American Red Cross
Scientific Advisory Council
Scientific Review
Compression Only CPR

Questions to be addressed:

For adult patients, in non-traumatic cardiopulmonary arrest, when managed by lay responders or trained healthcare providers, does continuous cardiac compressions (CCC) or hands only CPR, without expired air ventilation, improve outcomes?

Introduction/Overview:

Achieving a favorable outcome for a patient in cardiopulmonary arrest, defined as discharge from a hospital with minimal to no neurological deficits, is highly dependent on early cardiopulmonary resuscitation. However, despite that this fact has been well known for some time, engagement of bystanders to perform CPR has not been robust. In an effort to bridge this gap, community leaders have encouraged the lay public to perform compression only CPR without ventilations. It is thought that since compression only CPR is easier to learn and doesn't carry the perceived risks of infectious contamination, the public will be more willing to perform compression only CPR compared to traditional CPR with ventilations. Yet, outcome literature on compression only CPR is variable with some studies showing favorable results and others showing equivocal or worse results. Therefore, the purpose of this scientific review is to examine the outcomes of continuous chest compression CPR without pauses for ventilations compared to traditional CPR with pauses for ventilations. This review focuses on both the patient and the rescuer. Regarding the patient, the primary outcomes of interest are survival to discharge and survival to discharge neurologically intact. The outcome of interest regarding the rescuer is willingness to perform CPR on a stranger.

Search Strategy and Literature Search Performed

Key Words Used

"chest compression CPR" OR "chest compression cardiopulmonary resuscitation" or "compression only-CPR" OR "compression-only CPR" OR "compression only-CPR" OR "compression-only CPR" OR "compression-only Cardiopulmonary Resuscitation" or "CARDIC CHEST COMPRESSION*" or "continuous cardiac compressions"
OR
Search "hands only CPR" OR (hands only cardiopulmonary resuscitation) OR (hands-only cardiopulmonary resuscitation) OR "hands-only CPR" OR "hands-only cardiopulmonary resuscitation"

Inclusion Criteria (time period, type of articles and journals, language, methodology)

- Dates of search: Jan 2005 – April 2016

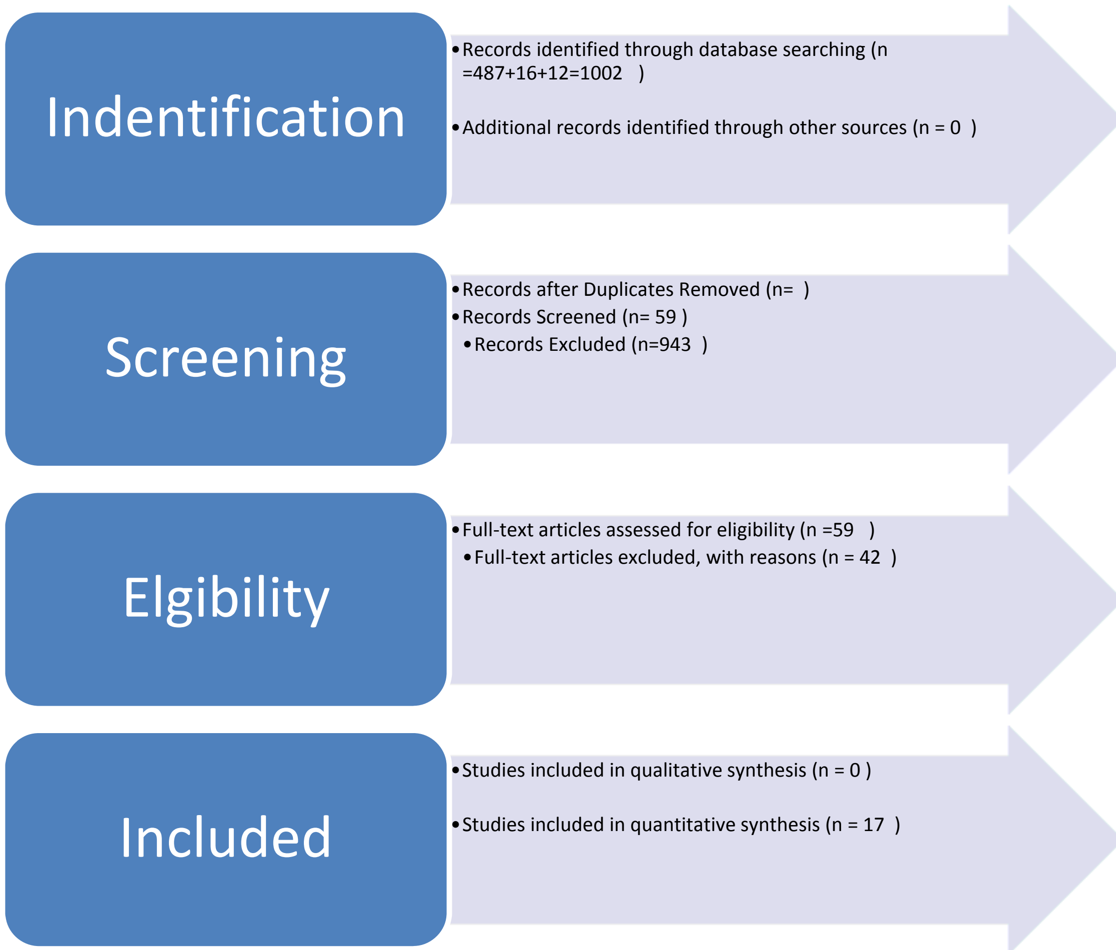
- Article address the study question
- Studies CPR performance by lay responders
- Non-traumatic cardiopulmonary arrest
- Human studies; Animal studies - to assess ROSC
- Manikin studies - to assess CPR fraction
- Article contains quantitative or qualitative data that can be analyzed
- Compares CCC to traditional CPR (edit made on 10/23/15)
- All languages - final review must be able to acquire an English language translation
- Full article review

Exclusion Criteria (only human studies, foreign language, etc…)

- Letters
- Editorials
- Position statements
- Review articles
- Abstracts that did not reach the level of full article publication

Databases Searched and Additional Methods Used (references of articles, texts, contact with authors, etc...)

- PubMed
- CINAHL



Scientific Foundation:

Outcomes of continuous compression CPR compared to traditional CPR have been studied since the 1990s. Early animal studies by Berg et al and Kern et al published in the late 90s tended to favor CPR with pauses for ventilations. However, latter animal studies, including a study by Kern at all published in 2002, demonstrated improvement with continuous compression CPR. Notably Kern demonstrated improved neurological outcomes, as tested by a standardized method to assess neurological status for swine, with 3 of 15 swine in the traditional CPR group having favorable neurological outcome compared to 12 of 15 swine in the continuous compression group having a favorable outcomes. In aggregate, animal studies that have compared continuous compression CPR to traditional CPR have shown improved results with continuous CPR. Further, the studies that have included an arm with no CPR have all shown that some method of CPR performs better than not doing any CPR.

Although the first two human studies showed equivocal results (Olasveengen 2008; and Ong 2008), the study by Bobrow et al (2010) caught the attention of the healthcare community and the lay press by demonstrating that a community wide effort focused on compression only CPR has the potential to positively affect outcomes. Bobrow et al implemented a large-scale community wide educational program on compression only CPR, known as the SHARE program. Connected to the SHARE initiative, they created a cardiac arrest database and entered cases into the database when bystanders where involved. Bystanders where able to choose the method of performing CPR and EMS providers recorded results. Through a retrospective review of the SHARE database the authors showed that compression only CPR improved outcomes of survival and discharge neurologically intact compared to CPR with ventilations.

With mounting pressure to implement compression only CPR programs after the Bobrow study, researchers in Japan studied their national cardiac arrest database demonstrating higher survivao rates with traditional CPR with ventilations. When looking at all of the human studies comparing compression only CPR to traditional CPR with ventilations, compression only CPR does not demonstrate improvement in survival to discharge or neurologically intact survival compared to traditional CPR with ventilations. Most notably, the only study that has collected prospective data published by Nichol et al from the resuscitation outcomes consortium demonstrated no difference between the two techniques with regards to survival or discharge neurologically intact.

While compression only CPR has not been shown to improve patient oriented outcomes, the technique does have potential for engaging the public to act. A series of survey studies by Blewer et al, Cho et al, Lu et al, and Cheeks et al have all shown that the lay public is more willing to perform CPR on a stranger using compression only CPR than traditional CPR with pauses for ventilations. Yet, these survey studies have examined the theoretical attitudes of lay public rescuers in performing CPR on a stranger, and do not provide data on actual cases of patients in cardiac arrest.

Taken in aggregate, the science of compression only CPR compared to traditional CPR with pauses for ventilations shows equivocal results in patient oriented outcomes between the two techniques, if not better results with traditional CPR. This is balanced by the literature showing that the lay public is more willing to perform compression only CPR on a stranger than CPR with pauses for ventilations.

Recommendations and Strength:

Standards:

- Perform chest compressions on adult patients with out-of-hospital cardiopulmonary arrest

Guidelines:

- When feasible, CPR should be performed with ventilations in a compression to ventilation ratio of 30:2

Options:

- Chest compression only CPR may be taught as an alternative to CPR with compressions and ventilation and should be performed when compared to no CPR for patients in cardiopulmonary arrest

Knowledge Gaps and Future Research:

This scientific review identifies that when possible CPR should be performed with intermittent ventilations, but also shows a disassociation in that the lay public is more willing to perform compression only CPR. The results of this review suggest that the untrained lay public should be encouraged to perform compression only CPR, but individuals in the lay public that are motivated to be more fully trained and professional healthcare providers should perform CPR with ventilations.

What is not known is the relationship between compression only CPR as performed by untrained bystanders and the care provided by EMS providers. We also do not know if lives are actually saved through the integration of these trainings. Finally, we know that the attitudes of bystanders favor compression only CPR, but we don't know rates of the public actually engaging in CPR by compression only vs. compression with ventilation CPR

Implications for ARC Programs:

ARC programs should focus on training that meets the individual needs and attitudes of the learner. A one size fits all approach will only push out those that are not interested in performing ventilations. Rather, we should encourage and train the lay public to perform the skills that they will ultimately feel comfortable performing with the philosophy that something is better than nothing.

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Summary of Key Articles/Literature Found and Level of Evidence/Bibliography:

Return of Spontaneous Circulation (ROSC)/24 hour survival/Good Neurological Outcome – Animal Studies

Full Citation	Summary of Article	Methodology	Key results and magnitude of results	Favors
Berg, et al. Assisted ventilation does not improve outcome in a porcine model of single rescuer bystander cardiopulmonary resuscitation. Circulation. 1997; 95: 1635-41.	Swine randomized to chest compression + ventilation (CC+V); CC Only; or No CPR	Prospective randomized controlled trial	ROSC CCV = 9/10 = 90% CCC = 10/10 = 100% No = 4/6 = 66.7% 24 hour survival CCV = 6/10 = 60% CCC = 5/10 = 50%	ROSC CCV Survival CCC
Berg, et al. Assisted ventilation during bystander CPR in a swine acute myocardial infarction model does not improve outcome. Circulation. 1997; 96: 4364-71.	Swine randomized to CC+V; CC only or No CPR. Prior to induction of VFib the LAD was obstructed with a cylinder.	Prospective randomized controlled trial	ROSC CCV = 8/15 = 53.3% CCC = 8/14 = 57.1% No = 9/14 = 64.3% 23 hour survival CCV = 3/15 = 20% CCC = 5/14 = 35.7% No = 1/14 = 7.1%	ROSC Survival CCC
Kern, et al. Efficacy of chest compression only BLS-CPR in the presence of an occluded airway. Resuscitation. 1998; 39:179-88.	Swine randomly assigned to standard CPR with ET tube for ventilation with 15:2 or compression only CPR with ET tube clamped	Prospective randomized controlled trial	24 hour survival CCV = 10/10 = 100% CCC = 9/10 = 90%	Survival CCV

Kern, et al. Importance of continuous chest compressions during cardiopulmonary resuscitation. Circulation 2002; 105: 645-49.	Swine randomized to standard CPR with 15:2 or compression only CPR	Prospective randomized controlled trial	ROSC CCV = 6/5 = 40% CCC = 13/15 = 86.7% Neuro intact at 24 hours CCV = 3/15 = 20% CCC = 12/15 = 80%	ROSC Neuro CCC
Ewy, et al. Improved neurological outcome with continuous chest compressions compared with 30:2 compressions to ventilations cardiopulmonary resuscitation in a realistic swine model of out-of-hospital cardiopulmonary arrest. Circulation. 2007; 116: 2525-30.	Swine randomized to continuous chest compression CPR or CPR with 30:2. Four groups with increasing duration of pause prior to initiating CPR: 3, 4, 5, 6 min	Prospective randomized controlled trial	Neuro intact survival CCV = 13/31 = 41.9% CCC = 23/33 = 69.7%	Neuro CCC
Ewy, et al. Continuous chest compression resuscitation in arrested swine with upper airway inspiratory obstruction. Resuscitation. 2010; 81: 585-90.	Swine randomized to 30:2; Continuous with unobstructed ET tube; or continuous with obstructed ET tube	Prospective randomized controlled trial	ROSC CCV = 8/10 = 80% CCC = 20/20 = 100% Neuro intact CCV = 8/10 = 80% CCC = 19/20 = 95%	ROSC Neuro CCC
Mader, et al. A randomized comparison of cardiocerebral and cardiopulmonary resuscitation using a swine model of prolonged ventricular fibrillation. Resuscitation. 2010; 81: 596-602.	Swine randomized to 30:2 with pauses for intubation or continuous chest compressions. Model for professional rescuer resuscitation.	Prospective randomized controlled trial	ROSC CCV = 8/26 = 30.8% CCC = 16/27 = 59.3% 20 minute survival CCV = 5/26 = 19.2% CCC = 11/27 = 40.7%	ROSC Survival CCC

Wang, et al. Effect of continuous compressions and 30:2 cardiopulmonary resuscitation on global ventilation/perfusion values during resuscitation of a porcine model. Crit Care Med. 2010; 38: 2024-30.	After 4 min of untreated VFib arrest swine randomized to 30:2 or continuous chest compressions	Prospective randomized controlled trial	ROSC CCV = 10/12 = 83.3% CCC = 10/12 = 83.3% 24 hour survival CCV = 8/10 = 80% CCC = 9/10 = 90%	ROSC No diff Survival CCC

Return of Spontaneous Circulation (ROSC)/24 hour survival/Good Neurological Outcome – Human Studies

Full Citation	Summary of Article	Methodology	Key results and magnitude of results	Favors
Olasveenven, et al. Standard basic life support vs. continuous chest compression only in out-of-hospital cardiac arrest. Acta Anesthesiol Scand. 2008; 52: 914-19.	Patients treated with bystander CPR, EMS providers assessed if patient received standard bystander CPR vs. compression only CPR. EMS providers then intubated and performed continuous chest compression with asynchronous ventilation at rate of 12/min. Outcomes studied. May 2003 – May 2006.	Retrospective observational study	Survival – discharge alive CCV = 35/182 = 12.5% CCC = 15/145 = 10.3% No = 23/269 = 8.6% P = 0.647 Neuro – discharge CPC 1 or 2 CCV = 31/281 = 11.0% CCC = 14/145 = 9.7% No = 23/269 = 8.6%	Survival No diff Neuro CCV
Ong, et al. Comparison of chest compression only and standard cardiopulmonary resuscitation for out-of-hospital cardiac arrest in Singapore. Resuscitation; 2008: 78: 119-126.	Comparison of patients in cardiac arrest by bystander CPR type – compression with ventilation, compression only or no CPR. Data collected by EMS provider from	Retrospective review of prospectively collected cardiac arrest registry data	ROSC CCV = 48/287 = 16.7% CCC = 27/154 = 17.5% P = 0.984 Survival – to Discharge CCV = 8/287 = 2.8% CCC = 4/154 = 2.6%	ROSC Survial No diff

	bystanders. Oct 2001 – Oct 2004.	from Singapore	P = 1.000	
Bobrow, et al. Chest compression only CPR by lay rescuers and survival from out-of-hospital cardiac arrest. JAMA. 2010; 304: 1447-54.	Comparison of patients in cardiac arrest by bystander CPR type – compression with ventilation, compression only or no CPR. Data collected by EMS provider from observation after specific training or from bystanders. Jan 2005 – Dec 2009	Retrospective review of prospectively collected data from the SHARE cardiac arrest registry database	Survival – to Discharge CCV = 52/666 = 7.7% CCC = 113/849 = 13.3% No = 150/2900 = 5.2% OR 1.60 (95% CI 1.08 – 2.35) Neuro – CPC 1 or 2 CCV = 34/666 = 5.1% CCC = 61/849 = 7.2% No = 86/2900 = 3.0% P < 0.001	Survival Neuro CCC
Iwami, et al. Dissemination of compression-only cardiopulmonary resuscitation and survival after out-of-hospital cardiac arrest. Circulation. 2015; 132: 415-22.	Study of impact of nation wide chest compression only CPR training. Assessed outcomes of three study groups OHCA – chest compression only, conventional with ventilation, or no bystander CPR. Jan 2005 – Dec 2012	Retrospective review of prospectively collected cardiac arrest registry data - Japan	ROSC CCV = 7982/100469 = 7.9% CCC = 15818/249970 = 6.3% No = 24163/465946 = 5.2% P < 0.001 Survival - 1 month CCV = 5717/100469 = 5.7% CCC = 10685/249970 = 4.3% No = 16636/465946 = 1.4% P < 0.001 Neuro – CPC 1 or 2 CCV = 2690/100469 = 2.7% CCC = 4846/249970 = 1.9% No = 5762/465946 = 1.2% P < 0.001	ROSC Survival Neuro CCV
Nichol, et al. Trial of continuous or interrupted chest compressions during CPR. NEJM. 2015; 373: 2203-14.	Patients randomized to EMS provider CPR by continuous with asynchronous ventilations or compressions with pause for ventilation. Percentage of patients	Randomized controlled trial	ROSC CCV = 2799/11051 = 25.3% CCC = 3058/12646 = 24.2% P = 0.07 Survival – to discharge CCV = 1072/11035 = 9.7%	ROSC Survival Neuro No diff

	receiving bystander controlled but not by the type of bystander CPR. June 2011 – May 2015.		CCC = 1129/12613 = 9.0% P = 0.07 Neuro – intact MRS < 4 CCV = 844/10995 = 7.7% CCC = 883/12560 = 7.0% P = 0.09	

Willingness to Perform CPR – Human Studies

Full Citation	Summary of Article	Methodology	Key results and magnitude of results	Favors
Cho, et al. The effect of basic life support education on laypersons willingness in performing bystander hands only cardiopulmonary resuscitation. Resuscitation. 2010; 81: 691-94.	Laypeople taking a CPR course. Before and after questionnaire regarding attitudes towards performing CPR	Prospectively collected before and after survey	Willing to perform CPR – stranger/no training CCV = 19% CCC = 30.1% OR 1.8 (95% CI) = 1.5 – 2.3) Willing to preform CPR – stranger/training CCV = 55.7% CCC = 71.9% OR 2.0 (95% CI 1.7 – 2.5) Willing to perform CPR – family/training CCV = 84.4% CCC = 86.9% OR 1.2 (95% CI 0.9 – 1.6)	Stranger CCC Family No diff
Blewer, et al. Continuous chest compression cardiopulmonary resuscitation training promotes rescuer self confidence and increased secondary training: A hospital-based randomized controlled trial. Crit Care Med. 2012; 40: 787-92.	Family members of hospitalized patients randomized to CPR training with chest compressions and ventilations or compression only CPR. Students surveyed regarding attitudes towards doing CPR and rates of sharing knowledge with others	Prospective randomized study with survey instrument	Willing to preform CPR – stranger/training CCV = 57/99 = 28% CCC = 71/207 = 34% P = 0.08 Likely to share training with others CCV = 139/199 = 67% CCC = 152/207 = 73% P = 0.03	Stranger No diff Share CCC
Cheskes, et al. Are Canadians more willing to provide chest-compression-only	Survey of random sample of Canadian citizens assessing	Prospectively collected data from	Willing to perform CPR – stranger/no training CCV = 38.8% CCC = 55.1%	Stranger CCC

cardiopulmonary resuscitation (CPR)? – a nationwide public survey. CJEM. 2015: 0: 1-11.	knowledge and willingness to perform CPR.	survey instrument	P < 0.001	
Lu, et al. An exploration of attitudes towards bystander cardiopulmonary resuscitation in university students in Tianjin, China: a survey. Int Emerg Nursing. 2015;	Convenience sample of university students. Survey of attitudes towards performing CPR with ventilations vs chest compression only CPR	Prospectively collected data from survey instrument	Willing to perform CPR – stranger/no training CCV = 32.7% CCC = 49.0% P < 0.05 Willing to perform CPR – family/ no training CCV > 0.05	Stranger CCC Family No diff

Level of Evidence	Definitions (See manuscript for full details)
Level 1a	**Experimental and Population based studies -** population based, randomized prospective studies or meta-analyses of multiple higher evidence studies with substantial effects
Level 1b	**Smaller Experimental and Epidemiological studies -** Large non-population based epidemiological studies or randomized prospective studies with smaller or less significant effects
Level 2a	**Prospective Observational Analytical** - Controlled, non-randomized, cohort studies
Level 2b	**Retrospective/Historical Observational Analytical** - non-randomized, cohort or case-control studies
Level 3a	**Large Descriptive studies** – Cross-section, Ecological, Case series, Case reports
Level 3b	**Small Descriptive studies** – Cross-section, Ecological, Case series, Case reports
Level 4	**Animal studies or mechanical model studies**
Level 5	**Peer-reviewed Articles** - state of the art articles, review articles, organizational statements or guidelines, editorials, or consensus statements
Level 6	**Non-peer reviewed published opinions -** such as textbook statements, official organizational publications, guidelines and policy statements which are not peer reviewed and consensus statements
Level 7	**Rational conjecture** (common sense); common practices accepted before evidence-based guidelines
Level 1-6E	**Extrapolations** from existing data collected for other purposes, theoretical analyses which is on-point with question being asked. Modifier E applied because extrapolated but ranked based on type of study.