Google Glass Video Capture of Cardiopulmonary Resuscitation Events: A Pilot Simulation Study

Stacey M. Kassutto, MD
Joshua B. Kayser, MD, MPH, MBE
Meeta P. Kerlin, MD, MSCE
Mark Upton, MD
Gregg Lipschik, MD
Andrew J. Epstein, PhD, MPP
C. Jessica Dine, MD, MSHP
William Schweickert, MD

ABSTRACT

Background Video recording of resuscitation from fixed camera locations has been used to assess adherence to guidelines and provide feedback on performance. However, inpatient cardiac arrests often happen in unpredictable locations and crowded rooms, making video recording of these events problematic.

Objective We sought to understand the feasibility of Google Glass (GG) as a method for recording inpatient cardiac arrests and capturing salient resuscitation factors for post-event review.

Methods This observational study involved recording simulated cardiac arrest events on inpatient medical wards. Each simulation was reviewed by 3 methods: in-room physician direct observation, stationary video camera (SVC), and GG. Nurse and physician specialists analyzed the videos for global visibility and audibility, as well as recording quality of predefined resuscitation events and behaviors. Resident code leaders were surveyed regarding attitudes toward GG use in the clinical emergency setting.

Results Of 11 simulated cardiac arrest events, 9 were successfully recorded by all observation methods (1 GG failure, 1 SVC failure). GG was judged slightly better than SVC recording for average global visualization (3.95 versus 3.15, $P = .0003$) and average global audibility (4.77 versus 4.42, $P = .002$). Of the GG videos, 19% had limitations in overall interpretability compared with 35% of SVC recordings ($P = .039$). All 10 survey respondents agreed that GG was easy to use; however, 2 found it distracting and 3 were uncomfortable with future use during actual resuscitations.

Conclusions GG is a feasible and acceptable method for capturing simulated resuscitation events in the inpatient setting.

Introduction

Cardiac arrest is a significant public health concern, with over 200 000 in-hospital arrests occurring annually. Despite hospitalization and immediate access to advanced cardiac life support providers, estimated survival is only 18%.[1] Concerns exist regarding variability in resuscitation care quality and guideline adherence. One study showed that 28% of in-hospital arrests had at least 1 error in care delivery. Not surprisingly, these patients also had decreased survival.[2]

Post-event debriefing and performance feedback can mitigate errors and improve resuscitation care.[3] A combination of debriefing and audiovisual feedback from defibrillators significantly improved resuscitation performance.[4] However, a survey published in 2007 of internal medicine residents showed that only 1% routinely received resuscitation performance feedback, and 55% worried that they had previously made errors during cardiac arrest care.[5]

Enhanced post-arrest provider feedback and education are needed. Reliance on provider recall and written documentation are major limitations to code debriefing and performance review. However, providing ideal real-time observation by clinical experts at all hours and locations is challenging, even in a research setting.

Video recording has been successfully utilized in resuscitation in the trauma bay to assess guideline adherence and provider performance feedback.[6] In contrast to arrests in the trauma bay, inpatient cardiac arrests occur at unpredictable sites in small crowded rooms, making use of conventional recording devices problematic. As a result, no study has focused on hospital-wide video capture of cardiac arrest events.

Given these limitations, novel, easy-to-use methods of resuscitation event capture should be considered. Google Glass (GG; Google, Mountain View, CA) is a wearable technology with an optical head-mounted display and 720p high-definition video-recording capability. Unlike a handheld cellular device, GG is hands free and, in contrast to the GoPro (San Mateo, CA), does not require a head mount or real-time adjustment of the image-capture angle. Although several studies have explored GG's utility in surgical education, teleconsults, and real-time remote feedback during pediatric resuscitation, its ability to capture interpretable footage of cardiac arrest

DOI: http://dx.doi.org/10.4300/JGME-D-17-00155.1

resuscitation for post-event review has not been investigated.[7–9]

In this study, we compared video capture of simulated resuscitation events using GG and a stationary video camera (SVC) with in-room physician direct observations (DOs). We hypothesized that GG is a feasible and reliable method for recording inpatient cardiac arrests and capturing salient resuscitation factors.

What was known and gap
Recording and debriefing cardiopulmonary resuscitation events offer opportunities for valuable feedback on trainees, yet current technology has limitations.

What is new
A test of Google Glass mobile technology for recording simulated resuscitation events and comparing it with stationary video camera and in-room physician direct observation.

Limitations
Small sample, single institution study limits generalizability.

Bottom line
Google Glass is a feasible and acceptable method for capturing simulated resuscitation events.

Methods

Setting and Participants

We conducted 11 simulated in situ cardiac arrests at the Corporal Michael J. Crescenz Veterans Affairs Medical Center (VAMC) in Philadelphia from March through July 2015. All events simulated a pulseless patient with a shockable rhythm. Local health care staff (including physicians, pharmacists, respiratory therapists, and nurses) were expected to respond and participate. Individual participants varied among simulations. The code team leader was an internal medicine resident certified in advanced cardiac life support (in accordance with real practice). A member of the clinical unit's nursing staff was assigned as the bedside nurse and first responder.

All simulations used a high-fidelity simulation mannequin (SimMan3G, Laerdal Medical, Wappingers Falls, NY) operated by a simulation expert. SimMan and the associated simulated code cart, medications, and the defibrillator were brought to the patient room prior to simulation initiation. All other necessary equipment was obtained directly from the point of care.

Intervention

To assess resuscitation behaviors, 24 distinct factors were identified based on prior research of resuscitation quality, national guidelines, and expert opinion (TABLE 1).[10,11] An observation evaluation form was created to include these factors, which were each classified as *visualized/heard well*, *visualized/heard poorly*, *clearly not done*, *unsure if performed*, or *not indicated*. In-room physician direct observers and video reviewers all completed the form and provided global visualization and audibility scores using a 5-point Likert scale.

TABLE 1
Summary of 24 Resusctiation Factors Assessed by Video Reviewers[a]

Factors Visualized	Factors Heard
Airway placement	Code leader self-identification as team leader
Airway confirmation (capnography or ETCO2)	Announcement of rhythm identification
Establishment of IO or IV access	Announcement of defined role assignment
Initiation of chest compressions	Verbal communication between resuscitation team members
Quality of chest compressions	Orders given by code leader
Rate of chest compression delivery	Requests for defibrillation
Hands-off time between compressions	
Rate of ventilation delivery	
Delivery of first defibrillation	
Delivery of subsequent defibrillations	
Number of individuals present	
Rhythm on monitor	
Medication administration timing	
Equipment availability	
Equipment functionality	
Enactment of defined roles	

Abbreviations: ETCO2, end-tidal CO2; IO, intraosseous; IV, intravenous.
[a] Reviewers were asked to rate factors as *visualized/heard well*, *visualized/heard poorly*, *clearly not done*, *unsure if performed*, or *not indicated*.

FIGURE 1
Recreation of Simulated Cardiac Arrest Detailing Room Location of Observation Methods Used

Note: The location of each observation method within the simulated patient room (center photo) is indicated by the arrows. Photos of the stationary video camera (top left) and Google Glass (top right) and example screen shots of video capture obtained by each recording method (Google Glass [bottom right] and stationary video camera [bottom left]).

All simulations were observed using 3 methods: (1) DO by 2 in-room board-certified internists; (2) SVC video recording; and (3) GG video recording. DO was used as the gold standard for event occurrence. The SVC (CAE Healthcare LearningSpace VHA Solutions Portable AV System, Sarasota, FL; $20,794) was placed in the corner of the room at the foot of the patient's bed, atop a mobile cart and angled toward the bed containing SimMan. The SVC location and height were optimized prior to simulation initiation. GG (Explorer Edition, $1,500) was handed to the physician code leader upon his or her arrival with video recording already in progress. The code leader wore the glasses for the duration of the scenario (FIGURE 1).

Four physicians and 4 nurses with patient safety, simulation, and/or critical care expertise reviewed all video recordings in no particular order. Reviewers received a detailed written document with viewing instructions and completed a practice review prior to viewing study simulations. The direct observers did not participate in video review given their prior knowledge of the events of each simulation.

Resident code leaders were invited to complete an electronic, deidentified 17-question survey (developed by the authors without prior testing) detailing their impressions of GG as a resuscitation observation and feedback tool. All surveys and observation forms were administered electronically via the REDCap data management system.[12]

Outcomes

Primary outcomes were the average global visualization and average global audibility scores. Secondary outcomes included the percentage of resuscitation factors visualized well, the percentage of resuscitation factors heard well, and the percentage of video observations where technical recording issues prevented overall resuscitation interpretability.

This project was approved by the VAMC Institutional Review Board.

Analysis

In-room physician DOs were reviewed for resuscitation factors that consistently occurred in all events. For each analyzed resuscitation factor, video reviewer responses were clustered into 3 categories: (1) *visualized/heard well*; (2) *visualized/heard poorly*; and (3) *clearly not done/unsure if performed/not indicated*. Only events that were witnessed and documented as occurring by both in-room physician DOs were included in analyses. Events categorized as *clearly not done*, *unsure if performed*, or *not indicated* were excluded because neither GG nor SVC could capture an event that did not occur. For example, if an airway clearly was not established as documented by both DOs, this factor would not be included in event analyses.

The percentage of events visualized well for each resuscitation factor was calculated as a percentage of

TABLE 2
Summary of Factors Visualized Well by Observation Method[a]

Resuscitation Factor	GG, n (%)	SVC, n (%)	DO, n (%)	Overall *P* Value	GG Versus SVC *P* Value	DO Versus SVC *P* Value	DO Versus GG *P* value
Visualized factors							
Initiation of CPR	60 (83)	61 (85)	18 (100)	.18	.82	.07	.06
CPR quality	48 (67)	39 (54)	18 (100)	.001	.13	< .001	.004
CPR rate of delivery	47 (65)	43 (60)	18 (100)	.005	.49	.001	.003
Hands-off time between compressions	43 (60)	41 (57)	17 (94)	.05	.82	.012	.02
First defibrillation delivery	54 (75)	45 (63)	17 (94)	.19	.25	.09	.42
Number of individuals present in room	37 (51)	55 (76)	18 (100)	< .001	.002	.002	< .001
Rhythm on monitor	19 (26)	4 (6)	5 (28)	.009	.002	.018	.10
Audible factors							
Verbal communication between team members	64 (89)	63 (88)	17 (94)	.58	.84	.34	.23
Orders given by code leader	70 (97)	67 (93)	17 (94)	.51	.25	.83	.06
Defibrillation requests	71 (99)	69 (96)	18 (100)	.44	.31	.38	.62
Global ratings							
Overall visualization**	3.75	3.08	4.28	.001	.008	< .001	.15
Overall audibility**	4.83	4.51	4.89	.049	.018	.25	.87

Abbreviations: GG, Google Glass recording; SVC, stationary video recording; DO, direct in-room physician observation; CPR, cardiopulmonary resuscitation.

[a] Numbers listed are pooled number of individual observations by method. A total of 9 simulated events were reviewed by 8 reviewers for a total of 72 individual video reviews each for GG and SVC. There were 2 DOs for each of 9 simulated events for a pooled total of 18 observations. All numbers are reported as total number of observations with the exceptions of those with ** (which are reported as an average score on a 5-point Likert scale).

total video reviews for each recording method. Pearson's chi-square test was used to assess for differences between recording methods. To assess interrater reproducibility, the intraclass correlation (ICC) statistic was calculated for resuscitation factors for each observation method. The ICCs calculated for global visualization and audibility scores were analyzed using the original 5-point Likert scale. A *P* value of .05 was considered significant. All analyses were performed using STATA version 13.1 (STATA Corp, College Station, TX) with the exception of the ICCs, which were calculated using StatTools, a web-based statistical toolkit.[13]

Results

Of the 11 simulations, 9 were successfully captured by all 3 observation methods. Two simulations had recording failures (1 by GG and 1 by SVC) and were excluded. Of the 24 identified resuscitation factors, 10 were performed in all simulations according to both physician DOs (TABLE 1). Eight experts reviewed all GG and SVC recordings for all 9 events (144 total video reviews, 72 for each method).

Of the 10 analyzed resuscitation factors, 5 were heard or visualized well for all observations by DOs, whereas neither GG nor SVC achieved this for any factor analyzed (TABLE 2). For 1 of 10 resuscitation factors, GG had a higher percentage of events *visualized/heard well* compared with SVC: visualization of rhythm on the monitor, 26% (19 of 72 observations) GG versus 6% (4 of 72 observations) SVC ($P = .002$) and 7% (5 of 72 observations) by DO ($P = .009$). See FIGURE 2 for comparison of visibility and audibility ratings of key resuscitation events among the 3 observation methods.

GG yielded significantly higher global ratings than SVC for overall visualization (3.95 versus 3.15, $P = .0003$) and audibility (4.77 versus 4.42, $P = .002$). Compared with SVC, DO had the highest global visualization ratings. No differences in global ratings were observed between GG and DO for overall visualization and audibility. When video reviewers were asked if the video-recording method limited overall simulation interpretability, GG outperformed SVC (19% [14 of 72] of GG reviews noted limitations versus 35% [25 of 72] of SVC reviews, $P = .039$). Video reviewers had poor agreement regarding perceptions of the performance of the identified resuscitation factors. The ICC of event scoring was highly variable, ranging from –1.17 to 0.80.

Of 11 residents, 10 completed the survey (3 postgraduate year 1 [PGY-1], 6 PGY-2, 1 PGY-3; 70% male). All agreed GG was easy to use. However,

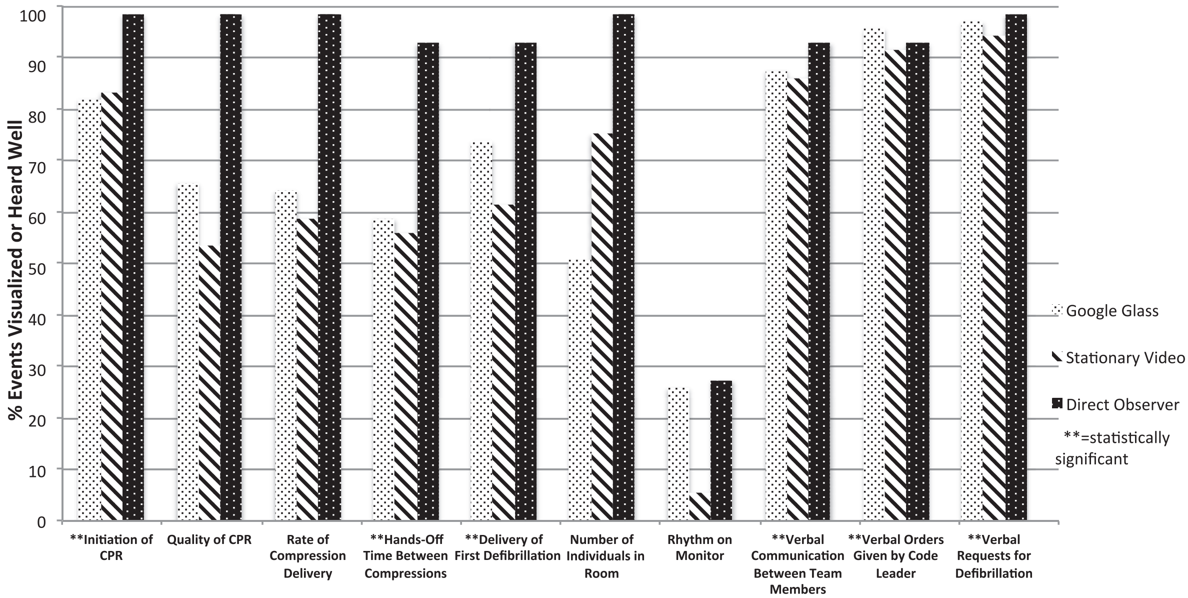

FIGURE 2
Visibility and Audibility Ratings of Key Resuscitation Events During Simulated Cardiac Arrests

2 found it to be a distraction from clinical care. Although all 10 residents wanted more directed feedback on their performance during clinical emergencies, 3 were uncomfortable with video recording during actual resuscitation care. Comments included issues with battery life, increased heat emission from the device during use, visual fatigue from the peripheral optical screen, and lack of familiarity with device operation. Of the 3 residents with prescriptive eyewear, all denied any issues with GG fit over their own glasses.

Discussion

In this first study of GG for simulated cardiopulmonary resuscitation event capture, GG was slightly better than SVC for global visibility and audibility. In-room physician DO demonstrated the best visual and audio capture. Although rhythm monitoring was captured poorly by all methods, GG was similar to DO and better than SVC. Residents found GG generally acceptable.

None of the observation methods achieved perfect visualization and audibility in all events for all factors assessed. This is likely due to the chaotic and unpredictable nature of resuscitation, even in a simulated setting. Use of GG should provide benefits due to the mobile nature of the head-mounted camera aligned with the code leader's field of vision, and theoretically, the most likely points of key clinical activity. In contrast, the SVC was sometimes placed at an unpredictably suboptimal fixed location prior to event initiation. Although positioning of the DO and SVC was not standardized, given variable patient room layout, we believe these inconsistencies would be exacerbated in a real clinical setting. Thus, portability, hands-free design, and the potential for rapid easy set-up are key advantages of GG compared with other methods of video capture, like SVC. However, GG's cost, availability, and user acceptance are critical factors that might further influence the choice of recording modality.

Residents' responses indicated a willingness to be video recorded, but the sentiment was not universal. Developing acceptance and resilience to video-based debriefing may be an important eventual goal for training programs. Perceived distraction from GG may be prohibitive for use in real patient care, although desensitization training may be possible. Because testing was performed in a simulated setting to avoid potential adverse effects on patient care, we were not able to assess some aspects of feasibility, including the practicality of a provider carrying and self-operating GG or battery life. Finally, the perceptions of other stakeholders (patients, family members, and other clinicians) need to be considered for ethical reasons, particularly given the overt nature of the recording device.

Limitations of this study include a small sample size, single-site testing, and lack of calculation of power needed to detect a difference between recording methods. Although in-room physician DO was used as the gold standard for event occurrence, we acknowledge that even this is imperfect and could contribute to flawed interpretations. Given the small number of observations, our analyses did not account for clustering by either reviewer or scenario. In addition, performing multiple associations between recording method and event capture may have produced spurious findings. As our interrater reliability was highly variable, some findings could change with alterations to the observation tool and rater training. We recognize that having only the code leader wear GG may limit capture of other team members' skills and competencies.

The variable interpretation of events by DOs indicates that identifying additional methods of objective event capture is valuable. Future study should include obtaining validity evidence for the resuscitation assessment tool, testing device ease of use by providers, and further examination of the acceptability of GG video recording by residents and the health care team for both simulated and actual patient care resuscitations.

Conclusion

GG appears to be a feasible and acceptable method for capturing simulated resuscitation events, and may have an advantage over SVC for visibility and audibility.

References

1. Merchant RM, Yang L, Becker LB, et al. Incidence of treated cardiac arrest in hospitalized patients in the United States. *Crit Care Med*. 2011;39(11):2401–2406.
2. Ornato JP, Peberdy MA, Reid RD, et al. Impact of resuscitation system errors on survival from in-hospital cardiac arrest. *Resuscitation*. 2012;83(1):63–69.
3. Edelson DP, Litzinger B, Arora V, et al. Improving in-hospital cardiac arrest process and outcomes with performance debriefing. *Arch Intern Med*. 2008;168(10):1063–1069.
4. Dine CJ, Gersh RE, Leary M, et al. Improving cardiopulmonary resuscitation quality and resuscitation training by combining feedback and debriefing. *Crit Care Med*. 2008;36(10):2817–2822.
5. Hayes CW, Rhee A, Detsky ME, et al. Residents feel unprepared and unsupervised as leaders of cardiac arrest teams in teaching hospitals: a survey of internal medicine residents. *Crit Care Med*. 2007;35(7):1668–1672.
6. Santora TA, Trooskin SZ, Blank CA, et al. Video assessment of trauma response: adherence to ATLS protocols. *Am J Emerg Med*. 1996;14(6):564–569.
7. Paro JA, Nazareli R, Gurjala A, et al. Video-based self-assessment: comparing Google Glass and GoPro technologies. *Ann Plast Surg*. 2015;74(suppl 1):71–74.
8. Chai PR, Wu RY, Ranney ML, et al. Feasibility and acceptability of Google Glass for emergency department dermatology consultations. *JAMA Dermatol*. 2015;151(7):794–796.
9. Drummond D, Arnaud C, Guedj R, et al. Google Glass for residents dealing with pediatric cardiopulmonary arrest: a randomized, controlled, simulation-based study. *Pediatr Crit Care Med*. 2017;18(2):120–127.
10. American Heart Association. Get with the guidelines–resuscitation clinical tools. http://www.heart.org/HEARTORG/Professional/GetWithTheGuidelines/GetWithTheGuidelines-Resuscitation/Get-With-The-Guidelines-Resuscitation-Clinical-Tools_UCM_314499_Article.jsp#.WBIUQOUrLRY. Accessed September 20, 2017.
11. Neumar RW, Shuster M, Callaway CW, et al. Part 1: executive summary: 2015 American Heart Association Guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015;132(18 suppl 2):315–367.
12. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377–381.
13. The Chinese University of Hong Kong. StatTools: intraclass correlation program. http://www.obg.cuhk.edu.hk/ResearchSupport/StatTools/IntraclassCorrelation_Pgm.php. Accessed September 20, 2017.

Stacey M. Kassutto, MD, is Assistant Professor of Clinical Medicine, Division of Pulmonary, Allergy, and Critical Care, Perelman School of Medicine, University of Pennsylvania, and Corporal Michael J. Crescenz Veterans Affairs Medical Center; **Joshua B. Kayser, MD, MPH, MBE,** is Associate Professor of Clinical Medicine and Bioethics, Division of Pulmonary, Allergy, and Critical Care, Perelman School of Medicine, University of Pennsylvania, and Corporal Michael J. Crescenz Veterans Affairs Medical Center; **Meeta P. Kerlin, MD, MSCE,** is Assistant Professor of Medicine, Division of Pulmonary, Allergy, and Critical Care, Perelman School of Medicine, University of Pennsylvania; **Mark Upton, MD,** is Executive Director of Performance Improvement and Reporting, Veterans Health Association Office of Community Care; **Gregg Lipschik, MD,** is Associate Professor of Clinical Medicine, Division of Pulmonary, Allergy, and Critical Care, Perelman School of Medicine, University of Pennsylvania, and Corporal Michael J. Crescenz Veterans Affairs Medical Center; **Andrew J. Epstein, PhD, MPP,** is Research Associate Professor of Medicine, Department of Medicine, Perelman School of Medicine, University of Pennsylvania; **C. Jessica Dine, MD, MSHP,** is Assistant Professor of Clinical Medicine, Division of Pulmonary, Allergy, and Critical Care, Perelman School of Medicine, University of Pennsylvania; and **William Schweickert, MD,** is Assistant Professor of Medicine, Division of Pulmonary, Allergy, and Critical Care, Perelman School of Medicine, University of Pennsylvania.

Funding: The authors report no external funding for this study.

Conflict of interest: The authors declare they have no competing interests.

Results of this study were previously presented as an abstract at the American Thoracic Society International Conference, San Francisco, California, May 13–18, 2016.

The authors would like to thank the following faculty and staff who assisted in this project: Jason Wagner, MD, MSHP; Joanna Hart, MD, MSHP; Jonathan Liu, MD; Lolita Bennett, RN; Susan Egler-Cruice, RN; Kathryn MacDavitt, RN; Erika Demartinis, RN; and Jennifer Snow, MD.

The contents of this work do not represent the views of the US Department of Veterans Affairs or the US government.

Corresponding author: Stacey M. Kassutto, MD, Hospital of the University of Pennsylvania, 839 W Gates Building, Philadelphia, PA 19104, 267.402.0080, stacey.kassutto@uphs.upenn.edu

Received February 28, 2017; revisions received June 30, 2017, and August 5, 2017; accepted August 9, 2017.