A Human Factors Approach to Building High-Performance Multi-Professional Cardiac Arrest Teams: Developing a Code Blue Team Performance Metric

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Background: The American Heart Association (AHA) estimates that annually there are approximately 200,000 in-hospital cardiac arrests (IHCA). Hospitals have implemented multidisciplinary teams trained in advanced cardiac life support (ACLS) to provide care during these events. Outcome measures of these team's effectiveness are typically mortality rates at discharge and reduction of unplanned cardiac arrest occurring outside of the ICU. Neither is a sensitive measure of team effectiveness. *Methods:* Using a retrospective analysis of 10 simulated code blue events we developed a metric of team effectiveness for code blue teams that also identifies specific teamwork weaknesses. *Results:* The new ASU-Mayo metric was highly correlated with Mayo high performance team scale (MHPTS) (r (6) = .71), team emergency assessment measure (TEAM) (r (6) = .84), and the observational skill-based assessment tool for resuscitation (OSCAR) (r (6) = .89) metrics as well as the ratings of the subject matter experts (r (6) = .88). *Conclusions:* We developed a team performance metric that allows for the identification of performance gaps therefore, can allow for targeted intervention with the intention of providing trainees richer feedback on performance. Also, it will generate quantitative assessments of the value of mock code exercises and can be used to evaluate interventions. Our understanding of teamwork during a simulated code blue event was also enhanced.

INTRODUCTION

The American Heart Association (AHA) estimates that in-hospital cardiac arrests (IHCA) range from 3.8 to 13.1 per 1000 admissions (Morrison et al., 2013). In 2004, the Institute for Healthcare Improvement (IHI) launched the "100,000 Lives Campaign" as a challenge to the healthcare community within hospitals to reinforce its obligation to make patient safety its highest priority (Berwick, Calkins, McCannon, & Hackbarth, 2006). The campaign identified three main concerns that needed to be improved upon during resuscitation events; failure to plan, failure to communicate, and failure to recognize a patient's deteriorating condition (failure to rescue).

To address these concerns, hospitals focused on implementing multidisciplinary teams trained in advanced cardiac life support (ACLS) that could hurry to the bedside of deteriorating patients with the intention of preventing respiratory and/or cardiac arrest leading to improve patient outcomes. These teams are referred to as many things, such as: cardiac code teams, code teams, medical emergency team (MET), rapid response team (RRT), rapid medical response team (RMRT), cardiac care team (CCT), critical care outreach team (CCOT), extended rapid response system (E-RRS), and a rover team, but no common name to describe these team has been adopted (DeVita, Schaefer, Lutz, Wang, & Dongilli, 2005). For consistency, we will refer to these teams as code blue teams. Outcome measures of these multidisciplinary teams are typically mortality rates at discharge and reduction of unplanned cardiac arrest occurring outside of the intensive care unit (ICU). The data on team performance is focused on patient outcome and does not suggest any true measurement of the team's performance. The purpose of this research was to develop a performance metric specific to code blue teams that focuses on team performance.

BACKGROUND

First described in groundbreaking work from researchers in Australia, the medical emergency team was envisioned with the purpose of responding to emergency calls where it was determined, by specific trigger criteria, a patient's condition was deteriorating (Lee, Bishop, Hillman, & Daffurn, 1995). This idea of a rapid response system (RRS) which initiates the response of a team is different than the historical use of "cardiac code teams" that responded when a patient is already in

full cardiac and/or respiratory arrest. Medical emergency teams were intended to prevent an arrest from occurring and typically respond to areas outside the intensive care unit (ICU) environment where as when a code is called, the patient is usually in cardiac arrest. Although not clearly defined in the research, members of these teams routinely include doctors, nurses, pharmacists, and respiratory therapists.

Current Metrics for Assessing Team Effectiveness

There are currently two metrics specific for evaluation a team during resuscitation; the team emergency assessment measure (TEAM) and the observational skill-based assessment tool for resuscitation (OSCAR). In a study that was specific for teamwork performance during resuscitation attempts, an Australian research group aimed to develop a tool to measure teamwork during emergency resuscitation (Cooper et al., 2010). The Team Emergency Assessment Measure (TEAM) was developed in five stages with the objective of providing a teamwork assessment tool observer could use to evaluate team effectiveness during resuscitation events in both a simulated and clinical setting. The rating system consists of 11 items that are rated from 0 to 4 (never/hardly ever to always/nearly always, respectively) with a 12th scale of 0 to 10 overall global rating of the team's performance. The TEAM was tested using second year medical and nursing students who completed an intermediate life support class the day before. They were placed in teams of five and observed in real time using high fidelity mannequins. Experts reviewed this tool and found it to be valid, reliable, and possibly useful for clinicians to measure their teamwork during resuscitation.

Developed after TEAM, the observational skill-based assessment tool for resuscitation (OSCAR) was developed with the objective of assessing team behaviors and non-technical skills during a cardiac arrest attempt for each of the core team members (Walker et al., 2011). Team members included an anesthesiologist, a physician, and a senior nurse. The researchers in this study defined non-technical skill behaviors as: communication, cooperation, coordination, monitoring, leadership and decision-making. These six behaviors were chosen from a compilation of the following three tools: the Observational Teamwork Assessment for Surgery (OTAS); the anesthetists' non-technical skills (ANTS); and the revised NOn-TECHnical skills (NOTECHS) scale for operating theaters.

Individual team member skills are assessed using ANTS or NOTECHS and OTAS evaluates the entire team. The OSCAR tool rates each of the six behaviors on a scale of 0 to 6 separately for three distinct group members of the team. Unlike TEAM, OSCAR does not evaluate teamwork as a behavior nor is it a behavior they defined as a non-technical skill. It does measure non-technical skills specifically in resuscitation team members individually, yet, does not assess the team as a whole.

Not specific to teams during resuscitation, the Mayo high performance teamwork scale (MHPTS) rates leadership, teamwork, communication and adaptability using 16 categories rated from 0 to 2 (never or rarely to consistently, respectively). This scale is more of a crisis resource management tool than a performance during resuscitation teamwork metric.

We aimed to develop a metric specific to team performance during simulated code blue events (SCBEs) in order to 1) allow for the identification of performance gaps for targeted intervention, 2) provide trainees richer feedback on performance, and 3) generate quantitative assessments of the value of mock code exercises and interventions. In addition, the data collected also should improve our understanding of teamwork.

METHODS

A retrospective examination was conducted on 10 simulated code blue events (SCBEs) that occurred at the Mayo Clinic Hospital in Phoenix, Arizona from June 6, 2013 thru November 10, 2015. Two of the ten codes were used as a baseline for metric category development. Knowledge was elicited from subject matter experts (SMEs) as they watched these two SCBE videos and commented not on the things the team performed satisfactory but on the errors that occurred during the SCBE.

A version of a new ASU-Mayo metric was then developed and used to evaluate the two baseline

SCBEs and then the current version of the metric was developed.
The eight remaining SCBEs were viewed four times and scored using the ASU-Mayo metric as well as TEAM, OSCAR, and the MHPTS. These eight codes were also viewed once by four code blue experts and scored based on an overall 1 to 5 rating with 1 being very poor and 5 being excellent in terms of overall teamwork, leadership, role clarity, workflow and timing/coordination, and communication.

RESULTS

The new ASU-Mayo metric was highly correlated with MHPTS (r (6) = .71), TEAM (r (6) = .84), and OSCAR (r (6) = .89) metrics as well as the ratings of the subject matter experts (r (6) = .88). The subscores in the categories of leadership, role clarity, communication, and workflow and coordination of the ASU-Mayo metric indicate that leadership and communication errors correlated with lower overall team performance scores. The ASU-Mayo metric is currently being validated for inter-rater reliability.

CONCLUSION

The new ASU-Mayo metric will facilitate the identification of specific performance gaps in teamwork to allow for targeted training intervention as well as a function as a tool for evaluating specific interventions used to improve teamwork. This work leveraged findings from the code blue drill pilot program at Mayo Clinic Hospital, human factors expertise at the Center for the Science of Healthcare Delivery, and expertise in individual and team cognition and performance at Arizona State University. We developed a novel and robust team assessment tool that we postulate will facilitate the building of high- performance cardiac arrest teams. The importance of the ASU-Mayo metric is that it is an objective measurement of team performance based on leadership, role clarity, communication, workflow, and coordination, and overall team performance along with measurements aligned with the "Get with the Guidelines" standards for resuscitation from the American Heart Association. Unlike the typical additive team measurement scales currently utilized, the ASU-Mayo metric is a scoring tool that takes off points for errors occurring by the team in each particular section.
It is clear that caring for acutely ill patients is demanding and resuscitation is a task that requires coordination of team members with varying skill sets in an extremely stressful clinical environment (Sutton, Nadkarni, & Abella, 2012). Many studies have discussed the negative outcomes of code teams regarding unchanged mortality rates and increasing of hospital costs, but none have offered a concrete plan to improve the teams (Chan, Jain, Nallmothu, &Sasson, 2010; Cretikos & Hillman, 2010; Howell et al., 2012; Karpman et al., 2013). Further evaluation and iteration of the ASU-Mayo metric is needed to make it even more team performance specific. It is important to understand the difference between practicing and running SCBEs and the actually training of teams to perform more effectively during SCBEs. We hope this tool can provide trainees richer feedback on performance, generate quantitative assessments of the value of SCBEs, and make simulated training exercises a more efficient training tool. The ultimate aim of building high-performing code blue teams would be improved patient outcomes following IHCA.

Acknowledgements

This study was funded by the Mayo Clinic Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery.

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