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

Worksheet author(s)

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Clinical question.

"In adult and paediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the interruption of CPR to check circulation (I) as opposed to no interruption of CPR (C), improve outcome (O) (e.g. ROSC, survival)?"

Is this question addressing an intervention/therapy, prognosis or diagnosis? Intervention
State if this is a proposed new topic or revision of existing worksheet: Revision

Conflict of interest specific to this question

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?
None

Search strategy (including electronic databases searched).

Searches were limited to: articles in peer reviewed journals between the years 1966 and 2008, English language, with abstracts.
- ECC Master library Jul 6, 2008
- PubMed (NLM) (1966 – Oct 1st, 2009)
- Cochrane Library (2009) in all Cochrane Databases
- Embase (1988-2009)
- OvidSP "find similar" and "find citing" tools on search engine
- Scopus, Google Scholar
- References from key articles
- Related articles and forward to the same author publications search tools from PubMed

Query: "heart arrest" [MeSH Terms] OR "resuscitation" [MeSH Terms] AND "pulse check" [All Fields] AND "outcome" [All Fields]
Query: "pulse check" [All Fields] AND "cardiac arrest" [All Fields]
Query: "check circulation" [All Fields] OR "signs of circulation" [All Fields]
Query: "cardiocerebral resuscitation" [All Fields]
Query: "chest compression" [All Fields] AND "damage" [All Fields]

Each item in query was also checked sequentially for a broader review

Reference worksheets:
- W147A_Yu_Tang.doc ("Interruption of CPR to perform rhythm analysis or check for a pulse worsens survival in out-of-hospital sudden cardiac arrest)
- W147B_Wassertheil.doc ("What are the sensitivity, specificity and clinical impact of interruption of CPR to check circulation?)

- State inclusion and exclusion criteria

Inclusion: adult and paediatric populations, human and animal studies, metanalyses, manikins and surrogate mathematical models.

Exclusion: not English language, single case reports, reviews articles, guidelines and/or scientific societies position statements, editorials and letters.

155 articles excluded: not matching the specific query.

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

After title and abstracts review, 13 new articles met criteria for further review.
From the previous C2005 worksheets were added 16 studies, showed on the tables in grey.

Summary of evidence

Evidence Supporting Clinical Question

"In adult and paediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the interruption of CPR to check circulation (I) as opposed to no interruption of CPR (C), improve outcome (O) (e.g. ROSC, survival)?"

Good					
Fair					Mather 1996[E]
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

In Italic paper from animal model…
In blue paper already listed in the previous C2005 WS

Evidence Neutral to Clinical question

"In adult and paediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the interruption of CPR to check circulation (I) as opposed to no interruption of CPR (C), improve outcome (O) (e.g. ROSC, survival)?"

Good					
Fair					
Poor					Breckwoldt 2009 [E] Tsung 2008[E] Risdal 2008[E] Losert 2007[E] *Cromie 2008[E]*
	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

In Italic paper from animal model…

In grey paper already listed in the previous C2005 WS

Evidence Opposing Clinical Question

"In adult and paediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the interruption of CPR to check circulation (I) as opposed to no interruption of CPR (C), improve outcome (O) (e.g. ROSC, survival)?"

Good					*Yu 2002*[A,B,E] *Kern 2002*[A,B,D] *Berg 2003*[A,B,D] *Bahr 1996*[E] *Brennan 1998*[E] Berg 2001[E]
Fair					*Walcott 2009*[A,B,E] Bobrow 2008[C,D] Kellum 2008[C,D] Kellum 2006[C,D] Rea 2006[A,E] Rea 2005[A,E] Van Alem 2003[E] Hallstrom 2000[A,C] Hallstrom 2000[B,C] Dick 2000[E] Moule 2000[E] Ochoa 1998[E] Liberman 1999[E] Eberle 1996[E]
Poor					Albarran 2006[E] Lapostolle 2004[E] Eftestol 2002[A,E]
	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

In Italic paper from animal model…

In grey paper already listed in the previous C2005 WS

REVIEWER'S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

Background, methodology and assumptions:

The research question as it was structured ["In adult and paediatric patients with cardiac arrest (out-of-hospital and in-hospital) (P), does the interruption of CPR to check circulation (I) as opposed to no interruption of CPR (C), improve outcome (O) (e.g. ROSC, survival)?"] could sound confounding from a clinical background prospective, where is more common to think that the intervention to improve CA patient's outcomes should be a "no CPR interruption" strategy, at leas according to the evidence available at present moment. Anyway, the question was not modified because it was considered correctly stated from a proper methodological/statistical prospective (to test the null hypothesis). Accordingly, the "opposing" evidence listed means in practice that is supporting a strategy aimed to minimize any CPR interruption (including for pulse check during resuscitation efforts).

In absence of enough specific literature able to make clear distinctions, the intervention ("check for circulation") was assumed to be mainly the time spent for pulse assessment during resuscitation efforts (in particular after DC shock). "Check for circulation" included both the check for a "carotid pulse" and the more general "signs of circulation". Anyway a wider search strategy was performed to warrant the inclusion of all the relevant articles.

No human studies have directly addressed this question, thought almost all of the listed papers have been used to generate extrapolations.

Beside one animal model more in scope with the question, the other studies reviewed were considered to support the concept of minimize the chest compression interruptions during CPR (i.e. to make the check for circulation) and to verify the reliability of the check pulse manoeuvres on the real setting.

Impact on outcome of different pause timing and duration

Only one swine model of prolonged unsupported VF was design to evaluate the relationship between resuscitation outcome and the timing and duration of a single chest compression pause early in the resuscitation attempt **(Walcott 2009 [LOE 5])**, comparing a Guidelines 2000 approach (20 sec before and 20 sec after the first 200 J AED shock) with 3 different allocation of a single pre-shock pause (ranging from 10 to 20 sec) and a group with no pause at all. The G2000 group showed the worst 4h survival rate (0/12 vs. 5-7/12) and an average longer time to ROSC (16.8 vs. 9.8-11.7 min) when compared with the other groups. No statistically significant differences were observed between the "no pause" group and the different "single pause" groups, which could suggest that a "no pause" approach could be as effective in term of outcome as a single pause of 10 to 20 sec before the first shock.

Minimize the "hands-off" / "no-flow" time during CPR:

In 4 animal models (**Berg 2001 [LOE 5], Berg 2003 [LOE 5], Kern 2002 [LOE 5], Yu 2002 [LOE 5]**), the interruption of chest compressions during CPR due to different reasons was consistently detrimental in terms of ROSC, survival and cardiac function in animals with untreated prolonged ventricular fibrillation. Human data are limited, but seem to be consistent with animal data (**Van Alem 2003 [LOE 5]**, **Eftestol 2002 [LOE 5]**). In one study (**Eftestol 2002 [LOE 5]**) the VF waveform deteriorated progressively during hands-off periods up to 20 seconds. The second study documented prolonged hands-off periods when using an AED (**Van Alem 2003 [LOE 5]**) no CPR was performed for 45 ± 15% of the AED connection time.

Six papers (**Bobrow 2008 [LOE 5]; Rea 2005 [LOE 5]; Rea 2006 [LOE 5]; Eftestol 2002 [LOE 5]; van Alem 2003 [LOE 5] ; Kellum 2006 [LOE 5] ; Kellum 2008 [LOE 5]**) clearly identify a significant correlation between shorter resuscitation time and better outcomes (ROSC, Survival to Hospital discharge and Neurological scores),as confirmed also by the results from **Hallstrom 2000 [LOE 5]** studies of dispatch assisted CPR showing a trend for a better survival 14.6% for the chest compression only arm when compared to 10.1% of the standard CPR instructions.

AED algorithms are affecting significantly the duration of the overall resuscitation (**van Alem 2003 [LOE 5]**, **Yu 2002 [LOE 5]**, **Rea 2005 [LOE 5]; Rea 2006 [LOE 5]**). Accordingly, recent research is focused on identify devices able to check for "spontaneous circulation" activity through AED pads by impedance measurements, and safely analyse the rhythm and charge the AED even during standard CPR (**Cromie 2008 [LOE 5]; Risdal 2008 [LOE 5]; Losert 2007 [LOE 5]**). When this kind of devices will be well verified and available, "check for spontaneous circulation" will probably be an automatic procedure.

Need for, reliability and quality of pulse check manoeuvre:

Only one paper (**Tsung 2008 [LOE 5])**, on a paediatric setting, highlight the need for alternative devices to ensure the physician about the absence of a pulse. The study present the data obtained with an echocardiography point-of-care device (+/- pulse check) as a reliable tool to guide and help physicians on the decision of when to start or stop resuscitation efforts in CA children.

An interview of 138 bystanders in OHCA aimed to evaluate which are the common methods used by lay peoples to assess a victim collapsed, showed that 25.9% reported a “bluish colour” and 28.1% an abnormal breathing. However, on 27% breathing and on 29% circulation were not assessed. On top of that, 45.3% of peoples do not assess CA at all. (**Breckwoldt 2009** LOE 5)

Only one study (**Mather 1996** LOE 5), comparing reliability of radial with carotid pulse in anaesthetised patients on a operating theatre, concluded that radial pulse is more rapid (< 5 sec) and reliable (98% in <5 sec and 99% <10 sec) that the carotid, that is not easily identified, requiring up to 10 sec to enable an identification rate > 95%. This is the only paper that showed a so high HCP’s ability to identify a carotid pulse within 10 sec.

van Alem 2003 LOE 5 on a study of 184 OHCA patients on an AED first responders scenario, showed that a palpable pulse was never present immediately after a shock, and ROSC was observed only in 3 of 184 patients before ambulance arrival.

Nine other studies all showed low ability for both HCPs and lay people to correctly identify a carotid pulse on real and simulated scenarios (patients and manikins):

Two studies (**Dick 2000** LOE 5**, Eberle 1996** LOE 5) assessed responder proficiency in determining the presence or absence of pulse in patients with spontaneous circulation and non-pulsatile cardiopulmonary bypass. Both identified a low proficiency of trained responders in determining the presence or absence of a carotid pulse within 10 seconds. 45% and 83% of trained responders were unable to determine the presence or absence of a pulse within 10 seconds. In one of the studies (**Dick 2000** LOE 5), 15% of subjects were able to determine the presence of a pulse in pulsatile subjects in less than 10 seconds. Only 2% of subjects recognised pulselessness. In the second study (**Eberle 1996** LOE 5), although the sensitivity for not finding a carotid pulse when absent was 90%, the associated specificity was 55% with a mean diagnostic delay of 24 seconds and a 17% overall efficiency for correct diagnosis within 10 seconds.

Studies on mannequins examining CPR techniques demonstrated similar poor results with less than 50% proficiency demonstrated in verifying the presence of a carotid pulse (**Moule 2000** LOE 5**, Liberman 1999** LOE 5**, Brennan 1998** LOE 5). In a study (**Bahr 1997** LOE 5) involving largely first aid providers only 73.7% of participants were able to determine the presence of a carotid pulse in young, healthy and non-obese subjects within 10 seconds.

A similar study was undertaken to establish the proportion of critical care doctors and nurses that could locate the carotid pulse in less than 5 seconds in a healthy male adult volunteer with normal blood pressure. 57% found the pulse in less than 5 seconds. At 10 seconds, 96% of the participants accurately found the pulse. Although clearly better than the lay group, the authors felt that proficiency was inadequate (**Ochoa 1998** LOE 5).

Lapostolle 2004 LOE 5 studied 64 HCP’s performance in checking carotid pulse for 10 or 30 sec, on a manikin setting with different pulse strength settings (normal, weak, absent): in pulseless scenario, 58% answer correctly after 10 sec and 50% after 30 sec; 83% after 10 sec if the pulse was weak; 92%, 84% and 84% when checking a normal pulse for 10 sec (twice) and 30 sec, respectively.

More recently, a study (**Albarran 2006** LOE 5) aimed to evaluate the ability of 119 HCP’s to perform a concomitant breathing and pulse check vs. a sequential approach on a manikin scenario (SIM-Man), showed that the sequential approach warrant more correct diagnoses (48.2% vs. 33.5%). However, only 44.1% had more then 5/10 correct sequential diagnoses, compared to an even lower 26.3% with a concomitant approach, that still confirm a quite low reliability of the pulse check, whatever the manoeuvre in use.

Rea 2005 LOE 5, on study of 481 OHCA patients aimed to test AED algorithm efficacy (3 sequential shocks), described that the termination of the VF was not synonymous of return of a pulse: the initial shock produced a pulse that was eventually detected in only 21.8% of cases and for the 24.5% (118 pts) of cases in which a pulse returned, the pulse was detected during the initial post-shock pulse check only 12 times (2.5% of all cases). According to post-shock AED algorithm the CPR was delayed for almost 29 sec. These results let the authors conclude that pulse check had low yield for achieving or detecting return of a pulse, contributing in delaying CPR resumption.

A second study from the same group (**Rea 2006** LOE 5), in which the G2000 AED algorithm was updated to a more rapid protocol, that included a single shock, without any rhythm reanalysis, stacked shock, or post-defibrillation pulse check) showed an significant improve of the survival to hospital discharge (46% vs. 36% p=0.008) and corresponded to a decrease in the interval from shock to start chest compressions (7 vs. 28 sec).

Conclusions:

These human behaviour studies support the hypothesis that a carotid pulse check, in adult OHCA patients, to determine the presence of a circulation during CPR and/or after a defibrillation cannot be supported by the data. This diagnostic procedure is often time consuming (negative impact on the “no-flow” concept), still unreliable (unacceptable levels of sensitivity, specificity) and apparently insufficient both for HCP and lay bystanders.

According to 2005 guidelines, the small evidence available today still suggest to keep the indication for a faster intervention time during resuscitation, shortening of the "hands-off” time, avoiding any kind of chest compressions interruption, including for “check for pulse/sign of circulation”, and even through a speed up of the AEDs algorithms, might have a positive impact on the outcomes (ROSC and survival).

On the light of simplify resuscitation procedures, on the absence of evidence that a pulse check/check for circulation at any time will improve outcome and having unclear evidence that chest compression can harm the patients in case of “undiagnosed” ROSC after defibrillation, the benefit to implement a “pulse/sign of circulation check” seems to e very low.
Acknowledgements:

Citation List in alphabetical order

Albarran JW, Moule P, Gilchrist M, Soar J.
Comparison of sequential and simultaneous breathing and pulse check by healthcare professionals during simulated scenarios.
Resuscitation. 2006 Feb;68(2):243-9.

Opposing; LOE 5; Poor (extrapolation)
Adult, manikin, HCP. Simulated scenario to evaluate the concomitant vs. sequential pulse + breathing check. 119 HCP. Low ability to correctly identify pulse & breathing (sensitivity for the pulse check was 99% for both assessments; specificity was 48.9% for a simultaneous assessment and 61.9% for the sequential approach). Sequential approach better, but more time consuming. The study suggested that, for HCP on manikins, a sequential assessment of pulse and breathing is more accurate that concomitant evaluation, however correct evaluation is still low, time consuming and far below 50%.

Bahr, J., H. Klingler, et al.
Skills of lay people in checking the carotid pulse.
Resuscitation 1997; 35(1): 23-26.

Opposing, LOE 5, Good
Comments: Demonstrates difficulty in lay persons finding a pulse within the AHA and ERC recommended time frames.

Berg, R. A.; Sanders, A. B.; Kern, K. B.; Hilwig, R. W.; Heidenreich, J. W.; Porter, M. E.; Ewy, G. A.
Adverse hemodynamic effects of interrupting chest compressions for rescue breathing during cardiopulmonary resuscitation for ventricular fibrillation cardiac arrest
Circulation 2001; 104:2465-70

Opposing; LOE 5; Good (extrapolation from breathing pauses)
The study was designed to assess the effects of pauses for rescue breathing (not for pulse check) after 3-minutes of untreated ventricular fibrillation (VF) in a swine model. In this model of brief VF, rescue breathing failed to improve the rate of ROSC, post-intervention survival at 24 hours and neurologic scores at 24 hours compared with a group that did not receive rescue breathing. Although no adverse effect on outcome was found with interruption of chest compression to provide rescue breathing, the measured coronary perfusion pressure during CPR was higher in animals without a pause for rescue breathing since more chest compressions were delivered. Not surprisingly, arterial oxygen saturation was significantly higher in the group receiving RB. The improved coronary perfusion pressure implies that there may be detrimental effects from pausing to deliver rescue breaths.

Berg RA, Hilwig RW, Kern KB, Sanders AB, Xavier LC, Ewy GA.
Automated external defibrillation versus manual defibrillation for prolonged ventricular fibrillation: lethal delays of chest compressions before and after countershocks.
Ann Emerg Med. 2003 Oct;42(4):458-67.

Opposing, LOE 5, Good (extrapolation)
The design of this study was to determine the effects of delays in chest compression caused by AED-guided or manual defibrillation. The delays were presented by the time interval between defibrillator arrival to first compression, to first shock and first shock to first compression. The intervals mandated by rhythm analyses or AED-guidance iteration were not summarized and/or compared between the groups. The neurologic outcome at 24 hours and ROSC favor the group with manual defibrillation, which was delivered with a shorter delay of chest compression.

Bobrow BJ, Clark LL, Ewy GA, Chikani V, Sanders AB, Berg RA, Richman PB, Kern KB.
Minimally interrupted cardiac resuscitation by emergency medical services for out-of-hospital cardiac arrest.
JAMA. 2008 Mar 12;299(10):1158-65.

Opposing; LOE 5 (extrapolation from LOE 2); Fair
Adult, OHCA, EMS (FD) metropolitan cities in Arizona. MICR vs. standard ALS. 886 pts; 174 witnessed CA. The MICR protocol for pre-hospital personnel includes an initial 200 uninterrupted chest compressions at 100 compressions per minute, rhythm analysis with a single shock when indicated, immediately followed by 200 post shock chest compressions before any pulse check or rhythm reanalysis. Possible confounding, being not specifically addressed the contribution of the pauses for pulse check time and duration on the overall outcomes. The study highlight the importance of CCC lowering the "hands off time" (delaying also the reassessment for any pulse and rhythm analysis after 200 CC post DC shock) and showed improved survival to H discharge associated to MICR protocol.

Breckwoldt J, Schloesser S, Arntz HR.
Perceptions of collapse and assessment of cardiac arrest by bystanders of out-of-hospital cardiac arrest (OOHCA).
Resuscitation. 2009 published on line (doi:10.1016/j.resuscitation.2009.06.028)

Neutral; LOE 5; Poor

Lay people, initial CA assessment. Retrospective interview of 138 bystanders in OHCA, aim to evaluate the method used to assess cardiac arrest. 45.3% didn't detect CA. 25.9% reported "bluish colour" and 28.1% abnormal breathing. On 27% of cases breathing was not assessed, and on 29% the circulation. Pulse or breathing checks are uncommon during OHCA detected by bystanders. Skin colour modification in collapsed patients is more commonly used by bystanders on the scene.

Brennan, R.T. and A. Braslow,
Skill mastery in public CPR classes.
Am J Emerg Med, 1998. 16(7): p. 653-657

Opposing, LOE 5, Good
Comments: The article identifies that roughly half of the students tested, inadequately assessed for presence of breathing and circulation (53% pulse check & 50% breathing).

Cromie NA,Allen JD, Turner C, Anderson JM, Adgey AA.
The impedance cardiogram recorded through two electrocardiogram/defibrillator pads as a determinant of cardiac arrest during experimental studies.

Crit Care Med. 2008 May;36(5):1578-84.

Neutral; LOE 5; Poor (extrapolation)
Preliminary data for automatic pulse identification devices integrated into AED. This technology might contribute to reduce no-flow time, but maintaining pulse check information.

Dick, W. F., B. Eberle, et al.
The carotid pulse check revisited: what if there is no pulse?
Crit Care Med 2000; 28(suppl)(11): N183-N185.

Opposing, LOE 5, Fair
Comments: A Very Important Paper. In this study skill rate was 16.5%. Feeling for a carotid pulse had a positive predictive value of 35%, and a specificity of 2%.

Eberle, B., et al.
Checking the carotid pulse check: diagnostic accuracy of first responders in patients with and without a pulse.
Resuscitation, 1996. 33(2): p. 107-116

Opposing, LOE 5 (estrapolation), Fair
Comments: Probably the most important article in the literature search. Figures are presented a little backwards than the way I have researched the topic. There were long delays in establishing an opinion as to the presence or absence of a pulse. Efficiency 15% within 10 seconds. Sensitivity 45% Specificity 90%

Eftestol T, Sunde K, Steen P
Effects of interrupting precordial compressions on the calculated probability of defibrillation success during out-of-hospital cardiac arrest.
Circulation. 2002 May 14;105(19):2270-3.

Opposing; LOE 5 (extrapolation from LOE 4); Poor
Adult, human, OHCA. 634 ECG intervals from VF patients. Previous guidelines protocols for AED setting. Evaluation of ECG related to hand-off time during resuscitation. Shortening of the hands-off time translate to a higher ROSC rate (the ROSC probability reduced from 8% to 11% after 20 sec). Possible confounding: not addressing only pulse check time role on patient's outcome. The interval between discontinuation of chest compressions and delivery of a shock should be kept as short as possible.This is a prospective observational study. Although the derivation of the observed "possibility of ROSC" based on ECG analysis is not a well-proven measurement for its predictive value, the report is interesting because it could offer a chance for rhythm analysis to rapidly stratify who in the population of victims of out-of-hospital cardiac arrests will benefit more from a shorter "hands-off" interval. This study showed that an initially high/moderate probability for ROSC decreased steadily with the duration of the hands-off intervals; there was no change in the rhythm during the hands-off period in those patients with low initial probability of ROSC based on analysis of their rhythm. To reiterate the implication, victims who have higher probability of ROSC based on retrospective analyses (with knowing the eventual outcome) will benefit more from shortened hands-off interval.

Hallstrom, A., et al.
Cardiopulmonary resuscitation by chest compression alone or with mouth-to-mouth ventilation.
N Engl J Med, 2000. 342(21): p. 1546-1553

Opposing, LOE 5, Fair
Comments: A good paper used extrapolatively. Suggests that outcomes of pre-hospital continuous CPR alone are not significantly different to formal CPR.

Hallstrom, A.P.

Dispatcher-assisted "phone" cardiopulmonary resuscitation by chest compression alone or with mouth-to-mouth ventilation.
Crit Care Med, 2000. 28(11 Suppl): p. N190-N192.

Opposing, LOE 5, Fair
Comments: A good paper used extrapolatively. Suggests that outcomes of pre-hospital continuous CPR alone are not significantly different to formal CPR.

Kellum MJ, Kennedy KW, Ewy GA.
Cardiocerebral resuscitation improves survival of patients with out-of-hospital cardiac arrest.
Am J Med. 2006 Apr;119(4):335-40.

Opposing; LOE 5 (extrapolation from LOE 3); Fair
Adult, OHCA, EMS in rural counties in Wisconsin. MICR vs. standard CPR. 33 witnessed CA. Survival to H discharge, and neuro outcome, improved by MICR, where post shock rhythm and pulse checks were eliminated, and chest compressions were resumed immediately after a shock was delivered. Possible confounding, being not specifically addressed the contribution of the pauses for pulse check time and duration on the overall outcomes. The study highlight the importance of CCC lowering the "hands off time" (delaying also the reassessment for any pulse and rhythm analysis after 200 CC post DC shock) and showed improved survival to H discharge associated to MICR protocol.

Kellum MJ, Kennedy KW, Barney R, Keilhauer FA, Bellino M, Zuercher M, et al.
Cardiocerebral resuscitation improves neurologically intact survival of patients with out-of-hospital cardiac arrest.
Ann.Emerg.Med. 2008 Sep;52(3):244-252.

Opposing; LOE 5 (extrapolated from LOE 3); Fair
Adult, OHCA, EMS in two rural counties in Wisconsin. MICR vs. standard CPR. 89 witnessed CA. Survival to H discharge, and neuro outcome, improved by MICR 39% vs. 15%). CC only group is the same of a previous paper from Kellum 2006 (duplicate patients). Possible confounding, being not specifically addressed the contribution of the pauses for pulse check time and duration on the overall outcomes. Retrospective control group from 2000 AHA guidelines. The study highlight the importance of CCC lowering the "hands off time" (delayed reassessment for any pulse and rhythm analysis after 200 CC post DC shock) and showed improved survival to H discharge associated to MICR protocol

Kern, K. B.; Hilwig, R. W.; Berg, R. A.; Sanders, A. B.; Ewy, G. A.
Importance of continuous chest compressions during cardiopulmonary resuscitation: improved outcome during a simulated single lay-rescuer scenario
Circulation 2002; 105 (5): 645-9

Opposing, LOE 5, Good
This study is a direct development and extension based on what was reported by Berg in 2001. Outcome was assessed by neurologically normal 24-hr survival, which favoured the group with continuous chest compression without pause for ventilation. Once again, lower coronary perfusion pressure (presented as a lower integrated area) was found in the group with interruptions in chest compression. Although both this and Berg 2001 papers assessed effects of interruptions for ventilation simulating bystander CPR procedures, they indirectly imply that pauses in chest compressions for any reason could be detrimental, or at least offset the possible benefits brought by rescue breathing or ventilation, if any. This model used a long period of chest compressions (12 minutes) prior to attempting defibrillation.

Lapostolle F, Le Toumelin P, Agostinucci JM, Catineau J, Adnet F.

Basic cardiac life support providers checking the carotid pulse: performance, degree of conviction, and influencing factors.
Acad Emerg Med. 2004 Aug;11(8):878-80.

Opposing; LOE 5; Poor (extrapolation)
Manikin, HCP. Simulated scenario to evaluate the ability to correct pulse check. 64 HCP. Low ability to correctly identify pulse.

Liberman, M., et al.
Cardiopulmonary resuscitation: errors made by pre-hospital emergency medical personnel.
Resuscitation, 1999. 42(1): p. 47-55.

Opposing, LOE 5, Fair
Comments: An important paper. 94% attempted to verify a carotid pulse. 45% were able to feel it. The results of this study showed a high rate of errors occurring in the CPR provided by emergency healthcare professionals.

Losert H, Risdal M, Sterz F, Nysaether J, Köhler K, Eftestøl T, Wandaller C, Myklebust H, Uray T, Aase SO, Laggner AN.
Thoracic-impedance changes measured via defibrillator pads can monitor signs of circulation.
Resuscitation. 2007 May;73(2):221-8.

Neutral; LOE 5; Poor (extrapolation)
Preliminary data for automatic pulse identification devices integrated into AED. This technology might contribute to reduce no-flow time, but maintaining pulse check information. This technology for automatic circulation assessment might help the recognition of ROSC during CPR, reducing the no-flow time.

Mather, C. and S. O'Kelly
The palpation of pulses.
Anaesthesia, 1996. 51(2): p. 189-191.

Supporting, LOE 5, Fair
Comments: Article simply found that radial pulse is easier to identify than carotid pulse of anaesthetised patients in the operating theatre. 95% detection rate in 10 seconds.

Moule, P.
Checking the carotid pulse: diagnostic accuracy in students of the healthcare professions.
Resuscitation, 2000. 44(3): p. 195-201.

Opposing, LOE 5, Fair
Comments: Accepted paper. Demonstrates an overall efficiency of 38% in finding a carotid pulse by nursing and allied health students.

Ochoa, F.J., et al.
Competence of health professionals to check the carotid pulse.
Resuscitation, 1998. 37(3): p. 173-175.

Opposing, LOE 5, Fair
Comments: Highlights the difficulty health professionals had in rapidly determining a carotid pulse. Less than 50% in 5 seconds but 95.8% were able to make a decision by 10 seconds.

Rea TD, Shah S, Kudenchuk PJ, Copass MK, Cobb LA
Automated external defibrillators: to what extent does the algorithm delay CPR?
Ann Emerg Med. 2005 Aug;46(2):132-41.

Opposing; LOE 5 (extrapolation from LOE 4); Fair
Adult, OHCA, VF, first tier EMS. Observational study. 481 pts. Setting: AED, 3 shocks sequence protocol. Termination of ventricular fibrillation was not synonymous with return of a pulse. The initial shock produced a pulse that was eventually detected in 21.8% (105/481) of cases. Stacked shocks produced a pulse in 10.7% (13/122) of cases. For the 24.5 % (n=118) of cases in which a pulse returned, the pulse was detected during the initial post shock pulse check only 12 times, or 2.5% of all cases. The median interval from initial shock until CPR was 29 (23, 41) seconds. Possible confounding: the study includes also post DC shock pulse check but was aimed to AED efficacy evaluation. The study suggested that a pulse check after DC shock has low probability to identify a ROSC, even when a pulse is regained. Pulse check procedure is time consuming and could negatively impact on the prompt recovery and duration of chest compressions.

Rea TD, Helbock M, Perry S, Garcia M, Cloyd D, Becker L, Eisenberg M.
Increasing use of cardiopulmonary resuscitation during out-of-hospital ventricular fibrillation arrest: survival implications of guideline changes.
Circulation. 2006 Dec 19;114(25):2760-5.

Opposing; LOE 5 (extrapolation from LOE 3); Fair
Adult, OHCA, 2 tiered EMS. Prospective cohort study vs. retrospective control. 134 pts. Setting: Single shock sequence protocol. Post shock pulse check abolished. Possible confounding: the study addressed change on defibrillation protocol that includes not only post defibrillation pulse check removal. The study showed improved survival to H discharge when a single shock, without rhythm reanalysis or post defibrillation pulse check and cardiopulmonary resuscitation increase from 1 to 2 min was implemented.

Risdal M, Aase SO, Kramer-Johansen J, Eftestøl T
Automatic identification of return of spontaneous circulation during cardiopulmonary resuscitation.
IEEE Trans Biomed Eng. 2008 Jan;55(1):60-8.

Neutral; LOE 5; Poor (extrapolation)
Preliminary data for automatic pulse identification devices integrated into AED. This technology might contribute to reduce no-flow time, but maintaining pulse check information. Automatic identification of pulse could avoid unnecessary pulse checks and thereby reduce no-flow time and potentially increase the chance of survival.

Tsung JW, Blaivas M
Feasibility of correlating the pulse check with focused point-of-care echocardiography during paediatric cardiac arrest: a case series.
Resuscitation. 2008 May;77(2):264-9.

Neutral; LOE 5 (extrapolation from LOE 4); Poor
Paediatric OHCA ED setting. Use of echocardiography point-of-care vs. pulse check to assist CA diagnosis. Authors stress the strong need for additional method (equivalent to pulse check) to help / guide start and stop resuscitation decisions during resuscitation on paediatric setting.

van Alem, A. P.; Sanou, B. T.; Koster, R. W.
Interruption of cardiopulmonary resuscitation with the use of the automated external defibrillator in out-of-hospital cardiac arrest
Ann Emerg Med 2003; 42 (4); 449-57

Opposing; LOE 5 (extrapolation from LOE 4); Fair
Adult, OHCA. AED first responders scenario. Previous guidelines protocols for AED setting. High hands-off time. Possible confounding: not addressing only pulse check time role on patient's outcome. A palpable pulse was never present immediately after a shock, and return of spontaneous circulation was observed in 3 of 184 patients before arrival of the ambulance.
This is an observation of the duration of interruptions of CPR based on analysis of the recording from AEDs used in out-of-hospital cardiac arrest, offering the only first-hand clinically relevant data about the interval of programmed non-CPR procedure mandated by AEDs. The unsatisfying rate of ROSC and discharge from hospital strongly suggest that dramatic improvement is required in the programming of AED devices to shorten their analysis period, and there is a need for better education of bystanders on the need to perform CPR.

Walcott GP, Melnick SB, Walker RG, Banville I, Chapman FW, Killingsworth CR, Ideker RE.
Effect of timing and duration of a single chest compression pause on short-term survival following prolonged ventricular fibrillation.
Resuscitation. 2009 Apr;80(4):458-62

Opposing; LOE 5; Fair
Animal Adult, OHCA in VF, 48+12 swines; ALS equivalent setting, RCT, The model compared the effect on outcomes (4h survival and time to ROSC) of pauses during CPR: pre-DC shock, that includes time for collapse evaluation and AED work out; and post-DC shock, that evaluates mainly time for pulse check. Groups: 20sec before and 20 sec after first 200J shock (G2000) control vs. 4 active groups with different timing and duration of the pauses (from 10 to 20 sec at different timings before DC shock and no pause at all before and after DC shocks). No interruption of chest compressions to check pulse after DC shock improved survival rate when compared with 20+20 sec pauses (G2000). No differences between active groups (i.e. "no pause" shows equivalent survival rate vs. pauses from 10 to 20 sec at different timing before DC shock).

Yu, T.; Weil, M. H.; Tang, W.; Sun, S.; Klouche, K.; Povoas, H.; Bisera, J.
Adverse outcomes of interrupted precordial compression during automated defibrillation
Circulation 2002 ; 106 (3): 368-72

Opposing, LOE 5, Good
The study was designed to simulate and evaluate the effects of interruptions imposed by AEDs in an established porcine model of cardiac arrest. The endpoints in this study include ROSC, post-intervention survival at 72 hours as well as cardiac function. It showed that longer interruptions of chest compressions further compromise resuscitability, and that pauses resulted in worse post-ROSC cardiac function as reflected by ejection fraction and mean arterial pressure. These effects could be explained by a longer duration of sub-threshold coronary perfusion pressure and less chest compressions per minute in groups with longer interruption intervals. It also suggests that minimizing the interruptions could be beneficial for victims, if they are inevitable.