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Inaccuracy of Patient Care Reports for Identification of Critical Resuscitation Events during Out-of-Hospital Cardiac Arrest

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Introduction

Out-of-Hospital Cardiac Arrest is a leading cause of mortality in the United States.¹ Patients who are treated with cardiopulmonary resuscitation (CPR) for cardiac arrest may achieve return of spontaneous circulation (ROSC), which is characterized by the return of pulses after CPR and/or electrical defibrillation. However, patients may often lose pulses after ROSC, a clinically significant event termed rearrest (RA). Two independent studies have previously shown that RA occurs in approximately 38–39% of cases and that RA is negatively associated with survival.^{2,3} When ROSC occurs, it is very important for medical providers to detect the event without delay so that ongoing chest compressions do not occur while the patient has a pulse, and transport to the hospital can be expedited. The timely detection of RA is also critical to minimizing any absence of blood flow by resuming chest compressions as soon as RA occurs. Reducing the time to identify RA is also a good indicator of adequate CPR quality as unwanted pauses before an intervention are avoided.

Medical providers in the out-of-hospital setting detect RA through the electrocardiogram (ECG) by identifying non-pulsatile rhythms such as ventricular fibrillation (VF), ventricular tachycardia (VT), pulseless electrical activity (PEA), or asystole (AS) as well as a physical check for pulse presence by palpating an artery. When patient care is transferred to the receiving hospital, medical providers that treated the patient then complete a patient care report (PCR). The PCR is a descriptive document that provides a narrative of patient assessment, medical interventions and patient outcomes. PCRs are retained in EMS systems with the purpose of keeping a formal medical record of the prehospital patient care.

Medical directors have the ability to use the PCR to assess for ROSC and RA presence on a case review basis for both quality improvement (QI) and research purposes. It is important that QI assessments for ROSC and RA in the PCR be as accurate as possible because the

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ability to accurately check for the presence of pulses is one of the most critical skills of the medical provider; return of pulses in the OHCA patient is vital for survival. Any deficiencies in ROSC and RA ascertainment by medical providers must be addressed in a timely manner by medical directors and minimal error in the PCR is necessary to streamline the QI process.

We sought to evaluate the accuracy of the PCR in the detection two critical resuscitation events, ROSC and RA, and to specifically compare it to the capabilities of ECG and other signals recorded on the defibrillator monitor, which we considered to be the gold standard determination. We expected to observe a considerable amount of discrepancy between the PCRs and defibrillator recordings.

Methods

Study Design

The study was approved by the University of Pittsburgh Institutional Review Board. The study was designed as a case review of EMS-treated OHCA patients where narrative descriptions of cardiac arrest obtained in PCRs were compared to multi-channel defibrillator data. Both PCR and defibrillator data were evaluated for the presence of ROSC and RA events.

Study Setting and Population

Case data for non-traumatic, EMS-treated OHCA were obtained from the Pittsburgh site of the Resuscitation Outcomes Consortium for the period spanning January 2006 to December 2008 and January 2011 to December 2012. CPR process variables needed to be present for inclusion into the analysis which meant that a full recording of the defibrillator data needed to have existed. The years 2009–2010 were excluded from the analyses due to an ongoing clinical trial during which data were embargoed (ROC-PRIMED).

Measures

Defibrillator data for all cardiac arrests were downloaded and analyzed in a custom MATLAB® software that time-coded the signal traces and displayed them on a graphical user interface. A sample tracing of the graphical user interface can be seen in Figure 1. Defibrillator recordings were obtained from a Philips MRX monitor (Phillips Healthcare, Andover, MA). To confirm ROSC, the defibrillator signal needed to have an audio recording verbalizing pulses, or an ECG conversion to a normal sinus rhythm (NSR) along with a greater than 10 second cessation of chest compressions. RA was determined by one or all of the following: paramedic verbalization of pulse absence on the audio recording or presence of VF, VT, or asystole (AS) along with a greater than 10 second presence of chest compressions. RA due to PEA was required to have audio confirmation of a “loss of pulses.” This approach is outlined in Figure 2. Chest compression presence was determined by assessing for the presence of a rhythmic signal in either the impedance signal trace measured by the defibrillation pads, or a force sensor that was placed on all patients within the study. Primary ROSC and RA was defined as the first event, while secondary ROSC and RA was defined as any successive event that followed the first event.

Data Analysis

After the signal data were marked for ROSC or RA, the corresponding PCR was read to compare findings of presence of ROSC or RA. The narrative component consisting of a written description of the cardiac arrest call, as well as temporal listing of the interventions, were analyzed and read in the PCR. Sensitivities and 95% confidence intervals were calculated using Stata software (Stata Statistical Software: Release 12. College Station, TX)

Results

We processed 1094 OHCA cases in our database. Of these cases, 158 had ROSC and all signals available. In these cases there were 163 instances of ROSC and 53 instances of RA (34%). The sensitivity of PCRs to identify the presence of all ROSC events was .85 (CI .795–.905), to identify primary ROSC events was .85 (CI .793 - .907) and to identify secondary ROSC events was .78 (CI .565 - .995). The sensitivity of PCRs to identify the presence of all RA events was .60 (CI .469 - .731), to identify primary RA events was .71 (CI .578–.842), and to identify secondary RA events was 0 (no secondary RA events were captured). Of the 32 RA incidents captured by the PCR, 15 (47%) correctly identified the correct lethal arrhythmia. The PCR detection outcomes are shown in Figures 3 and 4. If RA was identified by the PCR, the rhythm documented was assessed against the defibrillator ECG data as shown in Figure 5.

Discussion

In the OHCA cases that we analyzed, PCRs were insufficient in capturing ROSC and RA events. We speculate that this result is due to healthcare provider's difficulty in recalling specific, temporal events when completing the PCR after the cardiac arrest resuscitation and/or patient transfer at the hospital have occurred. These findings are supportive of recent evidence of imprecise documentation in time-dependent events in OHCA⁴. Cardiac arrest calls can be especially hectic and the after-the-fact narrative, when not supplemented with additional physiologic signals, may be an inaccurate tool when characterizing critical resuscitation events. Cardiac arrests with multiple ROSC and RA events may be especially difficult to recall and we have shown evidence of this in that secondary RA events were never captured in the PCR report. Inaccuracy in reporting the post-RA ECG rhythm reflects the lack of texture that may be present in PCR data as well.

To provide context to our PCR sensitivity findings, we conducted a literature search of past studies investigating OHCA that reported ECG characteristics and outcomes. Search terms within Pubmed that ranged from 1980–2013 included 'patient care report', 'cardiac arrest documentation', 'out-of-hospital cardiac arrest', and 'resuscitation'. Of the 17 studies we examined, 14 reported findings from PCRs alone^{1,5–17} while 3 extracted their data by using a combination of signal recordings and PCRs^{18–20}. It should be noted however that it was unclear if the "PCR only" studies included ECG recordings in their reports (many EMS systems do not). Therefore to generalize our findings, it would have to be assumed that PCRs consisted of the narrative component only, and excluded any printed or recorded ECG strips. It is also possible that ECGs may be in the PCR but not necessarily utilized.

We found that the ability to capture RA events was less sensitive than the ability to capture ROSC, especially secondary RA events. Successive RA events may be difficult for the medical provider to remember after the cardiac arrest call has finished. In addition to the poor detection capabilities of the presence of RA, the PCR identified the correct lethal RA arrhythmia only 15 out of the 32 incidences of RA. The signal record consisting of at least the ECG recording should be assessed before making ROSC/RA judgments solely based on the PCR.

Limitations

Limitations of the study include the small sample size as well as its retrospective nature. PCRs in other EMS systems may in fact include time oriented resuscitation signals such as ECG, which would be more sensitive to ROSC or RA. The study also limited in that only ROSC and RA were assessed. Perhaps other details of cardiac arrest treatment are documented more effectively in PCRs. The literature search we conducted shows that determining whether these signals exist is most times ambiguous.

Conclusions

We found PCRs to be an inaccurate source of information for assessing the presence of ROSC and RA. Relying on PCRs to accurately capture and identify an RA event is not as effective as defibrillator data. Those using narrative prehospital PCRs for quality improvement and research purposes should consider the limitations of this lone data source and should consider including ECG, audio, and compression data from the cardiac monitor.

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Highlights

- Patient care reports for out-of-hospital cardiac arrest can be inaccurate.
- ROSC and rearrest are often misreported.
- All defibrillator signals and narratives should be used in cardiac arrest research.

Figure 1.
Custom graphical user interface of sample ECG and chest compression data.

Figure 2.
ROSC and RA classification technique from defibrillator data

Figure 3.
ROSC sensitivity ascertainment from defibrillator and PCR data.

Figure 4.
RA sensitivity ascertainment from defibrillator and PCR data

Figure 5.
RA rhythm capture by PCR and defibrillator data.