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Code Blue: methodology for a qualitative study of teamwork during simulated cardiac arrest

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ABSTRACT

Introduction: In-hospital cardiac arrest (IHCA) is a particularly vexing entity from the perspective of preparedness, as it is neither common nor truly rare. Survival from IHCA requires the coordinated efforts of multiple providers with different skill sets who may have little prior experience working together. Survival rates have remained low despite advances in therapy, suggesting that human factors may be at play.

Methods and analysis: This qualitative study uses a quasiethnographic data collection approach combining focus group interviews with providers involved in IHCA resuscitation as well as analysis of video recordings from in situ-simulated cardiac arrest events. Using grounded theory-based analysis, we intend to understand the organisational, interpersonal, cognitive and behavioural dimensions of IHCA resuscitation, and to build a descriptive model of code team functioning.

Ethics and dissemination: This ongoing study has been approved by the IRB at UC Davis Medical Center.

Results: The results will be disseminated in a subsequent manuscript.

Strengths and limitations of this study

- This study applies well-established qualitative methodology to a novel area of inquiry (team dynamics in cardiac arrest resuscitation), and with a unique means of qualitative data capture (in situ simulation).
- This study takes place at a single institution, and is a study of simulated as opposed to actual cardiac arrest events, thus limiting its generalisability.

INTRODUCTION

Despite advances in the science of cardiopulmonary resuscitation over the past several decades, the odds of neurologically intact survival from in-hospital cardiac arrest (IHCA) remain low.[1 2] When IHCA occurs, a patient's survival depends on both the immediate recognition of the event (as each minute delay from the time of cardiac arrest to the initiation of cardiopulmonary resuscitation (CPR) corresponds to a 10% decrease in the likelihood of survival), as well as aggressive resuscitation in the form of CPR, mechanical ventilation, administration of cardioactive medications and electrical defibrillation.[3 4] Successful resuscitation from IHCA requires the immediate and coordinated efforts of multiple providers, often with different types of training and levels of experience in dealing with IHCA.[5]

A major challenge to hospital preparedness for IHCA involves its frequency. IHCA is neither common nor truly rare, occurring roughly 200 000 times per year in the USA, or an incidence of 4.5 cases per 1000 hospital admissions.[6] The infrequency of IHCA, coupled with the necessity for prompt and coordinated response, indicates a need for frequent and interdisciplinary training. Yet the American Heart Association's Basic Life Support, and Advanced Cardiac Life Support (ACLS) courses, which are the community standard for providers who participate in IHCA response in most US hospitals, require training only every 2 years despite evidence to suggest that the knowledge and skills gained in these classes degrades in as little as 12 weeks.[7 8] A number of studies have demonstrated that while close adherence to ACLS protocols can improve survival from in-hospital cardiac arrest,[9–11] the prescribed interval for cardiac arrest training leads to inadequate performance.[12–16] Additionally, these courses fail to recognise divisions in knowledge and expertise that become operationalised in the context of cardiac resuscitation. A respiratory therapist and pharmacist are likely to play very different roles in an actual cardiac arrest resuscitation, yet ACLS treats both providers as essentially the same with regard to their training and assessment needs.

Another overlooked yet fundamental aspect of the preparedness gap is a failure of hospitals to accurately apprehend the true nature of cardiac arrest teams. Hospitals

aspire to the model of 'high reliability teams' in which team members have a high degree of familiarity with each other and with their individual roles, and in which the leadership structure is mutually understood.[17 18] In truth, emergency response teams within hospitals "are defined by rapid formation, an abbreviated lifespan and often limited experience working together previously."[18] Further complicating matters, the traditional conceptualisations of cardiac arrest teamwork (eg, the assumption of physician team leader who possesses both the clinical knowledge and communication skills to successfully conduct a resuscitation) often serve to reinforce dysfunctional hierarchies and tensions between integration (collaborative work that transcends job specification) and specialisation (the distribution of work into distinct organisational categories by skill set or job specification).[19] Finn's[19] study of teamwork among members of an operating room staff put it thus: "Healthcare is characterized by an increasingly fragmented, specialized, professional division of labour. Each profession has a distinct role and socialized membership, with a historically developed and institutionalized set of hierarchical relations between them. This provides for fundamentally different professionals interests. As a consequence, the tendency is towards conflict and contestation, to the detriment of professional integration."[19] This movement towards specialisation serves to undermine the interprofessional collaboration necessary for healthcare teams to achieve a high degree of reliability.[17] Not surprisingly, ad hoc cardiac arrest teams are associated with poor performance in terms of critical care processes, such as CPR performance and timely defibrillation.[12 20 21]

There is evidence to suggest that high-fidelity simulation is useful for evaluating clinical processes, such as CPR performance as well as team interactions during simulated codes.[22 23] However, simulation has not previously been used as a means for studying the sociological forces at play within cardiac resuscitation via qualitative methodology. Previous efforts to study simulation as a training intervention have often limited themselves to the perspective of a single provider group. A recent study of simulation-based code training for physician team leaders found that it yielded no significant improvement in key processes of cardiac arrest care: time to initiation of CPR, time to administration of cardiac medication and time to defibrillation.[24] Yet, processes such as CPR initiation and defibrillator deployment rely on the actions of multiple providers, and they often unfold prior to the arrival of a physician leader.[25] The dynamic and unpredictable nature of response to cardiac arrest creates a tension between interdependence and the need for autonomous action within a diverse group of providers. Studies that focus entirely on interventions and assessment of physicians suffer from a critical limitation in perspective, and fundamentally overlook the training needs and essential roles of providers who must act even prior to the arrival of a 'team leader'. While the gap between expected and actual performance for cardiac arrest teams has become increasingly clear, an approach that incorporates the perspectives of all team members, and that addresses their specific needs is still lacking.

In order to understand the complex interactions inherent in cardiac arrest events within a hospital, the perspectives of each participant in a resuscitation team must be considered. Physicians, nurses, respiratory therapists and pharmacists each have their own knowledge sets, customs of communication, and views of themselves in relation to other providers within a healthcare system. In this way, each provider type can be construed as a distinct cultural group within a hospital.

We believe these issues are best viewed from a sociological perspective, drawing from the tradition of ethnography and its roots in anthropological field study as a fruitful and innovative methodological approach for our study. Such a qualitative approach allows us to examine not only the technical and procedural aspects of resuscitation but also the mental models, discursive practices and relational structures which underlie them.

To address these gaps in our understanding of cardiac arrest teams, we have selected an approach that emphasises the diagnostic application of simulation as well as the discursive engagement of all practitioners within the team. The specific objectives of this project are as follows: (1) to describe practitioners' experiences of code blue events and their self-perceptions of knowledge and skills in cardiac arrest, (2) to describe practitioners' views of teamwork, with a focus on roles, communication and coordination of response to cardiac arrest and (3) to identify organisational factors in order to improve cardiac arrest resuscitation training, teamwork and patient care. This study is intended to address the emic perspective of cardiac arrest resuscitation teams and the organisational and educational approaches that would best support their functioning.

Methods

This is a cross-sectional qualitative study of a large teaching hospital in California. Our methodological approach includes: (1) field observations of simulated 'Mock Code events conducted on units throughout the hospital (excluding intensive care units (ICUs), OR/post-anesthesia recovery unit, emergency room) and (2) focus group interviews with the various provider groups that constitute our hospital's cardiac arrest response: nurses (both ICU and non-ICU), physicians, respiratory therapists and pharmacists.

Our fieldwork is carried out in a 619-bed academic medical centre in Northern California, with over 33 000 hospital admissions annually. Since August 2012, a group of providers from the departments of emergency medicine, anaesthesia, internal medicine and the Center for the Professional Practice of Nursing have conducted 'Mock Codes' using in situ high-fidelity simulation within the hospital. These events are held three times per month, and in varying locations and times of

day and night, and will serve as the basis for our field observations of code team dynamics.

Data collection

Mock Codes

For each Mock Code event, the investigators bring a wireless, high-fidelity human patient simulator (Laerdal Inc, Wappinger Falls, New York, USA) to the designated nursing unit. A 'primary nurse' is selected from among the unit's staff, and receives a brief video orientation to the manikin. The nurse then reviews a patient chart describing the simulated patient's reason for admission to the hospital and clinical course. The scenario begins when the primary nurse goes to evaluate the patient and finds him unresponsive and without vital signs. Once the nurse recognises that the simulated patient is in duress and calls for help, a 'Code Blue Drill' announcement is made over the hospital's paging system. The Mock Code then proceeds as any other code would, with all members of the Code Team (ICU physician and nursing staff, pharmacists, respiratory therapists and anaesthesiology housestaff) attending.

The scenarios are recorded from multiple perspectives throughout the room using pocket-sized 'Flip Video' digital recorders on adjustable tripods (Cisco Systems, San Francisco, California, USA). One camera is placed directly above the patient's head to provide a view of chest compressions and airway manoeuvres. Three additional cameras are placed around the room to capture views of all providers and equipment placed in the room. One or more investigators are also present during the event, and station themselves as unobtrusively as possible in the room. The investigators interact with the participants only after the scenario has been completed, as part of a structured debriefing that reviews recommended approaches to clinical skills such as CPR. This debriefing also addresses the importance of role identification for team members, and closed-loop communication to increase the accuracy of communication during codes.

We have selected the Mock Code events as the primary source of field data for this study. Given the unpredictability and infrequency of actual codes, as well as the imperfect nature of recall in emotionally charged situations, these events provide the clearest window into the unscripted interactions between providers during a code event.[26] Data has been collected from approximately 10 Mock Code events from different nursing units in the hospital, including both day and night shifts.

Focus groups

We are conducting qualitative interviews with the provider groups involved in the hospital's Code Blue response: ICU and non-ICU nurses, physicians at different levels of training (residents, fellows and attendings) and from representative departments (medicine, emergency medicine, surgery and anaesthesia), respiratory therapists and pharmacists. All hospital staff members under these designations are invited to participate in the study regardless of having participated in a Mock Code event.

Interviews are conducted as focus groups and are limited to one provider-type per session. The interviews follow a semistructured format. The interviews focus on four major themes: background and prior training in cardiac arrest; perceptions of teamwork, division of labour, and customs of communication in cardiac arrest events; quality and culture of training for cardiac arrest; and perceived areas in need of improvement. Interviews are audio recorded and transcribed verbatim by a professional service with a strict confidentiality policy in place.

We have selected focus group interviews as our other primary source of data collection because they allow us to draw on providers' recollections of their experiences, and provide a collaborative environment in which each provider group can develop a shared conception of their role within resuscitation teams and the greater hospital structure. We view the focus groups as not only complementary but synergistic with the Mock Codes. It is through comparison between these two methods that we believe we can access providers' embodiment of their professional roles in cardiac arrest as well as their interpretation of those roles and their interaction.

Data analysis

Mock Code videos

Video data from the Mock Codes are analysed using a coding matrix created by the investigators (table 1). This tool was conceived, developed and refined by reviewing 10 videos of previous Mock Code events. Through an iterative process of individual and collaborative coding, we developed a coding matrix that divides the resuscitation into three distinct temporal and organisational phases: (1) recognition of the pulseless patient and initiation of the Code Blue response, which is typically performed by a single nurse, (2) team recruitment, in which personnel and resources within the unit respond to the crisis and (3) team management, in which the formal Code Blue response (an interprofessional team composed of personnel from throughout the hospital) arrives at the scene and continues the resuscitation. The coding matrix is designed to address the widely recognised key clinical processes involved in cardiac arrest resuscitation (performance of cardiopulmonary resuscitation, defibrillator deployment and operation, ventilator support and airway management, and administration of cardioactive medications) based on current conceptualisations of cardiac resuscitation described in the American Heart Association's ACLS course, and the balanced perfusion/oxygenation/ventilation model of Advanced Resuscitation Training.[8 27] Crisis Resource Management, a constellation of cognitive and communication techniques used to describe the activities of teams performing under time pressure and in high-risk settings, served as the theoretical basis for the non-technical aspects (key statements and responses) of the matrix.[28 29]

Table 1 Coding matrix for Mock Code videos

	Phase 1: recognition and initiation of code	Phase 2: team recruitment	Phase 3: team management
CPR			
▶ Initiation			
▶ Patient positioning			
▶ Technique			
▶ Transitions			
Airway management			
▶ Positioning			
▶ BVM technique			
▶ Airway adjunct			
▶ Ventilation rate			
Medications			
▶ Intravenous access			
▶ Epinephrine or vasopressin given			
▶ Repeat doses			
▶ Other meds			
Key statements			
Responses to key statements			
Incorrect statements			
Response to incorrect statements			

BVM, Bag-valve mask; CPR, cardiopulmonary resuscitation.

The tool is intended to be used for post hoc analysis of video-recorded Mock Codes, owing to the technical difficulty of attempting to anticipate, capture and analyse actual codes in real time. We have selected this approach as we believe it is the most objective means available to us for examining the actual behaviours of code team members in the midst of resuscitation. The videos also provide a substrate for comparison with statements made in the focus groups. This process of triangulation is essential for establishing the validity of interpretations made from qualitative data.[30 31]

The instrument is intended to provide structure to a narrative analysis of the Mock Code event. Two of the study investigators review and analyse the code videos in an iterative fashion (typically 3–4 viewings from multiple camera angles). Observations about each of the target activities, as well as the individual(s) performing them, and a time stamp of when they occur, are recorded in each of the matrix cells. Staff categorisation (eg, registered nurse, physician, respiratory therapist) is signified by scrub colour in our hospital, which aids in the identification of roles within the scenarios. After independent coding of two to three Mock Codes, two of the investigators meet to compare coding and resolve differences as needed. Following well-established data analysis procedures in qualitative methods, reliability is sought through ongoing discussions and revisions of the coding to remediate differences through a consensus-building process. The trustworthiness of the data is established via triangulation with focus group findings and detailed analysis across multiple Mock Code events in multiple settings (ie, day and night shifts, telemetry and non-telemetry nursing units).

Focus group transcripts

Verbatim transcripts of focus group interviews are coded in the traditional qualitative fashion, which involves iterative coding of data to identify themes and patterns. This is a consensus-building process where reliability is achieved through trustworthiness and data saturation. Study collaborators will code data independently per established protocol and they will proceed in qualitative tradition to compare coding results and discuss differences to resolve discrepancies.

This study will follow a grounded theory approach in which the process of data collection and analysis occur simultaneously.[24] The approach allows for the pursuit of emergent themes through early data analysis, as well as the discovery of basic social processes within the data that may shape subsequent data collection. Grounded theory is an inductive process by which abstract categories are constructed to explain and synthesise data. These categories are then integrated into a theoretical framework that describes the causes, conditions and consequences of the process being studied.

By applying this detailed analytic approach to video and transcript data from the Mock Codes and focus groups, we plan to build an explanatory model of code blue teamwork that can be used to guide subsequent organisational and educational interventions intended to optimise performance.

ETHICAL CONSIDERATIONS

Procedures have been developed to ensure data confidentiality and protection.

All focus group participants receive information on the design and goals of the study, and will sign an

informed consent for participation. All study records are kept confidential and secured to the fullest extent possible. Participant interview recordings, interviewer notes, and interview transcripts are coded with a unique identifying number. All qualitative interviews are edited to remove information that could identify participants (eg, names of persons or work location) before entering them into the qualitative data analysis programme. Digital recordings of interviews are kept in a secured, password-protected data base. Coded paper interview transcripts, coded screener interview questionnaires, and coded paper interviewer's notes do not leave the principal investigator's (PI) research office where they are stored under lock and key. A list of subject names and unique identifiers are kept separate from the questionnaires and transcripts, and are accessible to the PI and research collaborators, all of whom have completed online training in the protection of human subjects. No images or identifying information about participants are shared or published.

Results from this study will be disseminated via international and national peer-reviewed journals, separately and in papers, summarising the results. Key results will be shared at national and international conferences, and at local and regional meetings and symposia directed at practitioners, educators and researchers, as well as hospital administrators.

DISCUSSION

This study draws on qualitative methods that have been used in ethnographies of diverse workplace settings, and is intended to uncover the professional ideologies, organisational practices and labour divisions that underlie the IHCA response process. Qualitative studies are vanishingly rare in the world of cardiac arrest research. Given the inherently social and interpersonal nature of cardiac arrest resuscitation and its reliance on the coordinated efforts of people with distinct professional roles and training, we believe a qualitative approach can provide insights into the nature of these events that would otherwise be lost.

Our methodology is not, however, without limitations. This is a study being conducted at a single centre, and as such, the validity of our conclusions is limited by the experiences and perspectives of providers working in a single hospital. Additionally, we are relying on simulation to recreate the conditions of IHCA, which may fail to evoke all the emotional stress and interpersonal interactions than an actual IHCA would. While it would be ideal to directly observe team interactions (either in person or via recording) for actual Code Blue events, their relative infrequency, unpredictability, and the medicolegal implications of critical patient care would make such a strategy impractical. Rather than simply relying on providers' recollections of their experiences in cardiac arrest resuscitations, we have sought to recreate the conditions of cardiac arrest resuscitation with as high a degree of fidelity as possible. The simulations are carried out in actual patient care spaces within the hospital, and are responded to by all the providers who would manage an actual Code Blue. The codes are announced via overhead page, and responding staff have no prior warning of the event aside from the staff member playing the 'primary nurse' (who is provided with a brief orientation immediately prior to the scenario). We believe that the unannounced nature of these simulations and their placement in realistic healthcare settings allows us to recreate the psychological as well as physical conditions of cardiac arrest response in the hospital setting.

The management of IHCA presents challenges in terms of training, hospital organization and professional divisions of labour that have been often overlooked or else viewed as unchangeable. We believe this study will provide meaningful insights into each of these areas, and may provide additional lines of inquiry to inform future research.

Contributors SC developed the study design and protocol and oversaw the data collection and analysis. ECA-Vis a research mentor to SC. She helped to conceive the study design and has participated in the writing of the manuscript as well as the ongoing data analysis. JB helped in the data collection and analysis. In accordance with ICMJE authorship guidelines, all three authors contributed substantially to the drafting, revision and final approval of this manuscript.

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Competing interests None declared.

Ethics approval University of California, Davis IRB.

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