%), and none of the patient outcomes were verified. Therefore, it was considered an LOE 4 study of poor quality.


**Reviewer's Comment:** This non-randomized study compared PAD sites to non-PAD sites. The sample size of cardiac arrests was small with 7 in the PAD group and 13 in the control group. All survivors were in the control group. There were no major adverse events reported. This study was considered LOE 2 because of the control group but of poor quality because of the small sample size which lead to the outcome being time to defibrillation.


**Reviewer's Comment:** This is a case study of an inappropriate shock delivered by an AED. There is no outcome data provided for the patient and limited information regarding the incident.


**Reviewer's Comment:** This is a descriptive study that describes the PAD program initiated by Qantas Airlines for both its terminal and it large aircraft. The description is complete, although not a formal evaluation; therefore, it was rated as fair quality. They did obtain long term (2 year) patient outcomes.


**Reviewer's Comment:** This is a case series of patients treated on a commercial airline with an AED (LOE 4). The patients are followed to hospital discharge and neurologic
outcome is measured. The records appear to be complete with the exception of some lost downloads, and all rhythms were analyzed by two specialists (quality good).


**Reviewer's Comment:** LOE 1, good study, outcome is adverse events or E. This studied shows that during the PAD trial there were limited adverse events. Six additional references were identified in this article.


**Reviewer's Comment:** This is a mathematical modeling study that used actual patient data when no AED was available and then predicted how a PAD program could have improved survival, therefore it is LOE 5. The quality is fair because they were not able to determine type of location for all patients and the survival endpoint was not defined. An endpoint of E was used since the survival variable was not defined. While the authors conclude that the increase in survival may not be cost effective, they did show an improvement in survival. Therefore, it is being considered supporting evidence for PAD programs. Letters to the editor were reviewed as well, no new references identified.


**Reviewer’s Comment:** This meta-analysis included studies by Kellerman and van Alem which looked at first responder AED use and Hallstrom which look at layprovider AED use. This worksheet is looking at AED use compared to EMS response. First responder AED use is part of EMS response and thus these papers are actually comparing two different issues and for the purposes of this worksheet should not have been combined. Therefore, this does not provide any additional evidence for PAD programs beyond the contribution of the Hallstrom article.(2000)


**Reviewer’s Comment:** This case series (LOE4) was designed to evaluate survival to hospital discharge, therefore it was rated as a good quality study. It illustrates that security guards in public settings can use AEDs with positive outcomes.

**Reviewer’s Comment:** This paper was not included in the evidence grid since it presents the same data as Davies, 2005 and does not ask a different question. Therefore including it would be to double count this study.

**Articles reviewed but not used as Evidence**


**Reviewer’s Comment:** This is a policy statement from the American College of Emergency Physicians on PAD. There is no research presented and there were no references provided.


**Reviewer’s Comments:** This article is a consumer review of various brands of automatic defibrillators. No new references were identified.


**Reviewer’s Comment:** This study did not directly answer the worksheet question but it did show that a 2 hour CPR and AED course was enough to allow lay-responders to retain the training for one year.


**Abstract:** None available

**Reviewer’s Comment:** Review article. Two additional references identified.


**Reviewer’s Comment:** This study determined the rate of AED placement within a community. While it is relevant to the worksheet question it does not directly answer the question.


**Reviewer’s Comment:** This paper is relevant to the worksheet question but does not directly answer the question. Organizers of PAD programs should consider the incidence of cardiac arrest in a given location prior to starting a PAD program.

**Reviewer’s Comment:** This study evaluated the length of training needed to teach a lay responder to use an AED, this is relevant to this worksheet but does not address the worksheet question. One new reference was identified.


**Reviewer’s Comment:** This is a review article. No new research is reported and no new references were identified.


**Reviewer’s Comments:** This paper does not directly answer the worksheet question. However, the results of this trial (clinical trial number ISRCTN 07286796) are represented on this worksheet with the work by Moore.


**Reviewer’s Comment:** This article looked at different training schemes. It does not address the worksheet question.


**Reviewer’s Comment:** This article did not look at the worksheet question. However, it showed that AED skills could be retained for up to a year.


**Reviewer’s Comment:** This is a review article. Two new articles were identified.

Reviewer’s Comment: This paper discussed designing an incident report form for use when a PAD was used. It is not a research article.


Reviewer’s Comment: This is a letter that describes the location of cardiac arrests within a single community and discusses AED placement. It is related to the worksheet question but does not directly address the question.


Reviewer’s Comment: This is a position paper from Heart and Stroke Canada. No new references were identified.


Reviewer’s Comment: This article demonstrates that PAD is likely cost effective in high incidence locations.


Reviewer’s Comment: This study provides a mathematical model for the number of defibrillators needed to cover a stadium. It is related to AED placement but does not directly address the worksheet question.


Reviewer’s Comment: Does not directly relate to the worksheet question but shows that lay persons in community settings can be trained to use AED’s, they are enthusiastic about being trained, and most could still use the AED after one year. However, it was difficult to re-contact trainees and few completed the retraining sessions at one year.


Reviewer’s Comment: This is an interim report on a PAD trial be established in England. There are no results in this paper and no new references were identified.

Reviewer's Comment: This paper looked at psychological effects of responding, which is relevant but not the focus of this worksheet. Two additional references were identified.


Reviewer's Comments: This Case series discusses the presence of AED’s but combines those that were used by EMS and those used by Athletic Trainers.


Reviewer's Comment: This study is relevant to the worksheet question but does not answer the worksheet question. When considering PAD programs it is important to understand the potential impact this will have on the population. That is are these expensive devices likely to be used.


Reviewer's Comment: This study looked at the locations of local cardiac arrests for the purpose of resource placement. It is relevant to the worksheet question but does not directly address the question.


Reviewer’s Comment: This epidemiologic study did not consider PAD.


Reviewer’s Comment: This paper describes a public campaign to increase the number of PAD programs across Austria this is relevant but not directly related to this worksheet. Two additional references were identified.


Reviewer’s Comment: Relevant to the worksheet but does not directly address the worksheet question.

**Reviewer’s Comment:** This paper describes use of PAD in hospital out-patient settings. It does not directly answer the worksheet question because it does not address survival but does address location of arrests. Two additional references were identified in this article.


**Reviewer’s Comment:** This is a review paper on cost effectiveness. No new references were identified.


**Reviewer’s Comment:** This study is not directly related to the worksheet question but it illustrates that airline PAD programs are cost effective.


**Reviewer’s Comment:** This paper illustrates an unsuccessful police AED program. It does not address PAD response since it is within the EMS system.


**Reviewer’s Comment:** This paper evaluates police providers’ attitudes toward participating in an AED program. It is relevant to this worksheet but does not directly apply to the question.


**Reviewer’s Comment:** Does not address the worksheet question. However, shows that the presence of an AED does not increase the likelihood of volunteer response.

Reviewer’s Comment: Does not address the worksheet question.


Reviewer’s Comment: Review article. No new references identified.


Reviewer’s Comment: A sub-analysis of the PAD trial that does not directly answer the worksheet question but does evaluate the quality of CPR provided by lay-volunteer responders in a PAD program.


Reviewer’s Comment: This paper does not directly relate to the study question. However, it shows that AED function may be affected by the presence of electromagnetic interference. It may need to be considered when establishing PAD programs near these areas.


Reviewer’s Comment: This paper is not relevant to the worksheet question.


Reviewer’s Comment: This article demonstrated no improvement in survival when AED’s are given to fire fighter first responders. This article was not considered to apply to the worksheet question since fire fighter response is part of the EMS system and not truly a PAD program. However, it is an early indication that lay-providers can successfully use AED’s.

**Reviewer’s Comment:** This article is relevant to the worksheet but it describes survival rates when AED’s are used by EMS personnel. Therefore, it was not included as evidence.


**Reviewer’s Comment:** This study is relevant but does not directly answer the worksheet question.


**Reviewer’s Comment:** This is a review article. No new references were identified.


**Reviewer’s Comment:** This article demonstrated no improvement in survival when AED’s are given to lay and police first responders who are paged to cardiac arrest related requests for emergency aid. This article was not considered to apply to the worksheet question since in this case the lay and police responders were part of the formal EMS system. However, the study indicates that lay-providers can successfully use AED’s.


**Reviewer’s Comment:** This article demonstrates improved survival when AED’s are given to police. This article was not considered to apply to the worksheet question since police response is part of the EMS system and not truly a PAD program. However, it is an early indication that lay-providers can successfully use AED’s.


**Reviewer’s Comment:** This paper is relevant to the worksheet question but does not directly answer the question. Organizers of PAD programs should consider the incidence of cardiac arrest in a given location prior to starting a PAD program.

Reviewer’s Comment: This article demonstrates improved survival when AED’s are given to police. This article was not considered to apply to the worksheet question since police response is part of the EMS system and not truly a PAD program. However, it is an early indication that lay-providers can successfully use AED’s.


Reviewer’s Comment: This study looked at whether community based AED’s had been registered with the local EMS agency. While it does not directly answer the worksheet question it illustrates that these AED’s are not being integrated with the EMS system as is recommended.


Reviewer’s Comment: AHA proceedings article that describes the 4 levels of PAD. This review will focus on levels 2, 3, and 4.


Reviewer’s Comment: This was a cost analysis.


Reviewer’s Comment: This article demonstrates that PAD is likely cost effective.


Reviewer’s Comment: This is a review article. No new references were identified.


Reviewer’s comment: This is a methods paper on the PAD trial which is included in the evidence grid with the article by Hallsstrom.

Reviewer's Comment: This is a review article on the cost-effectiveness of a PAD trial. No new articles identified.


Reviewer's Comment: This article is a review of the PAD trial it does not report any new analyses but summarizes the study’s findings. This data is already captured by the Hallstrom article.


Reviewer’s Comment: This paper analyzes data from the PAD trial to determine if social marketing can improve cardiac arrest response. It is related to the worksheet question but does not address the effectiveness of PAD programs for survival.


Reviewer’s Comment: This paper analyzes data from the PAD trial to determine barriers to implementing PAD. It is related to the worksheet question but does not address the effectiveness of PAD programs for survival.


Reviewer’s Comment: This is a review article on training to use an AED.


Reviewer’s Comment: This is a sub-analysis of the PAD trial looking at skill retention by providers. It is relevant but does not directly answer the worksheet question.


Reviewer’s Comments: This study looked at stress levels and other issues related to responding to a cardiac arrest for bystanders. It does not directly address the worksheet question but does provide information on the effect of responding on by-standers.

Reviewer’s Comments: A sub-study of the PAD trial looking at skill retention among volunteers. Does not answer the worksheet question but is relevant.


Reviewer’s Comments: This article is relevant to the worksheet question, however because it does not address response outside the EMS system it is not considered evidence in the evaluation. Further, it does not compare outcomes and only services to illustrate that a police AED program is feasible.


Reviewer’s Comment: This was a sub-analysis of the PAD trial, looking at the effect of changing definitions on the study outcome. It was not included as evidence since it is already represented by the Hallstrom paper.

Sternbach, G., J. Varon, et al. (2003). "Defibrillation." Critical Care & Shock 6: 50-54. Abstract: None available. Reviewer’s Comment: This is a position paper from Heart and Stroke Canada. Two new references were identified.


Reviewer’s Comment: Not relevant to the worksheet question.


Reviewer’s Comments: This article is relevant to the question but does not address PAD use outside of the EMS system.


Reviewer’s Comment: This article is relevant to the worksheet question, however because it does not address response outside the EMS system it is not considered evidence in the evaluation. It examines AED use by ambulance service personnel at a mass gathering event.

**Reviewer’s Comment:** This article demonstrates improved survival when AED’s are given to firefighters. This article was not considered to apply to the worksheet question since firefighter response is part of the EMS system and not truly a PAD program. However, it is an early indication that lay-providers can successfully use AED’s.


**Abstract:** None available

**Reviewer’s Comments:** Review article.


**Reviewer’s Comment:** This paper describes the proceedings from a panel discussion. No new references identified.


**Reviewer’s Comment:** This is a case series looking at a police AED program. It is relevant to the question but does not address PAD use outside of the EMS system.


**Reviewer’s Comment:** This is a review article. No new references were identified.


**Reviewer’s Comment:** This is a review article. No new research is reported and no new references were identified.