RESEARCH ARTICLE

Reducing Time to Medical Intervention Through Code Team Restructuring and Simulation Training

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ABSTRACT

Background

Cardiac arrest is an acute event with very high morbidity and mortality rates. Ten in 1,000 admitted patients go into cardiac arrest each year and only a quarter of these patients survive to hospital discharge. Code environments are highly complex and require expert coordination among participants to improve patient survival. Despite recognition of the necessary elements for successful resuscitation. Time to medical intervention (TMI) and quality of chest compressions are well documented crucial aspects of a successful code, but other qualities such as demonstrative leadership, clear communication, effective team member interaction, and succinct task completion may also contribute to patient outcomes. Clearly identifying the role of each team member, their responsibilities, and bedside position may improve the success of a code situation. Similarly, pre-defined teams consistently outperform ad hoc teams.

Aim

The aim of this project was to decrease the time to medical intervention during mock code situations, improve close loop communication and leadership during a code.

Methods

We achieved our goals by restructuring our code team. First, all members necessary for a code team were identified, their respective roles clearly defined, and the most appropriate bedside positions for each role was carefully selected. Multidisciplinary team leaders were identified and trained as trainers by the core team for this project. Next, random mock codes were called to obtain baseline TMI. After the mock codes for baseline TMI to medical intervention, the trainers then trained the members of their unit on the appropriate roles and specific responsibilities they would be expected to complete during a code situation. Once training was completed, mock codes were randomly called and TMI was recorded. Also, there was a debriefing after these mock codes in which the participants were asked to give their impression of our Quality improvement project on the code team communication, leadership during the mock codes, quietness of the room and their comfort levels with performing the responsibilities of the role they performed. Time to medical intervention in these simulated codes were compared to the average time to medical intervention in our baseline mock codes.

Results

Post-code debriefings revealed a general sense of improved communication, improved crowd control, and clearer leadership when compared to other code situations the participants had been involved in. Similarly, time to shock delivery or medication administration shortened from the prior average of 2 minutes 46 seconds to 2 minutes 3 seconds, a statistically significant improvement (p-value 0.036). Participants also reported clearer communication, better understanding of their role and improved noise in the code environment.

Conclusions

Disorganized codes are costly in terms morbidity and post-arrest care. Having well organized codes with clear roles, responsibilities, and positions may decrease the TMI, communication, noise, leadership and improve patient outcomes. Real-life implementation and analysis of this intervention is needed.

TMI was defined as the time from when a code is called to the time when the first medication or defibrillation was administered which ever was warranted first.

Introduction

Cardiac arrest is an acute event with very high morbidity and mortality rates. Ten in 1,000 admitted patients go into cardiac arrest each year and only a quarter of these patients survive to hospital discharge. [1]

Cardiac arrest usually leads to the activation of a code team. The code team must act in a very timely, effective and efficient manner to for the best possible outcome. The outcome of codes is still poor despite major improvements within the past two decades. The survival rates for in-patient cardiac arrest have improved from an average of 17% in 2000 to an average of 25% in 2017.[2,3]

Code teams are made up of a multidisciplinary team of respondents, who have different roles and responsibilities during a code. Code team leaders may be leading a multidisciplinary team of experts who they have never worked with, and in an unfamiliar environment. Each code team member should know their role and be able to complete their responsibilities. They should be able to work under the leadership of the code team leader. Code situations are highly complex and require expert coordination among participants to improve patient survival. Both intrinsic factors such as advanced age and extrinsic factors such as quality of cardiopulmonary resuscitation (CPR) contribute to the success of a code.[4]

Some of the clearly reported elements of a successful resuscitation include: the quality of CPR, quality of chest compressions, optimize ventilation, early defibrillation, when applicable, early initiation of CPR and the time to medical intervention.[5] Despite recognition of the necessary elements of successful resuscitation, many would correctly identify time to defibrillation and quality of chest compressions as the most important aspects of a successful code. Other qualities such as demonstrative leadership, clear communication, effective team member interaction, and succinct task completion also play key roles in quality cardiopulmonary resuscitation.[6]

When there is a cardiac arrest, code team members quickly arrive to provide lifesaving care to patients they may not know. These codes may be in an unfamiliar environment and the code team members must work with other code team members who they may not know and have never worked with, or do not work with routinely. Clearly identifying the role of each team member and their responsibilities have been shown to improve patient outcomes (Prince 9). Pre-defined teams consistently outperform ad hoc teams throughout medical and non-medical fields.[7] Lack of explicit task distribution has also been noted to contribute to shortcomings during code simulation settings. [8]

Multiple studies have detailed the efficacy of code team training and simulation to improve the quality and success of cardiopulmonary resuscitation. [9-11] Given the success of studies such as Prince et al, we sought to implement a similar intervention at the Atlanta VAHCS due to perceived deficits during our codes. These deficits included poor organization, overcrowded and noisy rooms, lack of clear “code leader”, confusion regarding each team member’s role, delays in the time to medical intervention. We defined the time to medical intervention (TMI) as the time from when a code is called to the time when the first medication is

administered or the time when patient receives the first shock whichever comes first. In addition, disorganized codes usually lead to a delay in the start of CPR which has been shown to be a major contributor to the outcome of a code.

The aim of this project was to improve the outcomes of code situations within the Atlanta VAHCS through simulation. In addition, this project was designed to help staff members have a better understanding of the roles they were expected to perform during a code, assume necessary team roles, responsibilities and bedside positioning that will enable them to more effectively complete pre-determined tasks that are vital to the success of resuscitation.

Goals

The goals for this project were to improve the time to medical intervention for each code. The second goal was to improve communication during codes and create a more organized code environment. The third goal was to make sure that each member of the code team understood their roles and responsibilities. We wanted to identify the best bedside position for each team member to better perform the responsibilities for their role. Other objectives included improving leadership during code situations and more effectively controlling the crowd and unnecessary noise that might impede team member communication.

Methods

First, we identified all the roles required for a successful code team. These roles were from multiple disciplines. When then invited stake holders from each of these disciplines to be part of this quality improvement project. This was necessary in order to get a buy in from these various departments. The disciplines involved included all levels of nursing, respiratory therapy, anesthesiology, the intensive care team, pharmacy and the supply department which is responsible for preparing code carts. We worked as a team to come out with a list of responsibilities for each of these roles. We also identified the most appropriate level of training and expertise for each role. Specific responsibilities were assigned to each role. These roles were compatible with team member training and expertise, for example the respiratory therapist was responsible for airway management during a code. Second, we identified specific bedside positions for each role that would benefit communication, airway and CPR management, monitor visibility, as well as drug delivery during the code. Each of the champions was trained as a trainer. At this point, we called several random codes in order to obtain baseline time to medical intervention.

After the random codes, the champions then trained the potential code team members in their department. Each of the code team members were trained on the roles and responsibilities they were expected to complete during a code. Codes are multidisciplinary events, therefore representatives from all these disciplines were involved in the creation and implementation of this project. Some team members were trained on multiple roles because they may be required to play different roles at different codes based on staff availability for the roles. For example, a bed side nurse might be a primary nurse for a

patient who has cardiac arrest but may be expected to be a recorder when they are not the primary nurse for that patient. Rotating residents received monthly training on the roles and responsibilities they may be expected to complete during codes.

The roles we identified were:

- Code Team leader
- Unit Nurse Leader
- Patient's Primary Nurse
- Airway management Team (2-3 Respiratory Therapists)
- Intensive Care Unit (ICU) Medication Administration Nurse
- ICU Medication Preparation Nurse or Pharmacist
- Chest Compressors (4 people)
- Recorder
- Code Assistants (2 people)
- Supporting Physicians (1-2 people)

Finally, we created code team badges with the assigned roles on the front and specific responsibilities on the back. These badges were printed on antimicrobial paper.
The roles and responsibilities created and listed on the identification badges are listed in Table 1.

Table 1: Roles and responsibilities of code team members

Roles	Responsibilities
Code Leader	▪ Lead ("Run") the code ▪ Request medications ▪ Direct each team member on the next steps ▪ Read and interpret cardiac rhythm and decide next steps ▪ Listen to suggestions but make the final decision on course of action ▪ Ensure central line access if needed
Unit Team Leader **(Nurse Manager or Supervisor)**	▪ Assume the role as Code Team Facilitator ▪ Direct code team members ▪ Delegate responsibilities to team members ▪ Secure transfer location ▪ Assist with the resuscitation ▪ Depending on availability of personnel, may assist in administering medication ▪ Ensure adequate IV access

	▪ Assist with the identification of the cardiac rhythm ▪ Ensure that adequate equipment is available and functional ▪ Communicate with the recorder/serve as recorder to assure proper documentation of the rhythm, medication, and other interventions ▪ Ensure that Code Team Leader (Physician) has the best possible (immediate) environment for resuscitation (decrease noise, onlookers, etc.)
Primary Nurse **(Patient's Nurse)**	▪ Call the code (if first on scene) ▪ Provide chest compressions until relieved ▪ Give information to the Code Leader ▪ Provide labs, current diagnosis, and code status ▪ Report resuscitation status and prognosis ▪ Ensure documentation is carried out appropriately
Airway Management Team **(Respiratory Therapist or Anesthesia)**	▪ Manage patient's airway ▪ Provide advanced airway maintenance and ventilation (bagging) OR intubation ▪ Obtain intubation supplies from Code Cart and/or bring Glidescope and supplies ▪ Ensure suction equipment is setup and functioning properly ▪ May draw Arterial Blood Gas ▪ Communicate all relevant data to Code Team members
ICU Medication Administration Nurse	▪ Pending physician arrival, direct the resuscitation ▪ Establish roles of participants ▪ Ensure priorities of the code are carried out effectively and efficiently ▪ Coordinate defibrillation, intubation, and medication administration ▪ Call for help if indicated from anesthesia, police, escort etc. ▪ Check resuscitation status and prognosis ▪ Communicate with ICU team

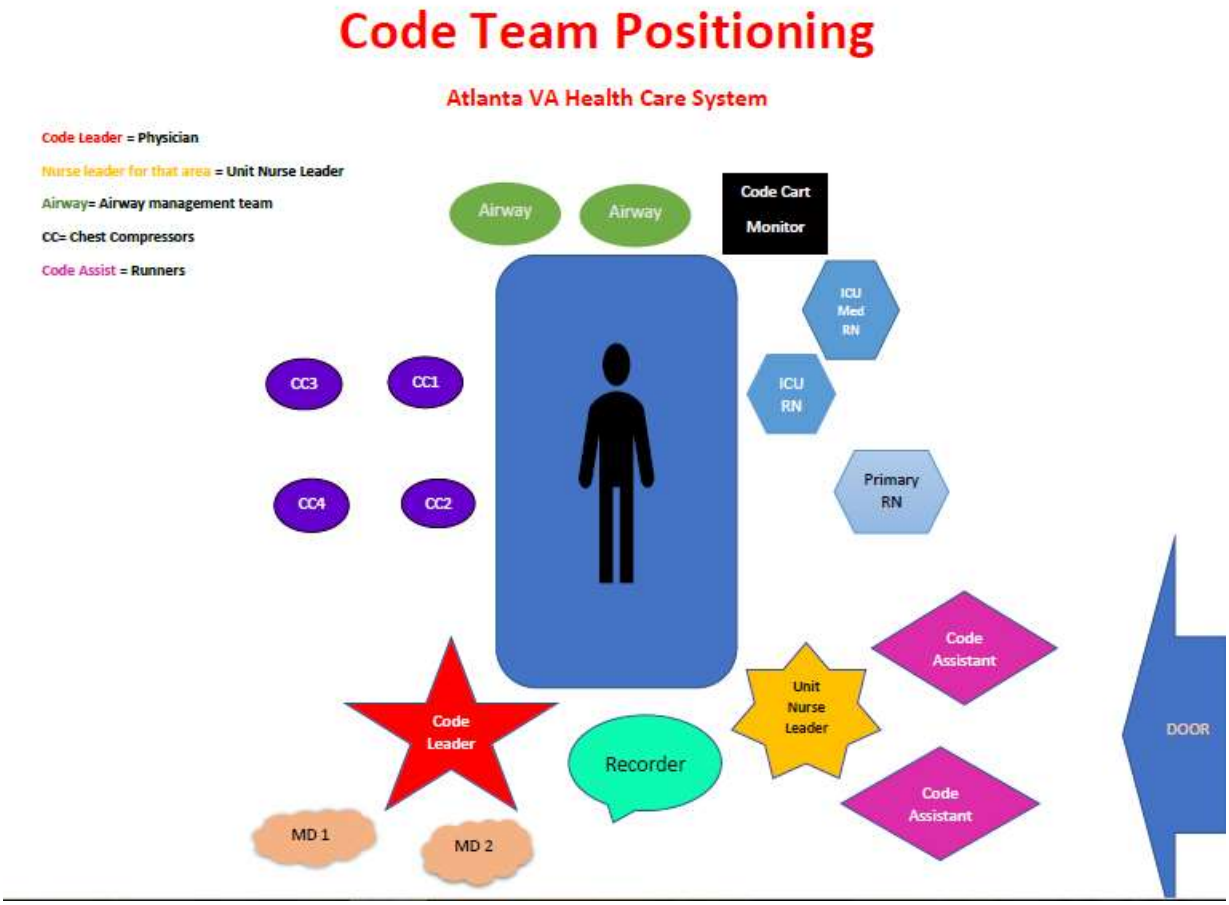
	▪ Ensure family is notified ▪ Organize post-resuscitation care ▪ Ensure documentation carried out appropriately ▪ Ensure a debriefing is completed ▪ Administer medication(s) to the patient
ICU Medication Preparation Nurse or Pharmacist	▪ Obtain medications from the code cart, prepare medication, hand medication to the ICU Medication Administration Nurse
Chest Compressors **(Four People)**	▪ Rotate chest compressors every two minutes ▪ Ensure 100 quality compressions per minute
Recorder	▪ Record every action taken during a code with the time performed ▪ Read out every action recorded for close-loop communication ▪ Announce time intervals to the code leader ▪ Ensure appropriate time interval between medication(s) ▪ Ensure appropriate documentation (signatures) are obtained after the code
Code Assistants	▪ Report to the primary nurse/unit leader for instructions ▪ Obtain code cart ▪ Ensure patient is appropriately connected to oxygen source ▪ Connect wall suction ▪ Place the patient's bed in CPR mode ▪ Place the patient monitor in a visible position for the Code Team Leader ▪ Help clear the patient room of objects that could interfere with resuscitation efforts. ▪ Obtain any supplies needed
Supporting Physicians	▪ Provide aid to Code Team Leader as requested

Once badges and bed position diagram were created, and training was complete, we started conducting random mock codes. During these mock codes, the code team members were expected to position themselves in the designated position for their role and perform the responsibilities for that role.

The mock code simulations took place in many different clinical locations of the hospital. Some sessions were conducted in the Atlanta VA Health Care System (Atlanta VAHCS) simulation center where rooms were staged to simulate a patient room.

During simulation sessions, the code badges (printed on antimicrobial paper) were placed on the code cart. Once each code team member arrived at the code scenario, they selected the card for the role they were going to be responsible for during the code, or they were given a card by the Unit Nurse Leader that corresponded to a role that was appropriate for their level of training and the training they had received. They were then immediately directed to the position assigned for that role. At the end of each code team simulation, there was a debriefing on the general code team performance and on each role and assigned responsibilities. The results of these debriefings are detailed below.

Figure 1 Code team member positioning.



Results

A code sheet was used to record the events and times of each code and the actions during sixteen of the mock codes with a total of 98 participants. The time to medical intervention which was the time from when a code was called to the first medication administration or defibrillation was recorded on the code sheets. The average time to medical intervention for the baseline mock codes was 2 minutes 46 seconds. After implementation of responsibilities, badges

and bedside positioning as well as corresponding training, the average time to medical intervention for the mock codes was 2 minutes and 3 seconds. There was a decrease in the time to medical intervention of 43 seconds (P-value 0.036, two-sided t-test) after our intervention.

During debriefings most participants stated that they perceived these simulated codes as better organized than prior code situations they had participated in. Specifically, they felt that during these simulations they knew every team member's role. They knew who to refer to for any needs during the code. Due to the structure of the new code team, any person who had no role or responsibility during a code was cordially asked to wait outside of the patient's room or go back to completing their daily task. With specific roles already designated, participants felt that the Unit Nurse Lead (responsible for controlling the crowd) had better, less abrasive tools to request non-active participants to exit the code area. The residents were pleased to learn exactly what was expected of them as team leaders of a code team, and to be able to run a code in a more organized environment. The code team members thought that having the identification badge with each person's role enhanced team work, improved communication and reduced confusion

Discussion

In-hospital cardiac arrest is still a less studied area of medicine as compared to out of hospital cardiac arrest. Very few randomized controlled trials have been completed on in-hospital cardiac arrest. Most of the knowledge applied today comes from observational studies, registries, extrapolation from out of hospital cardiac arrest and expert opinions. Outcomes of in-hospital cardiac arrest have improved in the last two decades, but there is still much room for improvement. Studies have shown that more-active hospital participation in standardized in-situ mock code trainings improve in-hospital cardiac arrest survival.[12]

Code situations are hardly unique or uncommon. In-hospital cardiac arrest remains an area which has been relatively neglected by research as compared to out of hospital cardiac arrest. Only about 4% of studies on cardiac arrest focus on in-hospital cardiac arrests.[13] There are standardized advanced cardiac life support protocols for the various cardiac arrest situations. Despite all the protocols already established, the outcome of cardiac arrest is still poor. Studies have shown that there are several external factors such as location of the code, which could play a vital part in the outcome of a code.

There are several non-modifiable factors such as age and gender that can influence a code outcome. Fifty-eight percent of in-hospital cardiac arrest occurs in men. Also, white patients have a better outcome post cardiac arrest as compared to black or Hispanic patients.[14,15] Some of these differences have narrowed overtime.

The presenting rhythm also greatly influences the outcome of a code.[5,16,17] Patients who have a shockable rhythm at presentation have up to three times better survival rates as compared to patients with non-shockable rhythms.[2,16]

Modifiable factors such as time to medical intervention and quality of CPR have proven

to have a major influence on the outcome of in-hospital cardiac arrest. Our focus was on modifiable factors that could improve the TMI. We applied evidence-based quality improvement concepts to restructure our code team and to reduce the TMI.[18]

Disorganized codes usually cause significant delays in TMI and are costly in terms of morbidity and mortality. Codes are acute event that do not leave any room for delays or errors. Restructuring code teams with specifically designated roles, responsibilities, and bedside positioning, and then training the re-designed team have been shown to produce more effective and efficient codes.[18]

Delays in medical intervention as well as poor quality of CPR have been shown to greatly impact the outcome of a code team.[18] A code team that is organized with each team member knowing what is expected of them during a code and how to clearly communicate has been shown to regularly outperform ad hoc teams. Ad-hoc teams may be made up of multidisciplinary team members who are not very sure about where they fit in the team and what their responsibilities are during a code. It is important for each code team member to know what is expected of them during a code. They should know their role, responsibilities and where to position themselves at the patient's bedside to best perform the responsibilities of their role during the code. One of the goals of our team was to provide these skills to our code team members in a safe, simulated environment.

There is evidence that non standardized aspects surrounding the Advanced Cardiac Life Support (ACLS) protocols such as having organized and structured environments, reduced noise, clear leadership, and communication, play a very important role in the success of a code.[18] ACLS trainings usually do not come with training on these skill sets which are fundamental to the outcome of code.

The improvement noted in our projects could be attributed to the fact that these multidisciplinary teams had the opportunity to interact with other code team members in a controlled environment. The team dynamics that were created in these more relaxed environments could have also played an important role in the results that we got from this project.

These simulated training sessions on the responsibilities of each role provided the less experienced code team members with the knowledge and confidence to perform these responsibilities with certainty of what was expected of them. There was no delay in trying to identify who will perform what role since each team member had been appropriately trained in the possible roles they could be expected to perform.

Simulations are now recommended in the training of code teams. Simulation gives team members who are not routinely involved in codes the opportunity for hands on learning in a low stake environment.

Organized environments allow for clear communication and clarity in the progress of the code. A team leader who is fully aware of the expectations can easily communicate clearly and direct a close loop communication. This is a necessary aspect of a successful code.

Trainings in these roles have led to demonstrative leadership, clear communication, effective team member

interaction, and succinct task completion. All of these factors have been shown to translate into improved post-cardiac arrest outcome such as neurologic function and quality of life.[18] Implementing such a project in a hospital-wide setting would likely lead to better outcomes in our patients and significant cost savings. Code team simulations with assigned and clear roles, responsibilities, and bedside positioning give code team members the opportunity for hands-on practice. This allows the team members to gain more confidence in their role.

Communication errors can lead to poor outcomes in codes, so proper simulation training on code team member roles and clear close-loop communication strategies should be practiced and applied during codes to improve the outcome. In 2014 Prince et al. published the results of a similar intervention undertaken at their hospital in Marshfield, WI. After designating specific roles as well as positioning of code team members relative to the patient, their team found that communication was much better during their codes.[18] These findings are similar to what we noted after we restructured our code team. They also noted an improvement in their time-to-defibrillation every year since this restructuring took place.

Simulation based resuscitation exercises have been proven to decrease cognitive load and increase situational awareness in participants.[6] The experiences of these prior studies as well as our internal data suggest that conducting mock codes and restructuring the code team as proposed may help improve real-life codes in our facility. Our study was undertaken in a unique setting – a Veterans Administration hospital, which is also an academic facility. The added oversight required for projects such as this at a federal facility required significant buy-in from multiple departments and specific training that may not have been required at other facilities.

Project Limitations

The Atlanta VAHCS is a teaching hospital with monthly rotating residents from two separate residency programs. Therefore, there is need for monthly training with the new house staff prior to their involvement in codes. This project was intended to serve as a pilot project for our final intervention during live code situations, but due to the initial improvements noted, the project was requested to be implemented on real life patients. We are now implementing the quality improvement project to our real-life cardiac arrests.

Conclusions

Having organized code teams with clearly identified roles, bedside positions, and responsibilities could greatly improve the outcome of a code through more effective communication, a reduction in the TMI, improved code environments and familiarity and comfort with the expected roles and responsibilities. Simulated mock codes allow for testing of new interventions in a safe environment. On top of this, being able to practice the responsibilities and bedside positions of each code team member during a simulation may improve confidence and understanding of responsibilities. Similarly, team members are given the chance to work together multiple times, which may improve

trust and ease within the team. The goal of this quality improvement project was to improve patient outcome through prompt and organized intervention leading to a decrease in TMI.

Due to the success observed in the simulation training, we are currently implementing this quality improvement project in our hospital through the plan-do-study- act quality improvement model. Future directions include implementing these badges and bed positioning throughout our hospital. Data will be collected via a post-code survey distributed to providers who participated in the code. TMI will also be recorded during the life codes to see if these changed after implementation of this new code restructuring in real life codes

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