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

Worksheet author(s)

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Clinical question.

In pediatric patients with cardiac arrest (prehospital [OHCA] or in-hospital [IHCA]) (P), does the use INVASIVE MONITORING (I) compared with CLINICAL ASSESSMENT (C), improve ACCURACY of diagnosis of a PERFUSING RHYTHM (O)?

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

Search strategy (including electronic databases searched).

Initial search for: "Cardiac arrest" AND ("infant" OR "children" OR "pediatrics") AND ("invasive monitoring" OR "clinical assessment" OR "perfusing rhythm") AND ("diagnosis" OR "assessment")

Invasive monitoring refers to monitoring of arterial pressure by arterial line and CVP by central line.
Clinical assessment includes pulse palpation or the absence of signs of life.

Search in: PubMed, AHA EndNote library, Google scholar, EMBASE.

Years covered: All available in each database.

• State inclusion and exclusion criteria

Inclusion criteria:
Age: From newborn to adolescence, including neonate, infant, baby, child, adolescent, pediatrics.
Condition: Cardiac arrest, including in-hospital, in-PICU, prehospital, out-of-hospital,
Site: in- or out-of- hospital
Markers: arterial pressure, central venous pressure, pulse palpation, absence of signs of life
Languages: All if abstract in English.

Exclusion criteria:
Age: Adults.
Markers: echocardiography, etCO2, CVO2, Saturation, ptO2, goal directed therapy
Participants: Laypeople.
Type of evidence: Reviews, Expert opinions, Letters.

Number of hits per database:

Database	Search for:	Articles found	Articles that meet criteria for evaluation
PubMed	Cardiac arrest AND (infant OR children OR pediatrics) AND (invasive monitoring OR clinical assessment OR perfusing rhythm) AND (diagnosis OR assessment)	131	1
	Cardiac arrest AND (infant OR children OR pediatrics) AND pulse palpation	5	2
	Cardiac arrest AND (infant OR children OR pediatrics) AND arterial pressure	161	1
	Cardiac arrest AND (infant OR children OR pediatrics) AND central venous pressure	21	0
	Cardiac arrest AND (infant OR children OR pediatrics) AND absence of signs of life	19	1
EMBASE	Cardiac arrest AND (infant OR children OR pediatrics) AND (invasive monitoring OR clinical assessment OR perfusing rhythm) AND (diagnosis OR assessment)	38	1
	Cardiac arrest AND (infant OR children OR pediatrics) AND pulse palpation	4	3
	Cardiac arrest AND (infant OR children OR pediatrics) AND arterial pressure	166	1
	Cardiac arrest AND (infant OR children OR pediatrics) AND central venous pressure	44	0
	Cardiac arrest AND (infant OR children OR pediatrics) AND absence of signs of life	2	0
Google scholar	Cardiac arrest AND (infant OR children OR pediatrics) AND (invasive monitoring OR clinical assessment OR perfusing rhythm) AND (diagnosis OR assessment)	5370	?
	Cardiac arrest AND (infant OR children OR pediatrics) AND pulse palpation	4550	?
	Cardiac arrest AND (infant OR children OR pediatrics) AND arterial pressure	36700	?
	Cardiac arrest AND (infant OR children OR pediatrics) AND central venous pressure	22200	?
	Cardiac arrest AND (infant OR children OR pediatrics) AND absence of signs of life	29300	?

	? The high number or results and their diversity makes impossible to do a rationale search in this case.		
AHA EndNote Library	Invasive monitoring	4	0
	Clinical assessment	4	0
	Perfusing rhythm	1	0
	Pulse palpation	1	0
	Arterial pressure	9	0
	Central venous pressure	5	0
	Signs of life	0	0
SCOPUS	Access not permitted		

• Number of articles/sources meeting criteria for further review: 7

Summary of evidence

Evidence Supporting Clinical Question

Good				**Tsung, 2008, E**	**Inagawa, 2003, E Sarti, 2005, E Sarti, 2006, E**
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
* = overlapping patients

Evidence Neutral to Clinical question

Good					**Sende, 2009 E**
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 Opposing Clinical Question

Good		**Tibbals, 2009, E**			
Fair					**Owen, 2004, 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

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

In pediatric patients with cardiac arrest (prehospital [OHCA] or in-hospital [IHCA]) (P), does the use INVASIVE MONITORING (I) compared with CLINICAL ASSESSMENT (C), improve ACCURACY of diagnosis of a PERFUSING RHYTHM (O)?

The diagnosis of the presence or absence of a perfusing rhythm is essential to detect cardiac arrest, to initiate cardiopulmonary resuscitation efforts and to monitor the effect of such efforts. At the pre-hospital level, when laypersons use to be the first responders and where devices availability is limited, it seems rationale to rely on clinical assessment methods to detect a perfusing rhythm. At the in-hospital level, in addition to clinical methods done by expert health staff, invasive monitoring methods should help to accurately diagnose and monitor the perfusing rhythm in arrested and resuscitated children.

There are several hemodynamic monitoring methods. In this worksheet the authors were asked to limit the term invasive monitoring to monitoring of arterial pressure by arterial line and CVP by central line, and clinical assessment to pulse palpation or the absence of signs of life.

Unfortunately, the results of the search for evidences to answer the proposed clinical question have been very limited due to the nearly absence of studies (in animals, adults or children) designed to compare invasive monitoring with clinical assessment in this context.

In the absence of invasive arterial pressure monitoring and in the pre-hospital setting, pulse palpation has been considered the most feasible and accurate method to detect and monitor the presence/absence of a perfusing rhythm and it is recommended for health care staff. On the other hand, it is considered a difficult procedure, particularly when done by lay rescuers and in infants. Therefore, it is not recommended for laypeople, who are instructed to look for surrogates of signs of circulation, such as breathing, coughing and movement.

No LOE D1 studies have assessed pulse palpation usefulness and accuracy in children in cardiac arrest and during resuscitation.

One LOE D4 observational study, done in a series of 14 pediatric cardiac arrest patients, reported the results of focused point-of-care echocardiography and its correlation with pulse check during resuscitation (Tsung, 2008). The study concluded that focused echocardiography is feasible during CPR and permits correlate image with pulse check and also it could guide resuscitation procedures and the decision to initiate or terminate CPR.

One study (LOE D2) challenged the ability of expert rescuers to determine if a pulse was present in 16 children on extracorporeal circulatory support, a scenario that can be considered to resemble cardiac arrest (Tibbals, 2009). The results of this nice study indicate that pulse palpation is unreliable to diagnose pediatric cardiac arrest, event when done by health staff.

Three studies (LOE D5) have compared several techniques and/or sites to check the pulse and to count heart rate in anesthetized infants in the operating room. One study (Sarti, 2006) was done in hypotensive infants and the other two (Inagawa, 2003 and Sarti, 2005) were done in normotensive infants. Therefore, they are not really representative of the hemodynamics and clinical situation of infants in cardiac arrest. The results of two studies (Inagawa, 2003 and Sarti, 2005) indicate that apex auscultation technique is better than finger palpation of pulses to detect and counting heart beat. When sites to check the pulse were compared, results were discordant: In one study (Inagawa, 2003) brachial was better than carotid and femoral; in hypotensive infants (Sarti, 2006) femoral proved to be the best site; and in the remaining study (Sarti, 2005) palpation of brachial, carotid, or femoral pulses yielded similar results.

Another LOE D5 study (Owen, 2004) has tested the ability of trained health care providers to detect pulses and count heart rate in healthy newly born babies. The participants failed to detect 75% of present brachial and femoral pulses and detected only a half of umbilical cord pulsations.

Despite been used routinely in pediatric intensive care units in unstable patients as well as during CPR in children who suffer an in-PICU cardiac arrest, results of studies designed to assess the usefulness of invasive monitoring to accurately detect a pefusing rhythm have not been reported.

One LOE D5 observational study in adults, reported the ability of mobile emergency medical units' staff to perform arterial catheterization (Sende, 2009). They concluded that invasive arterial pressure is feasible and superior to non-invasive monitoring in emergency out-of-hospital hemodynamicaly unstable patients. Unfortunately, it is not easy to extrapolate these results to the pediatric population.

Conclusions:
- In out-of-hospital cardiac arrest, pulse palpation (femoral, brachial, carotid) may be considered a relatively accurate method of diagnosis of the presence of a perfusing rhythm, but this procedure is not easy to undertake for most of laypeople and health personnel.
- Although no specific evidences have been published, in case of in-hospital cardiac arrest, the invasive monitoring methods already in use before the patient suffers from a cardiac arrest, can be useful and accurate systems to diagnosis and monitor a perfusing rhythm.

Significant knowledge gaps remain about:
- Optimal monitoring method.
- Actual usefulness of these methods.
- The relative relevance of the "accuracy of diagnosis" in the cardiac arrest scenario where "soon and good quality" resuscitation must be emphasized.

REVIEWER'S CONFLICTS OF INTEREST:

Antonio Rodriguez-Nunez. Pediatrics, Pediatric Intensive Care. No intellectual or commercial conflicts.

Citation List

Inagawa G, Morimura N, Miwa T, Okuda K, Hirata M, Hiroke K. A comparison of five techniques for detecting cardiac activity in infants. Paediatr Anaesth 2003;13:141-6.

LOE D5. Study designed to assess the comparative efficacy (in terms of rapidity and accuracy) of five clinical techniques for detecting cardiac activity in infants. The subjects were experienced operating room nurses who tried to detect signs of cardiac activity and to determine the heart rate in 13 anesthetised infants scheduled for elective surgery. The results indicate that the direct auscultation technique was better than finger palpation of: apical impulse, brachial pulse, carotid pulse and femoral pulse. The authors suggested that direct auscultation technique is superior to the palpation of brachial artery in CPR in infants, but the assumption that anesthetised infants mimic unresponsive and apnoeic infants requiring CPR is difficult to be accepted.

Owen CJ, Wyllie JP. Determination of heart rate in the baby at birth. Resuscitation 2004;60:213-7.

LOE D5. A randomized study in healthy newborn babies (with heart rate above 100 bpm). Within 5 minutes of birth they were assessed by trained midwives or senior house officer to detect femoral, brachial or cord pulse and categorize heart rate. The results indicate that health staff trained in newborn resuscitation fail to detect brachial and femoral pulses present at birth and that, umbilical cord palpation although more reliable, also fail to detect pulses in near half of cases. These data results cannot be directly extrapolated to the cardiac arrest scenario.

Sarti A, Savron F, Ronfani L, Pelizzo G, Barbi E. Comparison of three sites to check the pulse and count heart rate in hypotensive infants. Paediatr Anaesth 2006;16:394-8.

LOE D5. Clinical study with a blind randomized design that compared the ability of 2 doctors and 2 nurses to detect pulse and count heart rate in hypotensive children in a controlled setting (operating room). In this scenario that resembles at least in part the hemodynamics of children with imminent cardiac arrest, femoral proved to be better than brachial and carotid for pulse palpation. The results cannot be directly extrapolated to the cardiac arrest scenario but indicate that femoral palpation may be the best site for detecting the pulse also in cardiac arrest.

Sarti A, Savron F, Casotto V, Cuttini M. Hearbeat assessment in infants: a comparison of four clinical methods. Pediatr Crit Care Med 2005;6:212-5.

LOE D5. Cross-sectional, repeated-measures study design that compared the performance of 4 clinical methods (apex ear auscultation, brachial, carotid and femoral pulse palpation) for detecting and counting heart beat in normotensive sedated infants in a postanesthesia care unit. In this population palpation of brachial, carotid, or femoral pulses yielded similar results. The results cannot be directly extrapolated to the cardiac arrest scenario.

Sende J, Jabre P, Leroux B, Penet C, Lecarpentier E, Khalid M, Margenet A, Marty J, Combes X. Invasive arterial blood pressure monitoring in an out-of-hospital setting: An observational study. Emerg Med J 2009;26:210-2.

LOE D5. Observational study that reports the ability of mobile emergency medical units' staff to perform arterial catheterisation in adult patients and compared the blood pressure values with invasive and non-invasive methods. They conclude that invasive arterial pressure is feasible and is superior to non-invasive monitoring in emergency out-of-hospital care of hemodynamicaly unstable patients.

Tibballs J, Russell P. Reliability of pulse palpation by healthcare personnel to diagnose paediatric cardiac arrest. Resuscitation 2009;80:61-4.

LOE D2. A very good study that challenged the ability of 209 expert rescuers (doctors and nurses) to determine if a pulse was present in 16 children on extracorporeal circulatory support. The results indicate that pulse palpation is unreliable to diagnose pediatric cardiac arrest even when done by health staff. Although the scenario was not a cardiac arrest it can be a considered a very good surrogate.

Tsung JW, Blaivas M. Feasibility of correlating the pulse check with focused point-of-care echocardiography during pediatric cardiac arrest: A case series. Resuscitation 2008;77:264-9.

LOE D4. Observational study that reports the results of focused point-of-care echocardiography with concurrently checking for a pulse during resuscitation in 14 pediatric cardiac arrest patients. The authors had extensive experience in the use of this technique and they were able to visualize the heart in all patients and rapidly correlate cardiac activity with the presence or absence of a pulse, without prolonged interruption of chest compressions. The authors conclude that focused point-of-care echocardiography is feasible and permits to correlate image with pulse check at the start and subsequently during CPR. Furthermore, it could provide additional information in the decision to initiate or terminate CPR and also could serve as a guide to specific resuscitation procedures.