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<th>Worksheet author(s)</th>
<th>Date Submitted for review:</th>
<th>Resubmitted 1/31/10</th>
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<td>Douglas F. Kupas, MD</td>
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**Clinical question.**
In adult and pediatric patients with cardiac arrest (out-of-hospital and in-hospital) and receiving chest compression only CPR (P), does the addition of any passive ventilation technique (eg positioning the body, opening the airway, passive oxygen administration) (I) as opposed to no addition (C), improve outcome (O) (eg. ROSC, survival)?

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

**State if this is a proposed new topic or revision of existing worksheet:** New topic

**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).**
OVID (Medline and Cochrane Library) and Embase
- [MeSH. Heart Arrest AND Cardiopulmonary Resuscitation (methods)]
- [tw. cardiac only OR compression only OR compressions only OR hands only]
AHA Endnote Master Library
- [compression only OR compressions only]
Manual search of additional references in articles identified by above.

**State inclusion and exclusion criteria**
Includes: Human and animal, Adult and children.
Excludes: Case reports, Review articles, Mannequin simulations.

**Number of articles/sources meeting criteria for further review:**
27 articles included outcomes related to compression only CPR and met criteria for further review. These were included in the citation list, but only 4 of these articles described any passive ventilation or airway technique.
## Summary of evidence

### Evidence Supporting Clinical Question

| Good | | | | | |
|------|---|---|---|---|
| Fair | | | | |
| Poor | | | | |
| 1 | 2 | 3 | 4 | 5 |

**Level of evidence**

- A = Return of spontaneous circulation
- B = Survival of event
- C = Survival to hospital discharge
- D = Intact neurological survival
- E = Other endpoint
- *Italics* = Animal studies
### Evidence Neutral to Clinical Question

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<td>Poor</td>
<td>Bobrow, 2009 D</td>
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**Level of evidence**

A = Return of spontaneous circulation  
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*Italics = Animal studies*

### Evidence Opposing Clinical Question

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

While there are many studies that describe outcomes with compression-only CPR (including animal, prospective observational, randomized dispatcher instructed CPR, and retrospective studies), these studies infrequently address additional techniques to improve ventilation or oxygenation.

Techniques that are advanced, for example transtracheal oxygenation or airway maintenance with an extra-tracheal airway adjunct, may not offer any advantage over endotracheal intubation and ventilation, and these more complex techniques carry a higher rate of complication. One study using rats (LOE 5, Ayoub 2005,1663) described survival with transtracheal oxygenation as equivalent to that with endotracheal intubation, and both were better than the survival with mask oxygenation in this small study. Transtracheal oxygenation during CPR is an invasive intervention that is beyond the “passive ventilation” techniques related to the query of this worksheet.

The only studies (Bobrow 2009,656; Bobrow 2008,1158; Kellum 2008,244; and Kellum 2006,335) that identify a passive ventilation/ airway technique all used the same protocol that includes the insertion of an oral airway and the administration of oxygen by non-rebreather mask. These studies all used the same protocol for minimally interrupted chest compressions rather than pure compression-only CPR because they permitted paramedics to choose, in a nonrandomized way, whether the patient would receive some interposed ventilations versus passive insufflation of oxygen during the continuous chest compressions. These studies by Kellum do not identify the compliance with providing these additional interventions, but these interventions are associated with almost no complications. Additionally, these compression-only studies that included these interventions showed a significant improvement in discharge with good neurologic outcome.

Acknowledgements:
Thanks to Claire Huntington for her assistance with the literature search and to Rebecca Plisiewicz, PA-C for her assistance in organizing this worksheet.

Citation List


   LOE 5 – Excluded, transtracheal oxygen provided in rats, but no comparison to other ventilation/ oxygenation .
   Rat study comparing three oxygen delivery methods (transtracheal oxygen, oxygen via endotracheal tube, and oxygen via passive mask). Five rats in each intervention group.
   Outcomes of PaO2 (significantly higher with TTO and endotracheal than with mask) and survival after resuscitation (no survival with mask oxygen, all survived with TTO and endotracheal oxygen).
   The only passive intervention was mask oxygen. This group did poorly, but this is not applicable to human CPR and there was no control that got no passive intervention.
   Not applicable.


   LOE 5 Excluded, no specific passive airway technique studied.
   Prospective randomized study of piglets after induction of cardiac arrest secondary to asphyxia by comparing 4 combinations of compressions and/or ventilation (control with no intervention, chest compressions only after removal of endotracheal tube without additional passive techniques, ventilation only via endotracheal tube with gas concentrations similar to mouth-to-mouth, and compressions with ventilations via endotracheal tube with gas concentrations similar to mouth-to-mouth).
   Outcomes included survival, neurologic outcome, arterial oxygenation, and pH.
   No applicable.
(3) Berg RA, Hilwig RW, Kern KB, Ewy GA. "Bystander" chest compressions and assisted ventilation independently improve outcome from piglet asphyxial pulseless "cardiac arrest". Circulation 2000 Apr 11;101(14):1743-1748

\textit{LOE 5 – Excluded, no specific passive airway technique studied.}

\textit{Piglet study of asphyxial cardiac arrest comparing various types combinations of compressions and ventilations (compressions/ventilation, compression only CPR with endotracheal tube removed and no other passive airway techniques, ventilations only via ETT, and control with no intervention). Outcomes of survival, neurologic survival, and ROSC. Not applicable.}


\textit{LOE 5 – Excluded, no specific passive airway technique studied.}

\textit{Swine model of induced ventricular fibrillation comparing various combinations of compressions and ventilations (compressions/ ventilations, ventilation only via ETT, chest compressions only after removal of ETT, and control with no interventions). Outcomes of survival and neurologic outcome. Not applicable.}


\textit{LOE 5 – Excluded, no specific passive airway technique studied.}

\textit{Swine model of induced ventricular fibrillation and bystander CPR comparing various combinations of compressions and ventilations (compressions/ ventilations, ventilations only via ETT, compressions only after removal of ETT, and control with no interventions). Outcomes were survival and neurologic outcome. Not applicable.}


\textit{LOE 5 – Excluded, no specific passive airway technique studied.}

\textit{Swine model of induced ventricular fibrillation comparing compressions/ ventilation, compressions only with endotracheal tube removed, and no CPR. Following study interventions, resuscitation was attempted. Outcome was survival and neurologic outcome, and swine receiving compressions with ventilation and compressions only CPR had equally good survival. Not applicable.}


\textit{LOE 3 – neutral – poor}

\textit{Retrospective analysis of OOH CA data from multiple EMS services in a single state. Minimally interrupted CPR done by EMS providers with either passive oxygenation by oropharyngeal airway and oxygen by nonrebreather mask without ventilation versus interposed ventilations with bag-valve-mask. Not randomized. Airway/ventilation intervention determined by chart review. Overall no difference in odds of neurologically intact survival, but subgroup of witnessed ventricular fibrillation cardiac arrest had improved outcome with passive oxygen insufflation and subgroup of nonshockable rhythms trended toward better outcome with some interposed ventilation with bag-valve-mask.}

LOE 5 - Neutral - Poor [oropharyngeal airway and high-flow oxygen via nonrebreather mask]
Prospective study that compared CPR using 2000 AHA guidelines with minimally interrupted cardiac resuscitation (200 compressions- shock- 200 compressions, early epinephrine, and delayed endotracheal intubation). During early CPR for intervention group, training encouraged "passive ventilation" by the insertion of oral-pharyngeal airway and high-flow oxygen by nonrebreather mask. Although there was a protocol compliance analysis to assure that the patients in the intervention group received the intervention, there was no description of the number of intervention patients that actually received the passive ventilation.
Outcome was survival to discharge. Using Utstein style, the overall cardiac arrest survival was 3.8% preintervention vs 9.1% postintervention. For witnessed ventricular fibrillation patients, the survival was 11.9% preintervention vs 28.4% postintervention.


LOE 5 – Excluded, no specific passive airway technique studied in chest compression only group..
Review of large Swedish cardiac arrest registry collected over a period of 15 years comparing traditional compression/ ventilation CPR with compression only CPR. Only 10% of study patients had compression only CPR. Outcome was survival at 1 month.
EMS personnel observations of bystander care used for the study, and the study did not report data on specific passive airway techniques in patients receiving the compression only CPR.
Not applicable.


LOE 5 – Excluded, all study animals received transtracheal oxygen which is invasive and not considered to be a passive airway technique.
Canine study of induced ventricular fibrillation that compared transtracheal oxygenation during chest compressions in animals in VF and NSR.
Outcomes were related to analysis of PaCO2, coronary perfusion pressure and other measurements, and 7/9 were eventually defibrillated after 15 min of transtracheal oxytenation.
All animals got transtracheal oxygenation, and there was no comparision with chest compressions without the transtracheal oxygen intervention. Animals receiving transtracheal oxygen had their mouths held open with bite blocks during study.
Although this is supportive of oxygenation with transtracheal oxygen during chest compressions, there is no comparision with control and transtracheal oxygen would not be considered a passive airway technique.
Not applicable.


LOE 5 – Excluded, no specific results provided for various airway techniques, and no passive airway techniques studied.
CC only CPR was done on 17 adult patients with out-of-hospital cardiac arrest after arrival to the emergency department using a mechanical CPR device. CC only CPR generated ventilation with a mean tidal volume of 41.5 mL. These patients had prolonged cardiac arrests prior to the study. Most patients had endotracheal intubation prior to study, but some also had placement of LMA or no airway. The study does not report tidal volumes during compressions only CPR separated by these airway techniques – and the techniques listed in this study are not passive techniques.

LOE 5 – Excluded, no specific passive airway technique studied.
Swine cardiac arrest model comparing compression only CPR with traditional CPR in simulated airway obstruction. Airway obstruction simulated by impedance valve blocking passive inspiration during compression only CPR. Swine receiving traditional CPR with interposed ventilation had ROSC sooner. Obstruction of passive inhalation during compression only CPR was detrimental to time to ROSC, but the study did not compare any airway techniques that were meant to improve the patency of the airway and the endotracheal tube was not removed during the compression only CPR.
Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied.
Swine model of VF comparing 30:2 CPR with continuous chest compressions, The results support continuous chest compressions in this model with 70% 24-hour neurologic survival vs 42%, but there is no mention of removal of the endotracheal tube at the time of compression only CPR. Although there was no comparison of passive airway techniques in this study, the animals that received compression only CPR appear to have had an endotracheal tube in place, possibly maintaining better airway patency than no intervention.
Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied.
Swine model of lung ventilation during chest compressions only. The volume of ventilation with only chest compressions does not exceed dead space and is postulated to be insufficient to ventilate the lungs. There is no comparison of whether the ventilation with chest compression only CPR could be improved with various passive airway techniques.
Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied.
OOH cardiac arrest study comparison of randomized dispatcher instructions for traditional CPR vs compression only CPR. Outcome was survival to hospital discharge. Although not statistically significant, the survival rate with chest compression only CPR was better than traditional CPR (14.6% vs 10.4%). The dispatcher scripts/protocols for compression only CPR did not mention any passive airway techniques as part of the procedure. Although this study supports the equivalence in survival using compression only CPR when delivered by bystanders taking telephone direction from dispatchers, the study does not evaluate the use of any passive airway technique during compression only CPR. The study does reveal that compression only CPR without any airway maneuvers leads to at least equivalent outcome to traditional CPR.
Not applicable.

LOE 5 – Excluded, no specific passive airway technique studied. Randomized prospective study of dispatcher CPR instructions comparing instructions for compression only CPR vs traditional CPR. When chest compression only CPR given, there was no specific mention of use of any airway technique, and the article does not provide the dispatcher protocol for review. Outcome was survival to discharge from the hospital. The results of this study support that compression only CPR without any attention to airway maneuvers is at least equivalent to traditional CPR, but does not further compare any specific airway techniques. Not applicable..


LOE 5 – Excluded, Endotracheal tube used in all animals to maintain patent airway, no specific passive airway technique studied. Swine model of induced ventricular fibrillation cardiac arrest comparing traditional compression/ventilation CPR with chest compressions only. Outcome was ROSC, arterial and mixed venous oxygenation, hemodynamic and ventilatory results. There were differences between ROSC and physiologic parameters measured by blood gases that favored the animals that received ventilation. The animals that had compression only CPR had an endotracheal tube in place that maintained a patent airway. There was no comparison of passive airway techniques in animals receiving compression only CPR. Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied. Prospective observation study of compression only vs compression/ventilation bystander CPR. The article does not list any passive airway techniques that were collected as data. After the bystanders were relieved by this Japanese EMS system, the EMS providers could use AED, insert IV, and insert adjunct airway, but they could not do any ACLS drugs or endotracheal intubation. Outcome was one-year survival. Not applicable.


LOE 5 - Neutral - Poor [oropharyngeal airway and oxygen by non-rebreather mask] OOH cardiac arrest study in a two county EMS system. Comparison of a 3-year period after changing protocols to compression only CPR with a similar time period preceding the protocol change when traditional compression/ventilation CPR was provided by EMS providers. During the study periods there was 39% survival with good neurologic outcome with compression only CPR vs 15% pre-study in the prestudy period. Patients in the compression only segment of the study could receive oxygen by non-rebreather mask and insertion of an oropharyngeal airway if a second rescuer was present. If a non-shockable rhythm was found, an advanced airway could be placed and ventilations would commence. The article does not specify how many of these patients had an oropharyngeal airway inserted or had NRB oxygen. The article also does not specify whether some patients with shockable rhythms had advanced airways placed and/or ventilations performed in contradiction to the protocol.


LOE 5 - Neutral - Poor [oropharyngeal airway and oxygen by non-rebreather mask]
Comparison of traditional compression/ ventilation CPR results and compression only CPR results over a 3 year period pre- and post- change in local protocol with 39% neurologic survival vs 15% neurologic survival pre-study.

If a second rescuer was available, an oropharyngeal airway could be inserted and oxygen could be administered by nonrebreather mask, but the article does not specify how many individuals received these interventions or how many even may have received ventilations during the resuscitation.

This study is similar to the Kellum (2008) study published in Ann Emerg Med, and the compression only group is the same.


LOE 5 – Excluded, no comparison of any specific passive airway technique studied.

Swine model of induced ventricular fibrillation cardiac arrest comparing standard compression/ventilation CPR with compression only CPR with an occluded endotracheal tube. As opposed to evaluating a technique to provide an airway intervention to increase lung ventilation during compression only CPR, this study purposefully occluded the airway. There was no difference after 6 minutes of CPR between the 100 % survival with traditional CPR and the 90% survival with compressions only CPR with 10 swine in each group.

Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied.

Retrospective observational study using observations of EMS personnel on scene to compare standard CPR with chest compression only CPR. Of note, a simultaneous study that randomized ALS medications to the patients who were also in this study was being done concurrently and some patients were in both of these studies.

Outcome of discharged alive was not statistically different between the two groups.

There is no mention of any collection of data regarding any passive airway techniques used.

Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied.

Retrospective review of patients in cardiac arrest to compare results of traditional CPR vs chest compression only CPR. No difference in survival, but no specific analysis of any airway techniques used in patients that received compression-only CPR.

Not applicable.


LOE Not Applicable – Excluded, Review article

Although a review article, this has been included in worksheet citations because the author cites several references related to positional airway obstruction and postulates reasons for recommending turning the head to the side during bystander CPR. The author's recommendation related to considering head rotation as a means of assuring a patent airway is speculative based upon variably related literature.

Included in citation list for completeness, but this study actually meets exclusion criteria as a review article.


LOE 5 – Excluded, no specific passive airway technique studied.
Prospective, multi-center, observational study of CPR by bystanders using chest compression only vs. traditional compression/ventilation CPR, but no mention of passive airway techniques. Not indicated.


LOE 5 Excluded, no specific passive airway technique studied. Retrospective study comparing cardiac arrest patients with bystander CPR that was determined to be correct (traditional CPR) and incorrect with compressions only or mouth-to-mouth ventilation only. There was no comparison of specific airway techniques used during compression only CPR. Not applicable.


LOE 5 – Excluded, no specific passive airway technique studied. Prospective collection of bystander CPR performance data. Chest compression only CPR is one of the data points included, but there is no reporting of any passive airway techniques used in this group. Not applicable.