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Short communication

Cardiopulmonary resuscitation quality: Widespread variation in data intervals used for analysis☆

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ABSTRACT

Aim: There is a growing body of evidence for the relationship between CPR quality and survival in cardiac arrest patients. We sought to describe the characteristics of the analysis intervals used across studies.
Methods: Relevant papers were selected as described in our recent systematic review. From these papers we collected information about (1) the time interval used for analysis; (2) the event that marked the beginning of the analysis interval; and (3) the minimum amount of CPR quality data required for a case to be included in the analysed cohort. We then compared this data across papers.
Results: Twenty-one studies reported on the association between CPR quality and cardiac arrest patient survival. In two thirds of studies data from the start of the resuscitation episode was analysed, in particular the first 5 min. Commencement of the analysis interval was marked by various events including ECG pad placement and first chest compression. Nine studies specified a minimum amount of data that had to have been collected for the individual case to be included in the analysis; most commonly 1 min of data. The use of shorter intervals allowed for inclusion of more cases as it included cases that did not have a complete dataset.
Conclusion: To facilitate comparisons across studies, a standardised definition of the data analysis interval should be developed; one that maximises the amount of cases available without compromising the data's representability of the resuscitation effort.

Introduction

Recently, increased emphasis has been placed on providing high quality cardiopulmonary resuscitation (CPR) to patients in cardiac arrest. Several studies have indicated a significant relationship between survival outcomes and CPR quality parameters such as chest compression depth,[1–5] rate[6] and fraction.[3,7] However, among studies, heterogeneity exists in how CPR quality parameters are reported for individual patients and then used in analysis. In 2007, Kramer-Johansen et al.[8] authored recommendations for uniform reporting of measured quality of CPR. These recommendations proposed that CPR quality data be collected over the entire resuscitation episode. The start of an episode should coincide with the first therapeutic event after arrival at a cardiac arrest patient, including first recorded chest compression, first defibrillator rhythm analysis, or first defibrillation.[8] For studies that investigate CPR quality and survival, it was recommended that researchers use discrete measurement windows of 30 s or less for parameters such as compression depth to detect haemodynamic changes associated with compressions.[8] In terms of undertaking analysis in these types of studies, no recommendations were made in regards to the length of the interval that should be used for analysis, nor the minimum interval length required for inclusion.

In practice, CPR quality is recorded using devices such as the Q-CPR™ (Philips Medical) or the Real CPR Help® (ZOLL Medical Corporation). Such devices provide CPR quality summary data for an entire resuscitation episode as well as on an interval-by-interval basis; however there is variation in the proportion of episode data that is used by researchers for statistical analysis. When considering the relationship between CPR quality and survival across existing

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Table 1
Summary of how CPR quality data was analysed across studies.

No.	Study ID	Cases	Interval used for analysis of CPR quality vs. survival	Event to signify the start of the interval	Minimum amount of data required for inclusion in analysis
1	Abella (2005)[10]	60	First 5 min	Not specified	Not specified
2	Babbs (2008)[1]	695	All available episode data*	Device activation	Not specified
3	Beesems (2013)[19]	199	The first and when available the last complete cycle of CPR	Prompt to "Start CPR" or, if compressions occurred before this, at the first compression	1 cycle
4	Bohn (2011)[21]	300	All available episode data*	Not specified	1 min
5	Camacho Leis (2013)[22]	108	All available episode data*	Not specified	Not specified
6	Cheskes (2011)[11]	815	Data from the first 3 shocks	ECG pad placement	Data for at least 1 shock
7	Cheskes (2014)[20]	2006	Data from the first 3 shocks	Not specified	Data for at least 1 shock
8	Christenson (2009)[7]	506	Minute interval during which first analysis performed and all recorded minute intervals before first analysis	Not specified	1 min
9	Idris (2012)[14]	3098	First 5 min	Not specified	Not specified
10	Idris (2015)[6]	10371	First 5 min	First monitored compression	Not specified
11	Kramer-Johansen (2006)[4]	284	All available episode data*	Not specified	Not specified
12	McInnes (2011)[23]	24	All available episode data*	Not specified	Not specified[a]
13	Niles (2012)[17]	35	First 500 chest compressions[b]	Not specified	Not specified
14	Sheak (2015)[24]	583	All available episode data*	Not specified	Only cardiac arrest events that contained ≥2 min of time-synchronised CPR quality and $ETCO_2$ data were included
15	Stiell (2012)[18]	1029	Minute interval during which first analysis performed and all recorded minute intervals before first analysis	Not specified	1 min[c]
16	Stiell (2014)[2]	9136	First 10 min	ECG pad placement	1 min[c]
17	Sutton (2014)[5]	87	First 5 min	Not specified	Not specified
18	Sutton (2015)[16]	390	First 10 min	Not specified	1 min
19	Vadeboncoeur (2014)[3]	592	Whole resuscitation episode	Not specified	Not specified
20	Vaillancourt (2011)[9]	2103	First 5 min	Not specified	1 min
21	Wik (2005)[15]	75	First 5 min	Start of first recorded chest compression	Not specified

CPR: cardiopulmonary resuscitation; ECG: electrocardiogram; $ETCO_2$: end-tidal carbon dioxide.
* Assumed from other information provided within the paper.
Further restrictions: [a] All CPR epochs lasting less than 30 s were excluded from analysis. [b] The initial 5 chest compressions were excluded from analysis. [c] Cases with >5 min of EMS CPR prior to application of AED pads were excluded.

studies, some studies analysed data collected over the entire resuscitation episode[3] whereas others only included the first 5 min.[9,10] Furthermore, there were variations in when the analysis interval began; in some cases it was from when CPR pads were placed on the patient's chest,[11] whereas in others it was from the first monitored compression.[6] There were also variations between studies in the minimum interval length required for analysis.

We aimed to describe the characteristics of the data analysis intervals used by papers that examined the relationship between CPR quality and survival, noting sources of heterogeneity, so as to encourage a uniform approach to data description.

Methods

We reviewed papers that reported the association between CPR quality and cardiac arrest patient survival. The protocol for locating and selecting these papers was documented in our previous systematic review.[12] In all identified papers, CPR quality was recorded using an automated CPR quality measurement device.

From relevant papers we collected information about (1) the time interval used for analysis; (2) the event that marked the beginning of the analysis interval; and (3) the minimum amount of CPR quality data required for a case to be included in the analysed cohort. We then compared this data across papers.

Results

Twenty-one studies reported on the association between CPR quality and cardiac arrest patient survival (see Table 1). In contrast to our systematic review,[12] we excluded one paper[13] that did not directly examine this association statistically.

Length of analysis interval

The majority of studies analysed data from the start of the resuscitation period, including six studies[5,6,9,10,14,15] that analysed data over the first 5 min and two studies[2,16] that analysed data over the first 10 min. Alternative analysis intervals included: up to the first 500 compressions (not including the first 5 compressions),[17] the minute interval during which the first analysis was performed in addition to all recorded minute intervals before the first analysis,[7,18] and the first, and where available, the last complete cycle of CPR.[19] Two studies used data from the first three shocks.[11,20] In six studies,[1,4,21–24] it was assumed, based on other descriptions in the paper, that the authors analysed all available episode data. In one study[3] it was explicitly stated that analysis occurred over the entire episode.

Start of interval

In two studies,[6,15] the measurement interval commenced from the first recorded compression, in two cases[2,11] from ECG pad placement, in one study[1] from device activation and in another study[19] either from the prompt to commence CPR or, if compressions were initiated prior to this prompt, from the first compression. In the remaining cases the starting point was not explicitly specified.