General

The A to E (ABCDE) Pit Crew Model: A Novel Approach to Team Based Care of Critical Patients in the Prehospital Setting

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Background

This study aimed to evaluate the effectiveness of a Pit Crew intervention to improve team dynamics and time to performance of critical actions in a prehospital critical care scenario. The primary outcome was successful completion of critical actions and time to completion of these critical actions. Secondary outcomes included effectiveness of communication and overall team functioning.

Methods

The study was conducted with a fire-based Emergency Medical Services (EMS) system with 233 paramedics and 115 Emergency Medical Technicians (EMT). Eight EMS crews comprised of five members each were randomly selected and assigned to either the intervention or the control group. The intervention group (n=20) watched a thirty-minute video prior to the training describing the "Pit Crew Approach;" the control group (n=20) did not watch the video. Each crew was given the same simulation scenario of a pediatric patient that had overdosed on a beta-blocker. Completion of predetermined critical tasks were noted and timestamped. A survey was administered to the participants following the training to assess team dynamics and level of confidence.

Results

Three outcomes were statistically significant between the two arms: The interventional group felt they themselves had a more defined role in the resuscitation in comparison to the non-interventional group (p= 0.021). The interventional group also felt that their team members had a clearer and more defined role than the nonintervention group (p= 0.018). The interventional group also felt more confident managing a beta blocker overdose than the nonintervention group (p.007). The only statistically significant secondary outcome finding was in scene departure decision: the interventional arm spent more time on-scene (p=0.031). Of note, the non-intervention group missed performing tasks more often than the interventional group and team leaders of these groups often performed task(s) while also directing the patient care.

Conclusion

The Pit Crew model was developed to optimize communication and team function. Our data identified that a formal instruction of the pit crew approach to a critical care scenario improved comfort in patient care. Future studies are needed evaluate other methods of training and the effects of continued formal pit-crew training over time.

INTRODUCTION

A career in EMS lends itself to intense and stressful situations where seconds matter and decisions must be made without hesitation, decisions that can affect the lives of patients forever. Complex, unstable patients require the provider to demonstrate an even greater ability to evaluate and treat while remaining both accurate and timely. The intensity, stress, and chaotic environment is challenging at the best of times. Well-meaning members of the team may not configure their roles according to what is most efficient. Team leaders often find themselves performing tasks instead of managing patient care which may lead to missed interventions and thus affect patient outcomes.

A ground-breaking change in the world of the out-of-hospital cardiac arrest came in the form of "Pit Crew" style resuscitation. In 2011, Salt Lake City Fire Emergency Medical Services (EMS) utilized this technique, and was shown to have improved survivability and neurological outcomes.[1] The tenets of this technique include assigning roles in order to share the load of responsibilities and allow for team leaders to make focused decisions that could better outcomes. EMS and hospital systems across the country have shown the pit crew method to be an effective means to improve patient outcomes.[2,3]

To explain the rationale for the improvement, the underlying components need identification. Survival rates prior to pit crew remained largely unchanged despite access to modern, early defibrillation, multiple iterations of Advanced Cardiac Life Support, and a focus on high-quality compressions.[4] Although the tools were unchanged, the Pit Crew provided a way to utilize them most effectively.[5] EMS systems train and test protocols frequently, but the presence of different conditions and the integration and management of different protocols may be difficult to initiate when encountering complex patients who often span several protocols simultaneously. The lead paramedic, therefore, needs to process, manage, and continuously evaluate these patients unencumbered. This requires not only the assignment of roles in an effort to perform tasks efficiently but optimization of the working memory of the provider, known as cognitive offloading.

Cognitive load theory separates stressors into intrinsic, extraneous, and germane cognitive loads. Intrinsic is often unchangeable and is related to the complexity of the situation at hand. Germane is related to the development and use of schemas born over time with experience. The extrinsic, however, is of particular interest as external factors can be modified and overcome to enhance processing in the moment.[6] Cognitive offloading allows for providers to clear that working memory to perform the task before them. Several techniques have been developed to enhance this process including but not limited to using lists or protocols, simple algorithms, distributing the work, and closed-loop communication.[7]

The success seen with the Pit Crew implementation in cardiac arrest provides an opportunity for expansion to other conditions, in the hopes of improving patient outcomes through medical interventions, protocolization, and cognitive offloading. Eventually, this approach could be used and adapted to cover ALL patients, especially those in critical condition in the prehospital setting. In this study, we assessed if a Pit Crew intervention improved team dynamics and time to the performance of critical actions in a prehospital critical care scenario.

METHODS

STUDY DESIGN AND SETTING

This was a randomized controlled single-blind trial of Emergency Medical Service (EMS) workers assigned to crews in an intervention group or crews in a control group. The study was conducted with members of the Osceola County Fire Department; a fire-based EMS system with 233 paramedics and 115 Emergency Medical Technicians (EMT). The system responds to 16,000 calls per year, covering 1500 square miles.

POPULATION

EMS personnel from the fire station were divided into eight EMS crews and were comprised of five EMS workers of different levels of training including emergency medical technicians (EMT) and paramedics (paramedics and paramedic firefighters). Each crew had at least two paramedics and one EMT.

INTERVENTION

Each of the eight EMS crews was randomly assigned to either the intervention (pit-crew group) (4 crews of 5 participants) or the control group (4 crews of 5 participants) for a total of 20 in each group. Randomization of each crew was performed using a computer-generated numerical assignment. Both groups (intervention and control) rotated through standard simulation training as required by their agency over an 8-hour period in November 2020 during regular duty hours. Those crews assigned to the intervention (pit-crew group) watched a thirty-minute video prior to standard training describing the "A to E Pit-Crew Approach" to care. Additionally, at the start of the simulation, they were asked to utilize the pit-crew method during the simulation. The crews assigned to the control group (control crews) did not watch the video and were not given instructions to utilize the pit-crew method. Although all EMS personnel in the study had routinely used a pit-crew approach in the management of cardiac arrest patients, they were never trained in this approach for other conditions.

The EMS crews were not blinded to the assignment but were asked not to discuss their assignments with other EMS crews. Each simulation session was observed by a member of the research team to notate the completion of critical actions and the time to the performance of each critical action. The researchers conducting the assessments during the simulations were blinded to the group assignments. The research team was comprised of three board-certified emergency medicine physicians and a 2nd-year emergency medicine resident. Additionally, team dynamics and level of confidence were evaluated by administering a survey to the participants following the training.

The study protocol was approved by the local research committee and deemed exempt by the University of Central Florida's Institutional Review Board.

THE ABCDE PIT CREW APPROACH

The Pit Crew training video focused on team dynamics and role assignment specifically for critical care patients. It described how to delegate prehospital tasks based on the well-referenced Emergency and Trauma "ABCDE" system. For example, a team member would be assigned to "A" for airway. This category would include tasks such as maintaining a patent airway by assessing for cervical spine injuries, performing a jaw thrust or chin lift, and establishing an advanced airway. "B" is for breathing and would include tasks such as monitoring oxygen saturation, respirations & endtidal capnography, applying supplemental oxygen, and progressing to pre-oxygenation as needed. "C" is for circulatory and includes tasks such as: obtaining and monitoring the blood pressure, performing an electrocardiogram, establishing intravascular access, and administering fluids and other medications. "D" is for disability and diagnosis which would include checking a blood glucose level and reviewing the EMS protocols to assist in appropriate diagnosis, treatment, and destination. "E" is for exposure which would prompt the team member to fully examine the patient, with attention to another well-known EMS acronym "DCAP-BTLS". This represents deformities, contusions, abrasions, penetrations or perforations, burns, tenderness, lacerations, and swelling.

Implementing this novel "ABCDE" approach for prehospital critical scenarios, the team leader would verbalize the category and the associated tasks specific to the call. The leader would then assign roles A, B, C, D, and E to the team members, serving as a reminder for the tasks to be addressed within that category. The team leader then advises on the intervention, based on the verbalized report of the assigned team members. In order to further optimize the use of this system, tasks were delegated according to their scope of practice as defined by the state of Florida. Acknowledgment of the individual skill sets within the group allows for appropriate designation of tasks and further promotes generalizability to any complex or critical prehospital scenario regardless of the composition of the team.

OUTCOME MEASURES

The primary outcome was the successful completion of critical actions and the time to completion of these critical actions. Critical actions for the simulation were established a priori based on the EMS local protocols and in coordination with the system's medical directors to assess competence and skill level by role.

The scenario involved an unresponsive 4-year-old pediatric patient found halfway down the staircase by his mother. Upon further questioning, she discloses information that prompts the suspicion of a beta-blocker overdose. EMS arrives to find the child unresponsive and with generalized tonic-clonic movements. The crews are expected to manage a hypoglycemic, seizing patient as a result of a beta-blocker overdose. The case progresses to prompt further interventions to manage hypotension despite fluid resuscitation and treat unstable bradycardia. The case concludes when the child is transported to a hospital.

Critical actions of the simulation included the application of a cervical spine collar, obtaining a glucose level and treating with a bolus of D10 (10% dextrose), managing a seizure with the appropriate dose of midazolam, establishing intravenous (IV) or intraosseous (IO) access, providing active airway assistance (using a bag-valve-mask, supraglottic or endotracheal tube), obtaining an electrocardiogram, administering a fluid bolus and initiating vasopressors, treating unstable bradycardia with pacing, and transporting to a Pediatric Trauma Hospital.

A stopwatch was used by the research team to record the times to the completion of the critical actions. The stopwatch was started at the beginning of the simulation session and stopped at intervals to mark the completion of each critical action.

Secondary outcomes included effectiveness of communication and overall team functioning in a prehospital critical care simulation as defined by the crew members having clear roles and reporting clear and direct communication amongst members.

DATA ANALYSIS

Data were described using frequencies. A chi-square analysis was used to compare the characteristics of the two groups. The times for critical actions were compared and analyzed between the two groups using a t-test. $P<=0.05$ was considered significant. Data analysis was performed by SPSS version 24.

RESULTS

There were 40 participants in total with 20 participants in the intervention group and 20 in the control group. There was no statistically significant relationship ($p>0.05$) between the two arms regarding prior simulation experience, familiarity with the team members, or prior experience with beta-blocker overdose. Each duty crew consisted of five team members and was led by a paramedic or paramedic-firefighter. The remainder of the crew consisted of a mix of EMTs, Firefighter-EMTs, Firefighter-Paramedics, Paramedics, and Firefighters only. The majority had more than 10 years of field experience (Table 1).

The primary outcome of this study was the successful completion of critical actions and the time to completion of these critical actions (Table 2). The "2nd Glucose Check" in the no intervention arm was excluded as no duty crew in that arm performed that specific action. Times for each arm were averaged and compared. The only statistically significant finding was in scene departure time: The "no intervention arm" took 11.11+/-2.76 minutes and the "intervention arm" took 16.41+/-2.57 minutes, $p=0.031$ ($p<0.05$). It is important to note that not all tasks were performed by every crew in the simulation. These can be seen specifically in Table 2. Of note, there was a noticeable difference in the following tasks: second glucose check, fluids, pacing, and vasopressor administration where the control group failed to perform these tasks more often than the intervention group. Also, only 1 group in the entire simulation (intervention group) performed an Electrocardiogram at some point during the case.

Other secondary outcomes measured were effective communication and team function in a prehospital critical care simulation. Mean survey responses to Q9-Q17 measuring secondary outcomes are listed in Table 3. Three outcomes were statistically significant between the two arms: "intervention arm" felt that it had a clearer and more defined role than the "no Intervention arm" ($p=0.021$); the "intervention arm" felt that its team members had a clearer and more defined role than the "no interventional arm" ($p=0.018$); the "interventional arm" felt more comfortable managing a beta-blocker overdose than the "no intervention arm" ($p=0.007$).

Finally, the observers were asked if it was clear who the team leader was in each crew (yes or no), if the team leader assigned roles to their crew (yes or no), and to rate the effectiveness of each crew's communication (Likert scale). No statistically significant relationship was found between groups.

DISCUSSION

Even in the most basic EMS calls, providers are asked to manage very complex situations. They may be attempting to provide care in hostile and dangerous environments while managing a potentially dying patient or managing complex medical conditions with limited resources, all the while trying to quickly transport a patient to the appropriate hospital. The Pit Crew model was developed as a means of mitigating the inherent risks faced by EMS. The model is a way of assigning roles and responsibilities to crew members. It helps to optimize communication and team function. Consistently there is a team leader who helps to direct communication and organizes the other team members. The lack of organization and communication are two of the most commonly cited problems in both true and mock codes.[8] When implemented correctly, the team leader is able to manage the situation at a more global level as opposed to trying to fill in the various deficiencies of the team. The model can be adapted based on the number of providers present and the needs of the patient.[9] The model has primarily been used and studied in the past in the area of cardiac arrest.

The critical care scenario presented to the EMS crews centered around a pediatric beta-blocker overdose with an additional component of trauma. Beta-blockers in overdose may lead to CNS depression, coma, and seizures. Additionally, some patients, specifical pediatrics, may present with hypoglycemia. It may be difficult to differentiate between an overdosed patient and one that had a mechanical fall with a decreased GCS, but EMS crews must be alert to the situation and to the possibility of a toxidrome. A thorough history and evaluation of the scene may provide vital information to the crew. By utilizing the pit crew model in this specific scenario, the team should have been able to complete a thorough primary survey and while completing the secondary survey take note of and treat the patient's seizure and hypoglycemia. There were other possible treatment modalities including the administration of glucagon as means of reversing the overdose. The authors of the case highlighted the treatment of the seizure, hypoglycemia, and overdose as the three primary objectives although there were multiple critical actions to be completed.

After reviewing the survey responses by the crews who completed the pit crew simulation training, four questions were found to have statistically significant different answers when comparing the interventional versus the control group. The interventional group felt they themselves had a more defined role in the resuscitation in comparison to the control group ($p = 0.021$). The interventional group also felt that their team members had a more clear and defined role than the control group ($p = 0.018$). The interventional group also felt more comfortable managing a beta-blocker overdose than the control group (p.007).

The control group missed performing several tasks more often than the interventional group including a second glucose check, fluid administration, pacing, and initiation of vasopressors. Team leaders often find themselves performing tasks instead of managing and directing patient care which may lead to missed interventions. The completion of additional tasks by the intervention group may be attributed to the significant cognitive offload seen when using the pit crew method, considering the video intervention did not cover beta-blocker overdose care. Cognitive offload contributes by clearly defining roles and adding comfort in a rarely encountered critical case. Increased comfort in managing a patient in the field along with performing several additional critical tasks likely led to the statistically significant difference in scene departure time between the two groups with the nonintervention group spending 11.11 +/- 2.76 minutes on scene and the interventional group spending 16.41 +/- 2.57 minutes ($p<0.05$) on scene.

Previous training studies in a wide range of areas such as trauma care, geriatrics, and weapons of mass destruction have noted similar findings where prehospital training and education increase comfort in skill performance and patient care.[10–12] In 2011 the Salt Lake City Fire Department was trained in delivering high-quality CPR including the use of the pit crew approach and implemented their training in out-of-hospital cardiac arrest care noting significant improvement in outcomes. Improvements included: patients which survived neurologically intact increased from 8 to 16% and overall survival to discharge increased from 37 to 50%.[13] Our data identified that formal instruction of the pit crew approach applied to a critical care scenario improved comfort in patient care.

Training time for many Fire and EMS agencies is limited due to cost, time for other tasks during the shift, and other competing training topics (such as fire training). Therefore, identifying which training makes the biggest difference in performance is key. Training on the pit crew approach represents an opportunity to improve confidence and increase efficiency in prehospital care and is worth consideration. The use of a single EMS agency contributed to the limitations of this study. The study was also limited by a small number of participants as only 40 providers out of a sample size of greater than 300 were included. Additionally, a more thorough intervention could have been performed to include a hands-on training session in addition to the pit crew video. However, we feel that this is worth continued consideration and research to try and identify the best way to improve and streamline prehospital resuscitation, and care and plan for future training. Future studies may include applying the pit crew method to various other critical care scenarios and evaluating the effects of continued training over time.

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