

Review article

Return of consciousness during ongoing cardiopulmonary resuscitation: A systematic review[☆]



Alexander Olausson^{a,b,*}, Matthew Shepherd^c, Ziad Nehme^{d,e}, Karen Smith^{d,e,f}, Stephen Bernard^{e,g,h}, Biswadev Mitra^{b,e}

^a Department of Community Emergency Health and Paramedic Practice, Monash University, Australia

^b Emergency & Trauma Centre, The Alfred Hospital, Australia

^c Ambulance Victoria, HEMS, Australia

^d Department of Research and Evaluation, Ambulance Victoria, Doncaster, Victoria, Australia

^e Department of Epidemiology and Preventive Medicine, School of Public Health and Preventive Medicine, Monash University, Prahran, Victoria, Australia

^f Emergency Medicine, University of Western Australia, Western Australia, Australia

^g Intensive Care Unit, The Alfred Hospital, Melbourne, Australia

^h Medical Advisor, Ambulance Victoria, Victoria, Australia

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ABSTRACT

Objectives: Cardio-pulmonary resuscitation (CPR) may generate sufficient cerebral perfusion pressure to make the patient conscious. The incidence and management of this phenomenon are not well described. This systematic review aims to identify cases where CPR-induced consciousness is mentioned in the literature and explore its management options.

Methods: The databases Medline, PubMed, EMBASE, Cinahl and the Cochrane Library were searched from their commencement to the 8th July 2014. We also searched Google (scholar) for grey literature. We combined MeSH terms and text words for consciousness and CPR, and included studies of all types.

Results: The search yielded 1997 unique records, of which 50 abstracts were reviewed. Nine reports, describing 10 patients, were relevant. Six of the patients had CPR performed by mechanical devices, three of these patients were sedated. Four patients arrested in the out-of-hospital setting and six arrested in hospital. There were four survivors. Varying levels of consciousness were described in all reports, including purposeful arm movements, verbal communication, and resuscitation interference. Management strategies directed at consciousness were offered to six patients and included both physical and chemical restraints.

Conclusion: CPR-induced consciousness was infrequently reported in the medical literature, and varied in management. Given the increasing use of mechanical CPR, guidelines to identify and manage consciousness during CPR are required.

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1. Background

Cardio-pulmonary resuscitation (CPR) facilitates blood flow throughout the body.¹ Good quality cardiac compressions reportedly provide 30% of normal pre-arrest cardiac output.² The latest resuscitation guideline update focuses on improved quality of CPR with emphasis on depth and rate of chest compressions

with minimal interruptions thereby improving cerebral perfusion pressure (CPP).³ CPP correlates closely with brain oxygenation during CPR.⁴ One potential consequence of good quality resuscitation is therefore CPR-induced consciousness. The incidence of CPR-induced consciousness remains unknown.

Martens and Mullie⁵ asked two decades ago whether sedation during CPR required a treatment guideline. Currently there are no recommendations by the International Liaison Committee on Resuscitation (ILCOR) for either pharmaceutical or physical management of CPR-induced consciousness.³ Avenues for the management strategies are unclear.

Among patients with CA, we aimed to identify cases of CPR-induced consciousness, perceivable by the rescuer, in the literature and management strategies.

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* Corresponding author at: Department of Community Emergency Health and Paramedic Practice, Monash University – Peninsula Campus, PO Box 527, McMahons Road, Frankston, Melbourne, VIC 3199, Australia.

E-mail address: alexander.olausson@monash.edu (A. Olausson).

2. Methods

2.1. Search strategy

This systematic review searched English and non-English literature according to PRISMA guidelines.⁶ A combination of the subject headings (//) and key words (".") was used in the following way: (*Consciousness/or Awareness/or Perception/or Pain perception/or Movement/or Wakefulness/or "combative" or "alert" or "awake"*) AND (*CPR/or "cardiopulmonary resuscitation" or "cardiopulmonary resuscitations" or "resuscitation cardiopulmonary" or "heart resuscitation" or "cardio pulmonary resuscitation" or "cardiac resuscitation"*).

2.2. Eligibility criteria

Patients: patients of any age receiving CPR within any arrest setting (e.g. out-of-hospital, in-hospital, ICU).

Exposure: CPR-induced consciousness detectable by the rescuer

Comparison: Unconscious in the same study

Outcome: Any reported outcome

Study types: All study types

Articles were excluded if they only reported on consciousness before or after CPR. Further, we excluded reports that described bispectral index (BIS) monitoring as the only measure of awareness, cough-CPR or subjective near-death experiences.

2.3. Information sources

We searched for articles from five databases (Medline, PubMed, EMBASE, Cinahl and The Cochrane Library), extending from the databases' commencement to the 8th of July 2014. Google and Google scholar were used for grey literature searching.

2.4. Study selection

Following the search, duplicates were removed and titles subsequently appraised for eligibility independently by two authors (AO and MS). The abstracts of the selected titles were read, and full-texts were sought for articles meeting the inclusion criteria. Consensus resolved any disagreements concerning inclusion decisions. Reference lists of relevant articles were checked for additional studies.

2.5. Data extraction

From the included papers we extracted demographic data, arrest setting, aetiology and rhythm, level of consciousness, CPR method and time, management and reported outcomes.

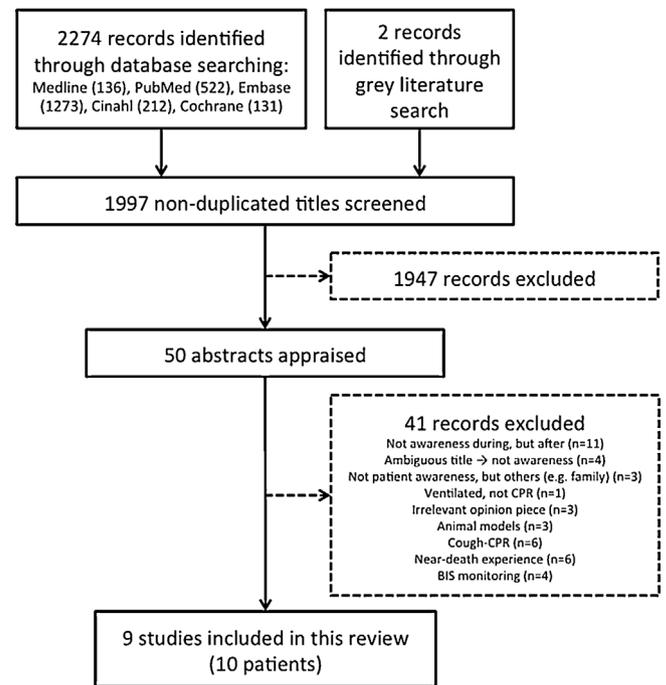


Fig. 1. CPR-induced consciousness PRISMA flow chart.

3. Results

The initial search yielded 2274 records, of which 1997 were unique. Fifty titles met the inclusion criteria; of which 41 were excluded as per protocol (Fig. 1). The nine included reports described 10 patients with a median age of 57 (IQR: 56–60).^{7–15} Six of these reports originated in the USA, two from France, one from Canada and one from Taiwan. Six out of 10 arrests occurred in hospital (Table 1). In five of the six in-hospital reports, CPR was commenced immediately after cardiac arrest. In the report by Lewinter et al. the patient received an immediate 300J counter-shock before mechanical compressions were initiated. In the four cases of out-of-hospital cardiac arrest, one patient had CPR commenced within 1 min, while the remaining cases did not report the timing to CPR.

The level of consciousness included purposeful arm movements in all cases. Additionally, the reports ranged from describing agonal breaths, eye opening and localising painful stimuli. Communication with the rescuer, both verbally and non-verbally were detailed, with a few patients understanding and adhering to the instructions received. In contrast, agitation and attempts to push the rescuer away were also noted. In one case the patient indicated a wish to cease resuscitation. No study reported the coma score using the Glasgow Coma Scale. The timing of consciousness, when

Table 1
Study quality.

Study author	Country	Patient(s), age, gender	Setting	Arrest rhythm	Aetiology of arrest
Frédéric et al. ⁸	France	57 yo male & 58 yo male	Pre-hospital	NR	NR
Tobin and Mihm ¹²	USA	62 yo male	In-hospital	PEA	Heart failure
Yu et al. ¹³	Taiwan	27 yo female	ICU	VT	Myocarditis
Bihari and Rajajee ⁷	USA	57 yo male	ICU	Asystole	Renal failure
Quinn et al. ¹¹	Canada	57 yo male	ED	PEA	AMI
Lewinter et al. ⁹	USA	60 yo female	ED	VT	AMI
McDonald ¹⁰	USA	Mid-forties male	ED	VF	AMI
Fauber ¹⁴	USA	56 yo male	Pre-hospital	VF	NR
Heightman and Greb ¹⁵	USA	61 yo male	Pre-hospital	VF	Arrhythmia

NR = not reported; yo = year-old; ICU = intensive care unit; ED = emergency department; VT = ventricular tachycardia; VF = ventricular fibrillation; PEA = pulseless electrical activity; AMI = acute myocardial infarction.

reported, occurred mainly at the beginning of the arrest. In cases using mechanical CPR devices, consciousness occurred within a few compressions, and disappeared with brief CPR pauses. In two cases,^{7,13} the patient was in and out of consciousness for the first 2 h.

Six patients had CPR performed by mechanical devices, three of these patients were sedated after consciousness was perceived, and three others had no specific management towards consciousness (Table 2). One of the four patients who received standard CPR was sedated. Other actions for the management of consciousness included physical restraint ($n=2$), and instructions to the patient to refrain from reaching for the endotracheal tube ($n=1$).

The length of CPR was documented in six cases. The median resuscitation time was 141 min (IQR: 57–187 min). Extension of the resuscitation time due to the consciousness varied from normal care to transport to tertiary hospitals and extracorporeal membrane oxygenation (ECMO).

Five cases reported that the level of consciousness interfered with the resuscitation, including pushing and grabbing the rescuer, withdrawing from the compressions, and pulling on endotracheal tubes and mechanical devices. Seven cases noted an absence of consciousness during periods of pulse check. Three cases reported additional pulse checks and/or halting CPR, as it was believed that return of spontaneous circulation had occurred. Four of the 10 patients survived to hospital discharge, with one patient recalling the CPR, stating he “remember(ed) this guy on top of me, trying to hold me down, and I just couldn’t get him off me”.

4. Discussion

CPR-induced consciousness has been infrequently reported in the medical literature. Among reported cases, both the level and management of consciousness varied widely. Mechanical devices may be more commonly associated with consciousness during CPR than traditional chest compressions. A perceivable level of patient consciousness had variable influence on the decision to continue resuscitation efforts.

The cause for CPR-induced consciousness is unclear, but is likely the result of a combination of factors. Two cases^{7,12} observed that a mean arterial pressure (MAP) exceeding 50 mmHg was sufficient to awaken their patients. No other reports included MAP readings. While manual chest compression rarely produce a MAP exceeding 40 mmHg,³ reports of higher MAP readings without associated consciousness exist.¹⁶ Individual factors, such as autoregulation,¹⁷ ischaemic threshold,¹⁸ and presence of co-morbidities¹⁹ may also contribute to CPR-induced consciousness, as they may influence brain oxygenation. Furthermore, Bihari and Rajajee⁷ speculated that early and skilled CPR by trained personnel (e.g. in-hospital witnessed arrest) are key factors leading to CPR-induced consciousness. Of the cases reviewed here, the majority occurred in hospital.

More than half (6 out of 10) of the reported cases occurred in the setting of mechanical CPR devices. While mechanical devices have not yet demonstrated improved survival rates compared with manual chest compressions, there is evidence supporting their role in improving the consistency of CPR while reducing interruptions,²⁰

Table 2
Consciousness, management and outcome.

Study author, year	Description of consciousness	CPR	CPR time	Management of the consciousness	Survived to discharge
Frédéric et al. ⁸ (57yo male)	Arm movement upon request. Opened and closed eyes	Automated chest compressions	NR	NR	No
Frédéric et al. ⁸ (58yo male)	Spontaneous movements of both arms	Automated chest compressions	NR	Sedation (not specified)	No
Tobin and Mihm ¹²	Reached for the ETT. Agonal breaths, wiggled toes, moved head, slightly open eyes. Gave “thumbs up” following explanation of the situation.	Manual	Approx. 120 min	The patient was told what was happening and that he had to refrain from pulling out the ETT	No
Yu et al. ¹³	Alert and responsive with finger gestures	Manual	280 min	No	Yes
Bihari and Rajajee ⁷	Brisk localisation of painful stimuli. Attempted to pull out the laryngoscope. Followed and responded to commands.	Manual	195 min	Physical restraint	No
Quinn et al. ¹¹	Purposeful movement. Agitation.	Active compression decompression device	36 min	Midazolam (0.1 mg kg ⁻¹) + succinylcholine (1.5 mg kg ⁻¹) Physical restraint	No
Lewinter et al. ⁹	“Responsive”; “Maintained consciousness”	Thumper	162 min	Small doses” morphine sulfate + diazepam	No
McDonald ¹⁰	Raised arms. Tried to push attending CPR-performer away	Manual	NR	Sedation (not specified)	Yes
Fauber ¹⁴	Grabbed at paramedics. Questioned what they were doing.	ResQPOD & ResQpump	NR	NR	Yes
Heightman and Greb ¹⁵	Moved limbs. Answered questions.	LUCAS Device	Approx. 20 min	NR	Yes

NR = not reported; ETT = endotracheal tube.

as well as improving CPP when compared to standard CPR.²¹ There is a delay between changes to CPP and changes to brain oxygenation during CPR, which is approximately 1.7 min long.⁴ Since manual CPR is paused briefly every second minute, while mechanical CPR can continue uninterrupted, it is likely that consciousness is a consequence of high quality uninterrupted compressions. If uninterrupted CPR becomes more common practice, either through increased use of mechanical CPR devices or improved manual CPR, CPR-induced consciousness may occur more frequently.

The conscious cardiac arrest patient may require specific management. The variation in consciousness described in the identified cases and the paucity of guidelines may explain the different treatment strategies deployed. Two common themes in the reviewed cases were CPR interruption for pulse checks and verification of the cardiac arrest, and patient interference with the resuscitation. Therefore, in situations of CPR-induced consciousness, interruptions to chest compressions are likely and require management. This might include education of the rescuers about the possibility of this presentation, and physical restraint and/or chemical restraint titrated to the patient's level of consciousness.

Four of the 10 patients described were sedated. Two cases did not describe the drug or dose used, one stated "small doses" of morphine and diazepam, while one case used 0.1 mg kg⁻¹ of Midazolam. Although no universal ILCOR guideline exist,³ local consensus-derived guidelines are emerging. A recently published Dutch guideline of pre-hospital CA²² suggested that agitation and/or pain during (mechanical) chest compressions can be treated with 2 µg kg⁻¹ of fentanyl IV (which can be titrated to 4 µg kg⁻¹), and 2.5 mg of Midazolam IV (which can be titrated to 5 mg). Other jurisdictions allow small doses of sedation to facilitate endotracheal intubation in the presence of a gag reflex.²³ These guidelines are not supported by high levels of evidence, but could potentially assist in delivering less interrupted CPR.

In the process of intubation, sometimes before or after CPR, a variety of sedative agents are commonly administered. Such agents include, but are not limited to, Propofol, Thiopentone, Ketamine, Etomidate and Remifentanyl. Common pre-hospital agents are Midazolam, Morphine and Fentanyl. Translating evidence for the use of such agents during CPR will require further studies. Selection of the most appropriate agent(s) and dose(s) will be influenced by the arrest setting (i.e. pre-hospital or in-hospital). Given the differences between these two settings in terms of level of training, jurisdictions and resources available, different treatment modalities are likely required. It is foreseeable that agents with minimal circulatory depression are optimal, as this concern is one of the main reasons clinicians may be reluctant to administer sedation during resuscitation.⁷ Notwithstanding the relatively limited value of advanced life support medications on cardiac arrest outcome,^{24,25} there would be concern that doses of sedation could impact on patient survival.

It is important to note that although agonal breaths may occur without return of spontaneous circulation,³ the presence of respirations and/or pupillary reactivity could help to prolong resuscitation efforts.²⁶ The influence CPR-induced consciousness had on extending the resuscitation time in the reported cases varied. In the case by Yu et al.¹³ despite 2 h of asystole, the presence of consciousness was instrumental in the decision to continue resuscitation efforts. In contrast, in the case by Quinn et al.¹¹ CPR efforts only lasted for 36 min, with the patient in asystole only during the last 14 min. In the case by Bihari and Rajjee,⁷ absence of spontaneous breathing and presence of fixed pupils for 1 h was used to guide the decision to withdraw CPR.

The implication of CPR-induced consciousness on survival, and therefore the value of ongoing resuscitation, is not clear. In a case report of a cardiac arrest due to amniotic fluid embolus, positive

bispectral index (BIS) levels (a measure of cerebral function and a surrogate for consciousness), was reportedly instrumental in deciding to continue resuscitation.²⁷ Although BIS monitoring does not appear to be associated with return of spontaneous circulation (ROSC) or survival,^{28,29} other methods of cerebral oximetry measuring, such as non-invasive infrared spectroscopy may correlate with ROSC.^{30,31} Awareness during CPR, as measured retrospectively in patients who are successfully resuscitated, have been described.³² Although these recalls may provide insight into the nature of human consciousness,³³ they do not interfere with CPR and are currently not perceivable by rescuers.

Overall, the paucity of literature on CPR-induced consciousness limits evidence-based development of management guidelines, necessitating consensus-derived guidelines instead. This review does highlight some potential principles of such guidelines. Firstly, a clear definition CPR-induced consciousness signs are required, which arguably should extend beyond agonal breathing. Secondly, methods of sedation need to be effective and humane, while balanced against adverse effects. In the pre-hospital setting, where physiological monitoring may be more basic, such guidelines may necessarily be more conservative. Thirdly, with respect to the extension of CPR time, we echo the opinion of Yu et al.¹³ and Frédéric et al.,⁸ that the presence and availability of newer treatment alternatives, such as ECMO, should favour CPR extension. Where such options are available, prolonged CPR is being observed, often using mechanical devices, which are capable of delivering higher quality chest compressions over longer periods of time. As such, consciousness during CPR may become more of an emerging phenomenon as such practice becomes more widespread.

This review has limitations. We were interested in CPR-induced consciousness, but given the varied presentation we did not apply strict inclusion and exclusion criteria on the level of reported consciousness. We did not include cases of "awareness" as described in the anaesthetic literature, or near-death experiences since these presentations cannot be detected clinically and do not interfere with resuscitation. The included reports were case reviews, of which some did not undergo peer-review. The small number of reported cases raises the possibility of reporting bias, and limits its generalisability to cardiac arrest populations. The low number of reported cases also hinders evidence-based recommendations for guideline outlining management during consciousness during CPR.

5. Conclusion

CPR may induce consciousness but this is infrequently reported in the medical literature. Treatment strategies for CPR-induced consciousness varied widely, and included physical restraint, administration of a benzodiazepines and/or opiate, or no specific management. The incidence, implications and prognostic value of CPR-induced consciousness remains unknown. Increased awareness by rescuers of the presence of CPR-induced consciousness and development of consensus-based guidelines to treat this condition are required.

Conflict of interest statement

None of the authors have any financial or personal conflicts of interest that could inappropriately influence their work.

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