Video Case Review for Quality Improvement During Cardiac Arrest Resuscitation in the Emergency Department

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Abstract

Background: Cardiac arrests (CA) are a leading global cause of mortality. The American Heart Association (AHA) promotes several important strategies associated with improved cardiac arrest outcomes, including decreasing pulse check time and maintaining a chest compression fraction (CCF) > 0.80. Video review is a potential tool to improve skills and analyze deficiencies in various situations, however its use in improving medical resuscitation remains poorly studied in the emergency department (ED). We implemented a quality improvement initiative, which utilized video review of cardiac arrest resuscitations in an effort to improve compliance with such AHA quality metrics. Methods: A cardiopulmonary resuscitation Video Review Team (CoVeRT) of emergency medicine residents were assembled to analyze CA resuscitations in our urban academic ED. Videos were reviewed by two residents, one of whom was a senior resident (PGY-3 or -4), and analyzed for numerous quality improvement metrics, including pulse check time, CCF, time to intravenous access, and time to patient attached to monitor. Results: We collected data on 94 cardiac arrest resuscitations between July 2017 and June 2020. Average pulse check time was 13.09 (SD $\pm$5.97) seconds, and 38% of pulse checks were less than 10 seconds. After the implementation of the video review process, there was a significant decrease in average pulse check time (p=0.01) and a significant increase in CCF (p=0.01) throughout the study period. Conclusions: Our study suggests that the video review and feedback process was significantly associated with improvements in AHA quality metrics for resuscitation in CA among patients presented to the ED.

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Running Title:

Video Review for Quality Improvement in Cardiac Arrest

Keywords: Cardiac arrest; Resuscitation; Video review; ROSC

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Methods: A cardiopulmonary resuscitation Video Review Team (CoVeRT) of emergency medicine residents were assembled to analyze CA resuscitations in our urban academic ED. Videos were reviewed by two residents, one of whom was a senior resident (PGY-3 or -4), and analyzed for numerous quality improvement metrics, including pulse check time, CCF, time to intravenous access, and time to patient attached to monitor.

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What's known

High quality cardiopulmonary resuscitation and minimal interruptions during chest compressions are core strategies associated with improved outcomes among patients with cardiac arrests.

What's new

Video review process is a valuable tool to improve skills and identify areas of performance improvement during cardiopulmonary resuscitation. This study shows pulse check times and chest compression fraction significantly improved with video review process

1. Introduction :

Cardiac arrests (CA) are the leading global cause of mortality.[1] In the United States alone, more than 500,000 CAs occur each year.[2] Survival rates of CA remain dismal with less than 15% of patients surviving to hospital discharge.[3]

Given the tremendous morbidity and mortality associated with CA, the American Heart Association (AHA) promotes several important strategies associated with improved outcomes. Chief amongst these strategies is high quality cardiopulmonary resuscitation (CPR). Minute changes in CPR quality, such as the percentage of chest compression fraction (CCF) and duration of pulse checks, correlate with return of spontaneous circulation (ROSC) and survival to hospital discharge. Several studies emphasize the importance of decreasing interruptions during chest compressions while maximizing CCF to improve patient outcomes.[4–7]

Despite these studies and interventions from the AHA, improving the quality of CPR and outcomes of CA remains difficult. This difficulty may arise from the often chaotic environment of the resuscitation bay and inherently poor outcomes. Many have strived to improve cardiac arrest outcomes through pre-hospital and in-hospital initiatives. Given its association with increased survival, the AHA has focused significant resources on improving rates of bystander CPR.[8] Furthermore, emergency departments (ED) have minimized the impact of the chaotic environment of resuscitations by improving communication and decreasing the number of interruptions in CPR.[9,10]

Video review is another tool to improve skills and identify areas of performance improvement.[11] Outside of cardiac arrest, video review has become a key practice in trauma centers to evaluate adherence to Advanced Trauma Life Support (ATLS) protocols.[12–14] However, there is little literature on the effect of video review on CA resuscitations in the ED.[11,15]

Our goal was to utilize video review of resuscitation in CA patients to drive quality improvement. We sought to improve our compliance with AHA quality metrics. To accomplish these goals, we collected and analyzed data for key resuscitation metrics.

2. Methods :

2.1 Data Collection

This was a prospective, observational study evaluating the care provided by emergency medicine physicians, nurses, and technicians at a single, urban, tertiary institution with 80,000 annual patient visits between July 2017 and June 2020. The project was approved through the Institutional Review Board (IRB#031819). A real-time video recording system in three resuscitation bays collected data for review. Researchers exported video within 72 hours of capture, after which the video was automatically deleted. Each day, the electronic medical record (EMR) was used to identify any patients who may qualify for the study and footage was reviewed from that time. If a qualifying case was found, the video was exported to an encrypted, password-protected flash drive which was stored in a locked office. Data collection was performed by reviewing the footage and corresponding medical record. Data points were collected on each case in accordance with the Cardiac Arrest Registry to Enhance Survival (CARES) .[16] Videos underwent review by two CoVeRT resident members to ensure accuracy and consistency. For each case, at least one reviewer was a post-graduate year 3 or 4 resident. Reviews were performed independently and a faculty member reviewed the data to ensure accuracy and consistency in observed values.

2.2 Criteria

Inclusion criteria were patients greater than 18 years old with out-of-hospital cardiac arrest (OHCA) and

transported to our facility, who were then placed in a resuscitation bay with AV recording capabilities. Patients who had return of spontaneous circulation (ROSC) prior to arrival were included if cardiac arrest recurred within the first 10 minutes of arrival to the ED. Exclusion criteria were patients with traumatic arrest, clinical death prior to arrival, ROSC prior to arrival with no further CPR during the ED stay, no CPR within the first 10 minutes of the visit, pulse detected at first pulse check, primary in-hospital arrest, or failed video capture.

2.3 Review Standards

Arrival time was the time of transition from the emergency medical services (EMS) stretcher to hospital gurney. Study data included all pauses in compressions, including pauses for procedures, pulse checks, compression device malfunction, or other causes. The case was considered completed 5 minutes after ROSC was achieved. Time of death was the time that death was announced. Time of ROSC was the time a palpable pulse was announced by either the code leader or provider who palpated the pulse. Pulse checks identifying ROSC or termination of resuscitative efforts were not included in analysis. Primary quality metrics were pulse check times and chest compression fractions. Secondary metrics included time to IV access, and time to patient connection to the monitor.

2.4 Participant Feedback

After review of a case, all involved care providers (technicians, nurses, resident physicians, and attending physicians) received individualized feedback over secure email, including objective data such as average pulse check time and compression fraction (Appendix 1). Subjective feedback was also included.

2.5 Educational Presentations

Resident physicians, attending physicians, advanced practitioners, nurses, and emergency medicine technicians attended presentations during protected emergency medicine grand rounds. These were private, closed-door sessions during which participants were reminded that all information shared was for educational purposes only, and was not to be discussed outside of the session. Members of the resuscitation team on the case that was being presented were made aware that the video would be presented beforehand. Members were able to opt out if desired. Each session began by emphasizing that review was for educational purposes only. Researchers presented selected cases with a complete review of video footage, followed by a lecture on relevant topics related to CPR. Topics included team roles, point-of-care-ultrasound, treatment of persistent ventricular fibrillation, airway management during CPR, team communication, post-resuscitation care, the presence of family during resuscitation, use of tPA in cardiac arrest, the Lazarus phenomenon, CPR-induced consciousness, and termination of resuscitation. Videos were broken down to discuss areas for improvement in communication, pulse checks, and a number of other factors. Cases chosen for lecture review remained on the encrypted hard drive until completion of the lecture, while all other cases were deleted immediately after review.

2.6 Statistical Analysis of Improvement Factors

Pulse check length and percent compression fraction were the primary outcomes of this study. Statistical analysis of pulse check length and percent compression fraction throughout the study period was performed by way of Spearman's rank correlation coefficient, a standard approach to detect trends over a specific time period. The coefficient, rho, is a measure of rank correlation between time and an outcome measure with the null hypothesis that there is no (monotonic) increase or decrease in the outcome measure over the study period. A rho of +1 or -1 indicates a perfect correlation in the positive or negative direction, respectively, while a rho of zero indicates no change in the outcome measure over the study period. Statistical significance was defined by $p<0.05$ in the analysis unless noted otherwise. All statistical analyses were performed using STATA (Stata Corp. Release 16. College Station, TX; Stata Corp LLC.).

3. Results:

Between July of 2017 and January of 2020, we captured a total of 94 cardiac arrests on video review (Table

1).

3.1 Pulse Check Time

There were 94 patients who had pulse check time recorded. The average pulse check time was 13.09 (SD±5.97). 38% of pulse checks were less than 10 seconds. There was a significant decrease in average pulse check time over the duration of the study period (rho= -0.26; p=0.01) (Figure 1). The average pulse check times per quarter are listed in Table 2.

3.2 Chest Compression Fraction

There were 93 patients who had CCF data available. One was excluded for incomplete data. The Spearman's correlation coefficient indicated a significant increase in CCF over time (rho= 0.26; p=0.01) (Figure 2). The average CCF per quarter is listed in Table 2.

3.3 Time to Monitor

There were 91 patients who had data for time to monitor. The average time to placement on the monitor was 80.22±56.63 seconds. The Spearman's correlation coefficient indicated no significant change in time to monitor over the duration of the study period (rho= -0.04; p=0.69).

3.4 Time to IV Access

There were 81 patients who had data for time to IV access. Patients were excluded if EMS had established IV access prior to arrival. The average time to IV access was 240±179.94 seconds. The Spearman's correlation coefficient indicated no significant change in time to IV access over time (rho= -0.12; p=0.29).

3.5 Feedback

Over the course of the study period, there were 12 grand rounds lectures given. Each lecture was given to approximately 30 residents resulting in a total of approximately 360 unique educational exposures. Grand rounds lectures included minute-by-minute review of recorded cases. Granular feedback was provided on all aspects of each resuscitation. Examples include details such as the positioning of the gurney and the movement of team members around the resuscitation bay, to the use of closed-loop communication and pulse check time. Further feedback was elicited from audience members including attendings, fellows, and residents. In addition to breakdown of each video, a traditional educational lecture was provided in conjunction with each case.

Following video review of a case, follow-up feedback was provided to the team, including the attending physician, residents, nursing staff, and emergency technicians. Feedback was sent via encrypted email. Included were the average pulse check time, CCF, time to IV access, and time to monitor placement for each case (Appendix 1). Furthermore, each email provided individualized commentary on notable aspects of the case along with areas for that should be targeted for improvement (Appendix 2).

4. Discussion

Cardiac arrest is a rare but highly fatal presentation in the ED. Often with little time to prepare, the resuscitation bay can be a chaotic environment where planned or simulated protocols break down. This makes high-fidelity quality improvement difficult, but greatly needed. CoVeRT utilizes video review as a quality improvement tool to improve metrics associated with increased survival in OHCA, to enhance resident education, and to develop interdisciplinary team dynamics in the ED.

Data from Jiang et al. suggests that video review can identify deficiencies in CPR in the ED.[15] Rolston et al. went further by showing that video review can improve outcomes and found an associated increased rate of ROSC.[11] We are the first to have demonstrated that video review of OHCA resuscitation can not only identify areas in need of improvement, but also enact change and increase compliance with AHA quality metrics. For example, our data suggest that the video review process was associated with a significant improvement in pulse check times. The AHA recommends limiting pulse checks to less than 10 seconds,

however, many resuscitation teams struggle to meet this metric.[17,18] Our data indicate that, with video review, we reduced pulse checks over time. Although, the overall average of our pulse check time was still greater than10 seconds. Furthermore, our results indicate an association between our interventions and a significant increase in CCF. The AHA recommends a total CCF of greater than 0.80, meaning that chest compressions occur more than 80% of total resuscitation time. Prior literature demonstrates improved survival with CCF of 0.6-0.8 in patients with cardiac arrest due to ventricular fibrillation.[19] Our data indicates not only that CCF improved over time with the establishment of CoVeRT, but also that only one case had a CCF less than the recommended 0.80.

Time to IV access and time to placement of the monitor are not AHA quality metrics, and there is no published data on these metrics in CA resuscitation. However, we consider them important to measure given that they represent essential components of a well-run resuscitation. Our data suggests that there was no significant change in these data points over time. Many patients arrive with an IV already in place. Additionally, time to IV access is more likely patient- and operator-dependent. Monitor placement is an essential aspect of any resuscitation and is one that our nurses and technicians prioritize.

Finally, regarding education, resident members of CoVeRT presented a total of 14 Grand Rounds lectures. Topics ranged from leadership and communication, to advanced resuscitation topics such as dual sequential defibrillation and the use of tPA in cardiac arrest. Group video review supplemented each lecture in order to allow open discussion of different perspectives on which aspects went well for each case and which could be improved upon. Additionally, feedback was sent to each resuscitation team regarding the metrics for each case. It has been demonstrated that such audit-feedback techniques are associated with improved performance by healthcare providers, and, specifically in resuscitation, improved chest compression performance.[20–22]

5. Limitations

Given the relative rarity of CA, the size of our sample is a limitation to our study. Additionally, our study was a single-center at an academic institution. The generalizability of the use of video review for quality improvement is also a limitation. Video review proved to be a time intensive endeavor. It required residents, in addition to their clinical commitments, to be on call in order to check the EMR and capture the video in time. Video capture had to occur in person in a narrow time window of 72 hours due to medico-legal requirements. Furthermore, video review time varied depending on the length of the resuscitation. The person-hours required to review video doubled to ensure the consistency between the reviews, requiring two residents to review each video. However, it is worth noting that even in the absence of video review capabilities, individualized and team-based feedback systems can, and should, be implemented to enhance compliance with AHA metrics and improve the quality of CA care in the emergency department. Such feedback systems can be implemented at both large academic centers and community sites through multiple means including but not limited to video review. Only three resuscitation bays in our ED have video review capability. Thus, the data set did not include resuscitations that occurred in other rooms. At the time of this article, the COVID-19 pandemic has greatly affected both video-collection capabilities and educational experience. Attempting to limit house staff exposure to the hospital environment greatly reduced our ability to collect data. Furthermore, CoVeRT educational experiences during Grand Rounds were discontinued due to the constraints of video review over online video conferencing platforms that are not HIPAA-compliant. Lastly, the increased utilization of PAPRs and masks impaired the camera quality and microphone sensitivity and has made certain communication inaudible.

6. Conclusion

In our urban academic emergency department, we utilized video review to help significantly improve both pulse check times and CCF. We demonstrated an improvement in both of these variables over our study period. Quality improvement initiatives aimed at providing individualized feedback should be implemented to enhance compliance with AHA metrics during CA. Further studies evaluating video review for similar high-stress situations are needed.

Conflict of Interest:

The authors do not have a financial interest or relationship to disclose regarding this research project. This is a non-funded study, with no compensation or honoraria for conducting the study.

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Table 1. Patient Demographics

Table 2. Pulse Check Time & CCF by Quarter

Figure 1. Pulse Check Time Trend

Figure 2. Chest compression fraction (CCF) Trend

Table 1. Patient Demographics	**Table 1. Patient Demographics**	
Age (mean±SD)		59.16±13.4
Sex	**n**	**%**
Male	64	68.10%
Female	30	31.90%
Race	**n**	**%**
African American	60	66.70%
White	27	30.00%
Hispanic	1	1.10%
Other	2	2.20%
Comorbidities	**n**	**%**
Coronary artery disease	10	10.60%
Hypertension	26	27.70%
End stage renal disease	12	12.80%
Cerebrovascular accident	4	4.30%
Diabetes Mellitus	21	22.30%
Veno thromboembolism	2	2.10%
None	19	20.20%

Table 2. Pulse Check Time & CCF by Quarter

Quarter	**Pulse Check Time Mean**	**Pulse Check Time SD**	**Quarter**	**CCF* Mean**	**CCF* SD**
1	16.29	5.29	1	0.915	0.02

2	12.34	6.82	2	0.932	0.04
3	11.99	5.45	3	0.939	0.03
4	11.81	4.43	4	0.934	0.02
Total	13.09	5.97	Total	0.93	0.03

*CCF: Chest compression fraction

Appendix 1. Example of Case Feedback

To: Team Member's Secure Email Accounts

CC: Nursing Leadership, Principle Investigator, Emergency Medicine Residency Program Director

ER team members,

The CPR Video-Review Team recently reviewed a case in which you were involved. The team provides quality improvement for prehospital CPR cases. The team has reviewed the case with Dr XXX and developed the feedback below. Here are some statistics from your case in ***{INSERT Room and DATE}****:*

Door to Monitor (Zoll) time: 1 min 54 seconds (below average)

Door to IV access time: 6 min 27 seconds

Time to iStat Result: (optional)

Average pulse check time: 20 seconds

Percentage of "Hands On" compressions time: 89.4%

Percentage of closed loop communication: 45%

Our overall goal is to minimize our door to monitor and IV access times, increase our "Hands On" time to greater than 90%, and have pulse checks less than 10 seconds.

Additionally, we wanted to note that {INSERT CLINICAL FEEDBACK}.

Thank you for participating in this program. Please contact us if you have any questions or concerns, we appreciate your time. Please continue to make an effort to utilize the [videotaped] resuscitation bays to increase the number of cases we can capture.

[Nursing leadership], *please pass this along to the nurses and techs who assisted in this resuscitation.*

Appendix 2. Team Feedback Examples

12/26/17

"The team performed very well together, with minimal interruptions or unneeded communication/noise. The team trouble-shooted the LUCAS device quickly and made adjustments appropriately. The team shocked the patient without stopping the LUCAS, allowing for more hands-on time during CPR. Overall, the only addition we would add is to consider converting to hands-on CPR if the LUCAS failed in the future. Your patient was admitted to the ICU and was later transitioned to comfort care. It appears she was an organ donor, so congratulations to the team for your hard work."

8/14/18

"The team did a great job of staying on the same page during this resuscitation under AAA leadership. The pulse check time was an amazing 8 seconds despite the use of cardiac ultrasound during all the pulse checks. Thank you to BBB for recording the ultrasound clips and analyzing after the pulse check! CCC, great job getting out of the head of the bed once the airway was confirmed. AAA, continue to improve on your closed loop communication and waiting for responses to your commands. Your team did a great job of picking up

un-directed commands (i.e. "is the monitor on?") this time. CCC and DDD did a great job of placing the patient on the monitor and securing IV access quickly - remember to call out loudly once the IV is in. Overall, great teamwork and communication in this resuscitation."

2/16/19

"The team did a great job of working together. This was a tough case all around - with difficult IV access and a difficult airway. The team stayed on top of the patient's vital signs and reacted immediately to all changes. The team kept the (single) pulse check before the first ROSC short at 8 seconds even with the use of ultrasound. The nursing staff were clear, loud, direct, succinct, and effective in their communication. Keep it up!"