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Editorial

Chest compressions: The good, the bad and the ugly

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Where exactly is the chest compression, where does it begin, when does it end, how deep does it go and at what rate are they performed? In short – how good or bad is the chest compression? These are some of the questions researchers ask themselves repeatedly. As well as these data, we need to know the proportion of resuscitation time spent giving quality compressions, the ratio of interruptions and several other parameters and we need to evaluate the effect on survival. Considering the increasing capacity for data storage and growing repositories of resuscitation data one might also ask what proportion of valuable research time is spent in analysing compressions.

In recent years there have been a growing number of research reports focussing on the quality of CPR. Studies based on data from resuscitation of cardiac arrest patients both in- and out-of-hospital provided evidence that resuscitation was not performed according to guidelines. In particular, interruptions in chest compressions and ventilations were found to be frequent during CPR.[1,2]

Since then, researchers have developed quantitative measures to characterise chest compressions, such as CPR fraction, compression depth, compression rate.[3–5] The importance of quality CPR and the relevance of these parameters have been verified by researchers who have related the quality parameters to changes in rates of survival, return of spontaneous circulation (ROSC) or other clinical outcomes. The quality parameters give the researchers a valuable tool enabling success or failure to be related to specific compression techniques or other key elements of treatment.[6–11]

Modern defibrillators make all of this possible. Several manufacturers offer systems that also measure signals related to the rescuer's performance. In some devices an accelerometer, possibly with force measurement capabilities, is placed on the sternum of the patient. The captured data have high resolution and each is typically measured several hundred times per second, which provides accurate information on the acceleration and force provided by the rescuers' hands.[12] Both speed and position can be determined. The thoracic impedance signal is measured by passing a current through the electrodes and is changed by compressions and by the volume changes associated with ventilations. The impedance signal will indicate compression rate but not depth. Although, primarily showing the cardiac rhythm, the electrocardiogram (ECG) recording can also indicate compressions, ventilations and defibrillations. In most studies, the quality data are derived by manual or semi automatic review of these signals. Manual evaluation of individual chest compressions is usually used to obtain the quality parameters. This evaluation is often limited to the first few minutes of the episodes. As the number of patients increase, the work involved becomes substantial and requires a lot of the research time.

Algorithms that automatically determine the location of each individual chest compression will enable a reduction in the resuscitation research time spent looking for compressions. Many resuscitation research parameters rely on the chest compression and rhythm annotations and this information, when integrated with the electronic defibrillator log data, can be used to derive these parameters automatically.[13]

The adoption of such algorithms demands careful evaluation against a database with manually annotated chest compressions. This evaluation should assess rates of true and false detections and also compare quality parameters derived manually and automatically.

In a study by Lin et al. in the current issue, quality parameters derived manually are compared with parameters calculated from a compression signal derived from the ECG using empirical mode decomposition (EMD).[14] This method splits the ECG into component signals, and a subset of these are weighted and combined into a compression signal. Several CPR quality indicators are computed and compared with the manually derived ones. This approach might benefit the CPR quality research on data from devices where only ECG is available, without introducing additional equipment to the rescuers. One of the limitations of the method in its current form is that it only evaluated the ECG when the underlying rhythm was asystole. Further development should include evaluation of data derived from all the resuscitation rhythms. The ECG might then be too complex to enable extraction of a compression signal. Alternatively, signals of lower complexity might be better suited for modelling or detecting the compressions.

The advantage of a reliable compression detector should be obvious when considering the development of international registries,[15–17] some of which also store defibrillator data.[15]

An open source device independent compression detection algorithm is essential if data from multicentre studies that use defibrillators of different brands are to be analysed to derive information on CPR quality.

Conflict of interest statement

No conflicts of interest to declare.

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