Internet Journal of Allied Health Sciences and Practice

Volume 20 | Number 2 Article 7

March 2022

Comparison of Survival Rates Between Two Cardiopulmonary Resuscitation Protocols and the Association of Crew Consistency

Stacey L. Parrish
Fort Lauderdale Fire Department, fortlaudff@yahoo.com

Lori Kupczynski
University of St. Augustine for Health Sciences, lkupczynski@usa.edu

Pradeep Vanguri
Nova Southeastern University, pv101@nova.edu

Comparison of Survival Rates Between Two Cardiopulmonary Resuscitation Protocols and the Association of Crew Consistency

Abstract

Background: Cardiac arrest is a life-altering event that requires swift, coordinated actions from numerous individuals for patient survival. Although return of spontaneous circulation is the goal of every emergency medical service agency, survival rates continue to be low due to many factors. Many variables are out of direct control of emergency medical service agencies, but some, such as protocol development and personnel training, are well within their power. Purpose: The purpose of this mixed-methods study was to examine the new HP-CPR protocol implemented by a large southeastern urban fire rescue department to see if changes to existing protocol assisted, in any way, with an increase in ROSC rates. The study also looked at group dynamics and whether crew consistency and well-defined positions played a role in patient survival. Operations personnel views and attitudes on the new protocol and importance of well-defined roles and consistency during a stressful event such as cardiac arrest were also investigated. Their input could shed light on other areas needing further research or improvement such as bystander intervention improvement strategies, response and on scene times, and location of arrest. Methods: This mixed-methods study evaluated the effectiveness of a protocol change in a large southeastern urban fire rescue department. It examined cardiac arrest incidents involving adults 18 years and older. The study compared survival rates between the previous protocol and the new high-performance cardiopulmonary resuscitation protocol, also known as pit crew cardiopulmonary resuscitation. It also examined whether crew consistency impacted survival rates and gathered crew perceptions of the new protocol and crew dynamics. Results: The results of the study provide evidence of effectiveness of the new protocol, areas for improvement, and whether group dynamics played a role in patient survival during out-of-hospital cardiac arrest. Conclusions: The results could guide future protocol development and provide a template for other agencies to follow that are experiencing low survival rates.

Author Bio(s)

Stacey L. Parrish, EdD, is a Fire Lieutenant for Fort Lauderdale Fire Rescue. She has worked as an athletic trainer at Pompano Beach High School and served as adjunct instructor in the Athletic Training Program at Nova Southeastern University. She completed her EdD at the University of St. Augustine for Health Sciences.

Lori Kupczynski, Ed.D. serves as a Professor of Education at the University of St. Augustine for Health Sciences. Previously, she served as Associate Professor and Program Director of the Educational Leadership doctoral program, transcripted certificate program in Higher Education Administration and Leadership (HEAL) and the Adult Education Masters Program.

Pradeep R. Vanguri , PhD, LAT, ATC, is an Associate Professor in the Department of Health and Human Performance in the Dr. Pallavi Patel College of Health Care Sciences at Nova Southeastern University. He completed his PhD in Instructional Leadership at The University of Alabama.

IJAHSP™
The Internet Journal of Allied Health Sciences and Practice
Dedicated to allied health professional practice and education
Vol. 20 No. 2 ISSN 1540-580X

Comparison of Survival Rates Between Two Cardiopulmonary Resuscitation Protocols and the Association of Crew Consistency

Stacey L. Parrish
Lori Kupczynski
Pradeep Vanguri

1. Fort Lauderdale Fire Department
2. University of St. Augustine
3. Nova Southeastern University

United States

ABSTRACT

Background: Cardiac arrest is a life-altering event that requires swift, coordinated actions from numerous individuals for patient survival. Although return of spontaneous circulation is the goal of every emergency medical service agency, survival rates continue to be low due to many factors. Many variables are out of direct control of emergency medical service agencies, but some, such as protocol development and personnel training, are well within their power. **Purpose:** The purpose of this mixed-methods study was to examine the new HP-CPR protocol implemented by a large southeastern urban fire rescue department to see if changes to existing protocol assisted, in any way, with an increase in ROSC rates. The study also looked at group dynamics and whether crew consistency and well-defined positions played a role in patient survival. Operations personnel views and attitudes on the new protocol and importance of well-defined roles and consistency during a stressful event such as cardiac arrest were also investigated. Their input could shed light on other areas needing further research or improvement such as bystander intervention improvement strategies, response and on scene times, and location of arrest. **Methods:** This mixed-methods study evaluated the effectiveness of a protocol change in a large southeastern urban fire rescue department. It examined cardiac arrest incidents involving adults 18 years and older. The study compared survival rates between the previous protocol and the new high-performance cardiopulmonary resuscitation protocol, also known as pit crew cardiopulmonary resuscitation. It also examined whether crew consistency impacted survival rates and gathered crew perceptions of the new protocol and crew dynamics. **Results:** The results of the study provide evidence of effectiveness of the new protocol, areas for improvement, and whether group dynamics played a role in patient survival during out-of-hospital cardiac arrest. **Conclusions:** The results could guide future protocol development and provide a template for other agencies to follow that are experiencing low survival rates.

Keywords: cardiopulmonary resuscitation; crew consistency; ROSC rates, Mixed-methods research

INTRODUCTION

Cardiac arrest occurs when the pumping action of the heart ceases, causing a person to become unresponsive, apneic, and pulseless.[1] The loss of the body's circulatory pump initiates a cascade of events that if not treated immediately will lead to irreversible organ damage within a few minutes.[2] As all healthcare providers (HCPs) are required to maintain a cardiopulmonary resuscitation certification, patients will have the best chance of survival if HCPs work together in an orchestrated manner providing quick efficient interventions.[3]

Although training and technology have evolved over the years, out-of-hospital cardiac arrest (OHCA) survival rates continue to be low. This study looked at survival rates of OHCA patients in a large southeastern urban fire rescue department. This department, like many others, experienced survival rates in the 20th percentile and aimed to improve these rates with the development of a high-performance cardiopulmonary resuscitation (HP-CPR) protocol. The need for change was multi-faceted and based on evidence-based medicine, medical direction, and guidance from outside agencies.

The new protocol was customized to fit the needs of the department and optimize the resources available. The new guidelines, compared to the previous, outlined specific paths of treatment based on the patient's origin of arrest (primary/presumed cardiac versus secondary/presumed non-cardiac), as well as rhythm presentation (shockable versus non-shockable rhythms). The new protocol also gave paramedics more lenient options regarding vascular access, compression technique, and airway management decisions that were more confined in the previous protocol so interventions could be performed quicker. High-quality cardiopulmonary resuscitation (CPR) is the cornerstone of any cardiac arrest algorithm and is emphasized in the new protocol. The delivery of high-quality treatment requires a team-based approach with well-defined roles and responsibilities for providers when responding to a patient in cardiac arrest. [4-5,2-3]

The newly implemented protocol within this study has clearly defined team member roles and responsibilities. However, there is a gap in the literature on crew dynamics and how familiarity, consistency, and communication between crew members during a cardiac arrest affect survival rate. Therefore, this study aimed to look at three areas of interest: 1) the impact on overall survival rates of differing protocols, 2) group dynamics and the role they played during cardiac arrest, and 3) employee perceptions of a newly implemented cardiac arrest protocol and associated crew dynamics.

The result of this study lends insight as to whether changes made were successful in improving survival rates overall and if crew consistency had a significant impact on patient outcomes. This information also provides the department with trends, both positively and negatively, that can be used for future training and education. Finally, the study equips other healthcare agencies looking to make performance improvement changes with a template.

LITERATURE REVIEW

A cardiac arrest event is a time-sensitive situation with many factors that play a role in successful resuscitation. The adult chain of survival signifies the actions needed for an individual to have the best chance of survival. The chain of survival's six links, with slight variation for in-hospital cardiac arrest (IHCA), includes 1) early recognition and activation of 911, 2) quick initiation of chest compressions, 3) early defibrillation, 4) early basic life support (BLS)/ advanced life support (ALS) intervention in the field, 5) in-hospital care, and finally, 6) recovery.[6,2,7-8] A fire department's role would fall within the fourth link unless the arrest was witnessed by emergency medical services (EMS) personnel at the time of collapse. Most likely, EMS would not be on scene and must be summoned by bystanders or other HCPs, leaving time between arrest and arrival, a critical time for the cardiac arrest patient.

Low survival rates are not uncommon. Survival rates seem to vary throughout the literature with a wide range from 1-50%. The majority though tend to fall between the 10-20% range.[9-12,13-14] Variations in survival rates are dependent on area demographics, protocol development, and successful implementation of community-initiatives. For a developed nation, such as the US, these rates are concerning. The fire rescue department examined by this study sought out multiple ways to improve their role in the chain of survival.

Description of the New Protocol

The new protocol was developed using the Lean Six Sigma (LSS) approach. The goal of the *Lean* aspect is to eliminate activities not needed or that do not add value to the situation while *Six Sigma* reduces variability and improves patient satisfaction and reduces waste.[15] The approach is collaborative in nature and typically seen in strategic planning. The lean six sigma project was implemented in 2019 with the primary initiative being the new HP-CPR protocol. The protocol evolved from a generic guideline to one that was patient-centered and required decision-making on the part of the paramedic.

The protocol is initiated upon arrival at the patient with a quick initial assessment. The first decision necessary after concluding a patient is in cardiac arrest is whether the arrest is of a primary origin or secondary origin. A primary etiology is anything cardiac in nature. This cause is most likely a myocardial infarction (MI) due to a blockage of a coronary artery but could be due to a cardiac dysrhythmia or sudden electrical disturbance such as electrocution. Secondary etiology is a cause due to factors other than cardiac. These incidents could include respiratory issues such as severe asthma or drowning, drug overdoses such as heroin causing depression of the respiratory drive, or a traumatic injury causing damage to the heart's pumping action or the vessels' ability to contain blood used for perfusion.[16-17] The initial decision based on patient cause will determine which side of the protocol the paramedic will use. The left side provides guidelines for HP-CPR or "pit-crew" CPR for cardiac etiology, while the right side provides guidelines for basic American Heart Association [AHA] ACLS treatment for secondary causes of arrest.

High-Performance Cardiopulmonary Resuscitation (HP-CPR)

HP-CPR is a team-based approach that provides quick interventions in an orchestrated manner due to cardiac arrest of a primary nature.[7,3,5] HP-CPR is also known as "pit-crew" CPR due to actions mirroring those of a pit crew within a NASCAR team: quick, efficient, and well-orchestrated due to endless practice.[7] Cardiac arrest treatment should be no different. Many allied HCPs, hospital employees, and EMS crews work together routinely or are provided with systemwide training so there is uniformity. The concept of HP-CPR or "pit crew" CPR is not new, yet many EMS agencies lack specific protocols mandating its use.

The AHA's 2015 and updated 2020 guidelines stress the importance of the team-based concept with primary positions for compressor, monitor, and airway and secondary positions for team leader, medications, and recorder when personnel are available. Many agencies have found success with cardiac arrest survivability using the team-based approach. A retrospective cohort study in North Carolina (NC), found "more patients survived upon arrival at the hospital (27.2%, 21%) and hospital discharge (11.5%, 7.3%) using team-based resuscitation versus standard CPR."[18] A retrospective study looking at a team-focused high-performance CPR protocol in a rural NC setting found a 16% increase in return of spontaneous circulation (ROSC) rates after protocol implementation.[5] The findings, although not significant statistically, did show improvement in overall quality and patient outcome. Although some studies may show minimal increases, they are increases in the right direction and provide evidence that choreographed approaches to cardiac arrest provide patients with the best chance of survival.

Within the new HP-CPR protocol for this study, three initial positions are filled first by the initial responding crew. In the fire rescue department within this study, this could be an engine, ladder, or rescue company as all individuals are cross trained as EMS providers and firefighters. Position 1 actions include initial compressions, Lund University cardiopulmonary arrest system (LUCAS) application, and intraosseous (IO) insertion. Position 2 actions involve monitor attachment and rhythm analysis, compressions as needed, and managing of the LUCAS once applied for rhythm analysis and pulse checks. Position 3 responsibilities mainly revolve around airway management and the occasional assistance with the monitor if that individual is providing chest compressions. Three secondary positions are used as personnel become available. These positions include a person to assist with advanced airway preparation, a patient packaging coordinator for patient transfer and transport, and a person to document interventions, act as a liaison, and assist with radio communications. These positions, when practiced regularly, become fluid and second nature.

Training and Implementation

Protocols should reflect evidence-based recommendations to promote optimal patient care.[19] According to Cheng et al, "deliberate consideration of the scientific evidence for effective design and delivery of resuscitation education and knowledge transfer is required to improve cardiac arrest outcomes."[20] Yet according to Yeung et al, many providers fail to implement changes to guidelines and policies that would reflect evidence-based recommendations.[21]

In 2006, the International Liaison Committee on Resuscitation [ILCOR] Statement on Education and Resuscitation introduced the formula for survival in resuscitation.[20] The formula stated that for survival to occur, you had to have the medical science, educational efficiency, and local implementation.[22] The department for this study used a multi-step process, including the evidence-weighted recommendations and updated guidelines from medical science, to develop the new HP-CPR protocol.[22]

Once the HP-CPR protocol was agreed upon, informal testing in the field began with individual rescue teams that were hand selected by the EMS Bureau. These teams used low- and moderate-fidelity simulation manikins to practice the roles and specific steps required to accomplish a successful resuscitation. Sullivan defined low fidelity training as "role play, case studies, or individual skills practice"; moderate fidelity training as "scenario-based training with basic mannikins," and high-fidelity training as "computer-based or in situ scenarios."[23]

The groups were comprised of two paramedics to simulate a real-life environment. Three-person rescue units had not yet been implemented. Each team worked with a member of the EMS Bureau and was videotaped for debriefing so deficiencies could be corrected and suggestions for improvement could be discussed. Various crew configurations were used to simulate 2-person medical rescue unit (MRU) crew first arrival with additional suppression unit assistance, 3-person suppression crew first arrival with addition of MRU crew, and finally the same scenarios with a 3-person MRU crew. Once the protocol was finalized and the teams felt comfortable with it, they were given authorization to use it in the field. Teams were required to provide informal feedback via e-mail or phone call after every resuscitation for quality improvement prior to the department-wide rollout.

According to Cheng et al, educational efficiency describes instructional design and options for informational dissemination for optimal knowledge transfer.[20] Many techniques for establishing knowledge retention and transfer are available, including feedback and debriefing, mastery and deliberate practice, contextual and spaced learning, innovative strategies such as Web 2.0 and social media, and finally, assessment.[22-23] While team testing was being conducted, online training was disseminated throughout the department for crew familiarity. The content was scenario-based and presented by a narrated PowerPoint and video. All training provided online required employees to take a short knowledge quiz and acknowledge that they had completed all aspects of the online training and understood the content presented. The new protocol was also discussed and practiced in all advanced cardiac life support (ACLS) and pediatric advanced life support (PALS) classes to keep information fresh prior to the department-wide hands-on training courses.

Upon completion of testing and initial online training, formal classroom training was mandated prior to an employee being able to use the new protocol in the field. The hands-on sessions were conducted in small groups to allow for optimal practice. The initial set of classes was conducted by a member of the EMS Bureau and a rescue lieutenant. Classes were held twice a day over the course of a four-month period, and each session lasted approximately four hours. All participants had to sign a roster on the day they attended, so management personnel could schedule accordingly, and there was record of 100% employee completion. The class used a step-by-step progression for maximum understanding. The instructor reviewed the overall protocol and discussed the reasons for the update in procedures. Each position, along with its responsibilities, was discussed individually. A feedback mannikin was used so quality CPR could be monitored throughout simulation. Finally, employees were placed in groups of two and three to mirror a real-life rescue and suppression group and simulated a cardiac arrest scenario using the new protocol. The simulation was run multiple times so each member had a chance to perform and be evaluated in each position.

The final step in the change process and the formula for survival included the actual *implementation* of the new protocol.[20] The complete roll-out of the protocol, including the use of the Cardiac Arrest Registry to Enhance Survival (CARES) database and CODE-STAT™ software, went live on January 1, 2019. The information generated from these resources were used for continuous quality improvement in hopes of improved survival rates.

Conceptional Framework

The guiding conceptual framework for this study revolved around the interactions of individuals during a cardiac arrest event and how those interactions could assist or hinder a successful resuscitation. Group dynamics is a field of study within the social sciences and can be defined as the study of behavior. According to Forsyth and Gencer, the dynamics of a group are the behaviors that influence the outcomes of the group or between groups.[24-25] Another term typically used to describe the collaboration of individuals is team dynamics. Wakeman and Langham defined team dynamics as “the unconscious, psychological forces that affect the behavior and impact of performance of groups of people working together.”[26] In healthcare, this interaction between personnel is often termed the “team-based approach” and includes both intra- an inter-group interaction. In the fire rescue setting, intragroup interaction occurs within the various organizational levels, while intergroup interaction occurs with individuals outside the department, such as community members and other healthcare providers.

According to Cartwright, group dynamics relates to the forces acting upon or within a group.[27] These forces can either build cohesion or cause dysfunction. A newer term involving a collaboration of individuals and their behaviors is interprofessional practice (IPP) because patient care involves the interaction of individuals from many entities.[28] The care the patient receives throughout transfer among teams is determined by the dynamics of all the groups involved.

Team Characteristics

According to Babiker et al and Cleary and Flanagan, a good team is one that works well together yet can function independently.[29,2] It is also able to adapt when necessary. Clear, common, and measurable goals, mutual respect and trust, effective, closed-loop communication, and understanding your limitations are just a few guiding principles that make teams successful.[30,29,2,31] The AHA

2020 guidelines condensed these team characteristics under three elements: Roles and responsibilities, communication, and debriefing.[4,6]

In cardiac arrest situations, these characteristics all play a role in a successful outcome. The healthcare team providing lifesaving care must have a common goal; they must be task-driven and capable of functioning independently, yet they must work in synergy and adapt to the needs of the patient if an optimal outcome is to occur.[29,32-33] Groups must be able to communicate effectively to avoid medical errors and oversights.[26] Finally, HCPs have their own strengths and weaknesses based on their experiences and skillsets. Knowing one's limitations and having the mindset to speak up strengthens the team by placing individuals in areas where they can be the most effective.

The Role of Group Dynamics in Fire Rescue Structure and Operation

Fire rescue departments vary in structure, but all have the same overall goal – to save lives and property. While fire rescue personnel may be required to have the same initial qualifications for employment and follow the same standard operating procedures (SOPs) and protocols, generational differences, years of experience, provider level and crew familiarity can lead to conflict and communication issues.[31] These issues can be detrimental to a patient, making good group dynamics essential. Maintaining crew consistency and continuous quality improvement (with training and feedback) are two areas where good group dynamics can be reinforced.

METHODOLOGY

A convergent mixed methods approach was chosen for this study to investigate whether the implementation of a new evidence-based HP-CPR protocol and crew consistency had association on ROSC rates in cardiac arrest patients. For this study, the researcher combined the data collection methods of personal interviews using operations personnel who had used both the traditional and the new evidence-based HP-CPR protocol, and data already in existence located in electronic patient care reports (ePCRs), the department's fire records management system (FireRMS), annual bid sheets, and CARES database.

Population and Sample

The target and source population for the quantitative portion of the study included all individuals within the city limits of the large southeastern urban fire rescue department. The sample consisted of all adults aged 18 and over who had suffered OHCA, within the last 36-month time. Using the G*Power calculator with parameters of a two-tailed t-test, an effect size of 0.3, which is medium effect size, an alpha level of 0.05, and a beta of 0.95, a calculated sample size of 134 was obtained. Quantitative data was obtained using the CARES database, ePCRs, FireRMS, and annual bid sheets. Recruitment was not needed; therefore, the Institutional Review Board (IRB) determined research as exempt, as data was evaluated retrospectively.

The target and source population for the qualitative portion of the study included fire rescue operations personnel of any rank hired before implementation of the new HP-CPR protocol. Ten to fifteen personnel were the target sample size for thematic analysis and did not need to be increased as saturation was reached at ten. Only operations personnel who have had experience under both protocols and who were willing to participate in interviews were selected.

Instrumentation

Open-ended semi-structured interviews were used to gather information from the perspectives of the employees who were involved in a cardiac arrest incident. Questions revolved around the strengths and weaknesses of the new evidence-based HP-CPR protocol and ways it may be improved. Employees were also asked about crew dynamics and how the consistency of a crew and well-defined roles may assist in improving patient outcomes.

Data Collection

Data came from multiple sources, including ePCRs, the CARES database, annual bid sheets, FireRMS, and semi-structured interviews conducted by the researcher. The quantitative aspect of this study included both descriptive and inferential data analysis. The qualitative portion of the study included the use of interviews to gather insight on employees' views of the new protocol and how crew dynamics played a role in cardiac arrest treatment.

Analysis of Data

In 2019, a new HP-CPR protocol was implemented in the department to increase the cardiac arrest survival rates of citizens served. The department's overall survival rate averaged 9%.[34] This study examined 495 cardiac arrest cases over a 3-year period to see if there was an association between the new HP-CPR protocol and ROSC rates as compared to the traditional CPR protocol that

had been in place previously. Eighteen months of retrospective data were examined from each protocol as well as crew status during all cardiac arrests to see if there was an association in cardiac arrest survival. See Table 1 for a breakdown of quantitative data.

Table 1. Quantitative Data Collection Breakdown

	n	%
Participants	495	
Protocol type		
Traditional CPR	202	40.8
HP-CPR	293	59.2
Total ROSC	124	25.1
Crew status		
CI	130	26.3
C-1	239	48.2
F	126	25.5

Abbreviation: CI, crew intact; F, float.
[a] CI: All bid members on apparatus.
[b] C-1: One member missing from normal bid crew.
[c] F: No bid members on apparatus.

From a qualitative standpoint, operations personnel participated in semi-structured interviews, answering questions about the new HP-CPR protocol and crew dynamics during a cardiac arrest event. Interviews were of a voluntary nature and so creating equal groups based on gender, rank, experience, service level, or bid status was not possible. See Table 2-3 for interview participant demographics.

Table 2. Interview Participant Demographics

	n	%
Participants	10	
Gender		
Female	2	20
Male	8	80
Total years' experience		
< 5 years	0	0
5-10	2	20
11-15	2	20
16-20	4	40
20 + years	2	20
Rank		
Captain	2	20
Lieutenant	3	30
Driver engineer	0	0
Firefighter	5	50

Table 3. Interview Participant Demographics		
	n	**%**
Participants	10	
Service level		
Paramedic	8	80
EMT	2	20
Bid status		
Apparatus bid	4	40
Float	2	20
Combination	4	40
Abbreviation: EMT, Emergency Medical Technician.		
[a] Bid status based on study timeframe of 36 months (July 2017-June 2020)		

Descriptive Statistics

The total sample size for this study was 495 patients (202 patients under the traditional CPR protocol and 293 patients under the new HP-CPR protocol). A total of 317 were male, while 178 were female. Upon arrival of EMS, most patients were found in a non-shockable rhythm, and approximately 20% of them regained pulses. Finally, approximately two-thirds of arrests (67.7%) occurred in the home. Of those arrests, 50% were witnessed and only 33% had some sort of bystander intervention provided.

RESULTS

Research Question 1

In adult cardiac arrest patients, was there a significant association between ROSC rates and an evidence-based CPR protocol based on origin of arrest compared with a conventional CPR protocol after 18 months of implementation?

A chi square (χ^2) test of independence was calculated comparing the frequency of ROSC rates in a traditional CPR protocol and a new evidence-based HP-CPR protocol. Looking at Pearson Chi-Square asymptotic significance, it appears that the protocol used does not significantly associate with higher ROSC rates (χ^2 (1) = 1.823, p < .05). See Table 4 for Chi-Square test results for protocol type. Looking at each protocol individually, 28.2% of cardiac arrests under the traditional protocol achieved ROSC while only 22.9% achieved ROSC under the new HP-CPR protocol. Evaluating whether ROSC was achieved between the protocols, 46% of patients regained circulation under the traditional protocol versus 54% under the new HP-CPR protocol. Finally, looking at the overall sample, 11.5% of patients regained pulses under the traditional protocol while the HP-CPR protocol had a slight increase of 13.5%.

Statement of Results

Although these rates do not show a significant change with the implementation of a new protocol, it does provide a benchmark for improvement. See Table 5 for a look at ROSC and protocol type cross tabulation.

Table 4. Chi-Square Test Results for Protocol Type					
	Value	**df**	**Asymptotic Significance**	**Exact Sig. (2-sided)**	**Exact Sig. (1-sided)**
Pearson Chi-Square	1.823[a]	1	0.1777		
Continuity Correction [b]	1.55	1	0.213		
Likelihood ratio	1.81	1	0.178		
Fisher's exact test				0.205	0.107
Linear-by-linear association	1.82	1	-0.177		
N of valid cases	495				
[a] 0 cells (0.0%) have expected count less than 5. The minimum expected count is 50.60.					
[b] Computed only for a 2x2 table.					

Table 5. ROSC and Protocol Crosstabulation

		Protocol type		
ROSC		Traditional CPR	HP-CPR	Total
Yes	Count	57[a]	67[a]	124.0
	Expected count	50.6	73.4	124.0
	% within ROSC	46.0%	54.0%	100.0%
	% within protocol	28.2%	22.9%	25.1%
	% of total	11.5%	13.5%	25.1%
No	Count	145[a]	226[a]	371.0
	Expected count	151.4	219.6	371.0
	% within ROSC	38.1%	60.9%	100.0%
	% within protocol	71.8%	77.1%	74.9%
	% of total	29.3%	45.7%	74.9%
Total	Count	202	293	495
	Expected count	202	293	495
	% within ROSC	40.8%	59.2%	100.0%
	% within protocol	100.0%	100.0%	100.0%
	% of total	40.8%	59.2%	100.0%

[a] Each subscript letter denotes a subset of Protocol type categories whose column proportions do not differ significantly from each other at the .05 level.

Research Question 2

In adult cardiac arrest scenarios, does consistency of crew member assignment associate with increased survival rates?

A χ^2 test was used once again to assess whether an association existed between crew status and ROSC rates. Looking at Pearson Chi-Square asymptotic significance, it appears that crew status does not significantly associate with higher ROSC rates (χ^2 (2) = .085, $p < .05$). See Table 6 for Chi-Square test results for crew status. This question examined crew status and whether ROSC rates were significantly different when all members normally assigned were present or one or all were missing. According to the literature consistent crews communicated better and understood the strengths and weaknesses of their counterparts.[26,31,35] Similarly, lack of familiarity decreased team cohesion.[31] A total of 495 cardiac arrests were included in the results. Three groups were examined for this question: crew intact (CI), crew minus 1 member (C-1), and floats (F). A total of 130 cases had the normal crew assigned to that apparatus, 239 had at least 1 member of the normal crew missing, and 126 cases had a crew made up entirely of float personnel. ROSC was calculated by crew status alone, between various crew makeups, and overall. ROSC rates did not differ much when looking at each group individually (23.1% CI, 21.8% C-1, 23.0% F) or overall (6.1% CI, 10.5% C-1, 5.9% F). They did differ when looking at total ROSC between each group (27% CI, 46.8% C-1, 26.1% F).

Statement of Results

These results show that consistency may not play as big of a role as well-defined roles and responsibilities and good communication during a cardiac arrest event. See Table 7 for a cross tabulation between crew status and ROSC rates.

Table 6. Chi-Square Test Results for Crew Status

	Value	df	Asymptotic Significance	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.85[a]	2	0.958		
Likelihood ratio	0.084	2	0.959		
Linear-by-linear	0.012	1	0.913		
N of valid cases	495				

[a] 0 cells (0.0%) have expected count less than 5. The minimum expected count is 28.00

Table 7. Crew Status and ROSC Rates Crosstabulation

		ROSC		
Crew Status		Yes	No	Total
CI	Count	30[a]	100[a]	130.0
	Expected count	29.2	100.8	130.0
	% within crew status	23.1%	76.9%	100.0%
	% within crew status ROSC	27.0%	26.0%	26.3%
	% of total	6.1%	20.2%	26.3%
C-1	Count	52[a]	187[a]	239.0
	Expected count	53.6	185.4	239.0
	% within crew status	21.8%	78.2%	100.0%
	% within crew status ROSC	46.8%	48.7%	48.3%
	% within total	10.5%	37.8%	48.3%
F	Count	29[a]	97[a]	126.0
	Expected count	28.3	97.7	126.0
	% within crew status	23.0%	77.0%	100.0%
	% within crew status ROSC	26.1%	25.3%	25.5%
	% of total	5.9%	19.6%	25.5%
Total	Count	111.0	384.0	495.0
	Expected count	111.0	384.0	495.0
	% within crew status	22.4%	77.6%	100.0%
	% within crew status ROSC	100.0%	100.0%	100.0%
	% of total	22.4%	77.6%	100.0%

[a] Each subscript letter denotes a subset of Crew Status ROSC categories whose column proportions do not differ significantly from each other at the .05 level.

Research Question 3

What are the views of operations personnel regarding group dynamics when using the new HP-CPR protocol for adult cardiac arrest patients?

Operations personnel were asked numerous questions regarding group dynamics during a cardiac arrest. Topics included experiences working with a consistent crew versus a crew not normally assigned to an apparatus; experiences when a suppression crew (or rescue) began working a code prior to arrival or arrived after said apparatus; differences seen with various numbers of personnel on scene; what number they felt was adequate staffing for a cardiac arrest event; recollection of calls that ran smoothly and/or resulted in ROSC and what made them work in that fashion; and any generational issues they saw while working a code.

Theme 1: Staffing is Essential

Participant A1 stated: "I think being on a two-person rescue, you and your partner kind of really have to be on the same page, especially if you're there by yourself." Recalling a previous experience responding as a single unit response to a possible lift assist, participant A1 explained how the patient was found to be in cardiac arrest and communication and good group dynamics amongst the two-member crew assisted in patient care. Participant A1 commented that the limited personnel hindered their ability to transport and treat the patient effectively without further assistance:

> "I think a three-person crew, we could have already been off scene so that could be something that could hurt us, we're delayed on scene if we're still waiting for that engine to get there to where a three-person crew, you can make the decision to transport." Participant A1

> "Put a third on a rescue it's like a completely different world. It just makes, just the weight of the responsibility is so evenly dispersed between so many people that it doesn't seem as, you know, just as heavy on you." Participant C1 expressed: "The sheer extra person helps out tremendously and it kind of actually completes the whole role of this whole process. You got three positions." Participant B1

Participants were asked about their ideal staffing for a cardiac arrest and their justification for their answer. The department's

response profile varies depending on how the call is dispatched. High priority calls require the response of a rescue (2- or 3-person) and a suppression unit (engine or ladder).

> "There is a breaking point where you get too many people, but I've seen a change in dynamics with the six-person crew." Participant D1

Participant F1 explained that a magic number was just as dynamic as the crew:

> "You can have three really good people and run the call with no problems or have five okay people and there will be issues so it is hard to answer." Participant F1

Theme 2: Crew Experience and Work Ethic are Important

During the interview, participants were asked questions regarding positive or negative differences or experiences regarding time of arrival on a code and generational differences seen amongst crew members. Individuals within the department work under two service provider levels: EMT or paramedic. Personnel also fall within four generational groups: Baby Boomers, Generation X, Millennials, and Gen Z. Participants had varying opinions on how crew experience played a role in a cardiac arrest scenario.

> "With newer people you do see that lack of street experience, I think sometimes the newer people are also afraid to make that decision or lack confidence." Participant A1

Participant E1 also weighed in on older individuals regressing to the previous protocol and stated:

> "You do still have people reverting to the old but the remedy is simple - just continuous training." Participant E1

Participant F1 expressed the differences with crew experience were not generational but knowing your job.

> "Unfortunately, not everybody knows their job. You can have a really good EMT, and an OK paramedic and they'll have the same skill set. It has a lot to do with taking pride in your job, knowing your job." Participant F1

Participants had lengthy stories about their experiences when arriving first on scene or after another unit. The answers to this question depended on the participants apparatus assignment. Participant E1 described previous rescue experience as:

> "Engines were a little bit less involved with the medical side, they relied on us to do the majority of the legwork on calls." Participant E1

Participant I1 noted:

> "I don't have high expectations for the engine crew having all the equipment with them. I have had captains and drivers jump in and start IV's and get involved. The downside is, they're not always familiar with what's going on. I'd rather have that and fix that, then somebody that stands off to the side and doesn't help." Participant I1

Theme 3: Communication is Key

The HP-CPR protocol was developed around three core roles and responsibilities and three additional roles when personnel permitted. Participants were asked if/when these roles and responsibilities were communicated during shift and reasons a code may run smoothly or been successful. Communication was noted as a key aspect to good group dynamics. Participant B1 described scenes as dynamic and unable to be scripted prior to occurrence:

> "I'm more subscribed to the idea that everyone is trained on each of those jobs and either gravitate towards the one that they feel most comfortable doing or the one they are closest to." Participant B1

Participants E1 and F1 agreed that communication should occur at the beginning of shift and on the way to the call. Participant F1 noted: "Preplanning makes a huge difference." Participant G1 noted: "Communication is done in the morning but may need to be improvised." Participant I1 expressed communication of roles and responsibilities was crew dependent. "If I'm at a new station and not familiar with everybody, I will discuss things in the morning."

Theme 4: Dynamics of Crew are Important

Finally, participants were asked questions about crew consistency and whether it assists or hinders a code situation. Four out of the ten participants interviewed provided a perspective from a purely float assignment while the other six provided insight from an annual bid assignment. Participant G1 expressed pros and cons of working with floats or a consistent crew:

> "Regular crew members are used to working with one another, they know how each other works, they know each other's deficiencies and strengths. I also feel as a float working with a crew that is normally together, I can see their strengths and weaknesses and correct them. I feel there is more continuity with a regular crew, when you have people that work together so much there is rarely every any talking." Participant G1

Participant D1 noted it all comes down to communication:

> "Working with a float crew, you may not have assigned roles with those individuals that are floating through for that day and it has to be done at the time the incident has occurred whereas, a bid crew knows to fall in line as soon as the incident happens."

Participant E1explained:

> "Bid personnel know each other's capabilities and with floats you lose that, you don't know their strengths and weaknesses." Participant E1

Based on the research question "*What are the views of operations personnel regarding group dynamics when using the new HP-CPR protocol for adult cardiac arrest patients?*", the themes of staffing, crew attributes, communication, and crew dynamics were the most apparent. A cardiac arrest call requires that crew members work fluidly in an uncontrolled environment with members of varying age and experience. These situations require good communication and overall leadership that can only be accomplished through proper staffing.

Research Question 4

What are the attitudes of operations personnel regarding the new HP-CPR protocol?

Operations personnel were asked to describe the HP-CPR protocol to gauge their `understanding. Participants were then asked to describe the roles and responsibilities and if, when, and how they were communicated to crew members. Personnel were asked how comfortable they felt using the new protocol and asked to compare the new HP-CPR protocol with the previous CPR protocol. Finally, they were asked if there was anything they could see as a need for improvement. Interviews were audiotaped and transcribed verbatim by hand by the researcher and with assistance of the computer software Otter.ai. From the transcription process, coding of transcripts was performed. Three major themes emerged.

Theme 1: The Protocol is Collaborative

Participants were asked questions pertaining to the new HP-CPR protocol regarding how comfortable they felt using it compared to the previous protocol. Many participants described it as collaborative, team-based, team-effective, and calming. Participants stated the well-defined roles and responsibilities assisted with the dynamics of the team and allowed the code to run smoother and more efficiently than under the previous protocol. The choregraphed timing of the LUCAS minimizes interruptions and frees up personnel for other responsibilities. They also emphasized a calming effect due to less constrictive requirements such as the number of intubation or intravenous (IV) attempts prior to moving to a more efficient skill such as a blind insertion airway device (BIAD) or IO placement.

E1 described how the new protocol is helpful:

> "It is helpful because everyone knows their roles and realistically once you get the LUCAS on, it takes a lot less personnel to be dedicated to that code." Participant E1

F1 explained: "Everybody knows their role and it just works. It frees up a lot of the confusion."

> "I think this protocol is more efficient, it gives you a second to breath, gather your thoughts. I feel it is more organized." Participant H1

Theme 2: Well Defined Roles and Responsibilities

Along with their comfort level with the new guidelines, personnel were asked to define the roles and responsibilities. Participants were asked whether they saw a need for change and what factor(s) played a role in a smooth and successful resuscitation. Participant A1 described the old protocol as:

> "Scrambling, whereas the new protocol allows for people to jump into positions and the team aspect takes over." Participant A1

Participant C1 stated:

> "People were just kind of like all over the place, now everyone has a specific role to do. I'm a firm believer that I've gotten more on the HP-CPR than the old." Participant C1

Participant D1 remarked:

> "The previous protocol left a lot of room for interpretation, HP-CPR makes it very clear, there is no room for interpretation." Participant D1

Theme 3: User-Friendly

Throughout the interview, operations personnel mentioned what they liked and disliked about the protocol. One of the emerging themes revolved around a protocol that was easy to use, organized, easy to explain, and less constrictive. Participant A1 stated:

> "It is a lot more user friendly for us, because of the fact that we do work in teams, it flows easier on scene and once everything is done there is not much communication needed if it was discussed beforehand." Participant A1

Participant I1 described the new protocol as "easy to explain". Participant J1 interjected:

> "The new protocol is a better way of doing CPR and allows us to focus more on high-quality CPR." Participant I1

A successful resuscitation can be the result of many factors. From an internal standpoint, protocol development and continuous training are key opportunities to improve a patient's chance of survival. The attitudes of operations personnel indicated the new HP-CPR protocol is collaborative, has well-defined roles and responsibilities, and is user-friendly in comparison to its counterpart. It provides personnel with a distinct way of approaching various patients in cardiac arrest, is evidence-based, and is less restrictive allowing for quicker implementation of interventions.

CONCLUSIONS

Well defined roles and responsibilities seem to be a key factor in a successful resuscitation due to the inconsistent nature of the crew and dynamic nature of scenes. In this study, a total of 73.7% of codes were missing at least one or all the members regularly assigned to the rescue truck that responded to the incident. Patterson et al. noted a person may work with an average of 19 different partners in a year and a lack of familiarity decreased team cohesion.[31] This inconsistent nature may also be seen in other healthcare settings though that was not investigated in this study. Other researchers found consistent crews understood the strengths and weaknesses of their partners and communicated better.[35,26] According to operations personnel, the well-defined roles provided an organized plan of action that anyone could step into. Inconsistency of crews is inevitable in the department within this study and most likely other agencies throughout the nation, therefore, well-defined roles and responsibilities must be practiced and understood for positive outcomes to be achieved.

The results of this study determined there was no significant association between a change in protocol type, crew status, and overall ROSC rates. This result does not mean the protocol was not an improvement or that crew consistency was not an important aspect of running calls. It means there is room for improvement through continuous training and education (internally and externally) and quality improvement endeavors.

Continuous training is essential and needed more often due to skill decay from limited exposure. According to Edler et al, "Research indicates that knowledge gaps exist among practitioners which may impact patient outcomes when they fail to recognize changes relevant to their practice setting".[36] For the department in this study, a cardiac arrest occurred less than 1% of the time compared to other medical emergencies. According to the literature, skill decay is a contributing factor to low success rates during resuscitation.[37,21] Cheng et al noted skill decay 3 months after training.[22] Edler et al found that "EMS personnel scored significantly higher than athletic trainers or any other group of participants in emergency care skills, suggesting that individuals who use these skills more frequently retain knowledge and skills more than those who do not."[36] The AHA's 2020 Guidelines reviewed multiple strategies for instructional design and teaching methods. HCPs in charge of quality improvement should customize training using various strategies to reach the adult learner, incorporate resources used by personnel during real-life resuscitation, and provide feedback to reinforce importance of skill retention.

Bystander involvement is key to successful resuscitations and needs to be addressed if positive outcomes are going to be achieved. According to the AHA, community endeavors that prevent emergencies and prepare individuals to respond in the event of an emergency is a critical aspect if outcomes are to improve.[1] Community education is necessary to strengthen the links of the chain of survival. Basic concepts of first aid, CPR, automated external defibrillator (AED) use, and Narcan administration need continuous dissemination in all public forums to assist in bridging the gap seen with bystander involvement. Over 40% of the cardiac arrests in this study were witnessed by bystanders or other healthcare providers (OHPs) in this study, yet only 33% performed compressions. It is well documented that overall survival increased when the chain of survival is followed yet OHCA numbers continue to be low.

Continuous quality improvement is necessary and desired by operations personnel in this study. Debriefing soon after the event is necessary due to poor recall as more time goes by. According to the AHA, debriefing accomplishes three key things: Educates personnel, improves deficiencies, and provides emotional support.[1] High quality CPR is the centerpiece of every resuscitation, yet crews rarely received insight into their actual performance. CODE-STAT™ software was installed on all LifePak 15 electrocardiogram (ECG) monitors. This software provides real-time metrics that occurred during a cardiac arrest event yet most participants in the study stated they had never seen a post-resuscitation report.[38] Studies have shown improvements in CPR quality when feedback is delivered during training, in real-time, and after the cardiac event.[39-40]

This convergent mixed methods study assessed if there was an association between type of CPR protocol and ROSC rates in OHCA patients. The study found no significant association between ROSC rates and the type of CPR protocol used. Additional inquiry looked at crew consistency and its association to ROSC rates. Crew consistency was found to not be associated with better ROSC rates. Finally, interviews were conducted to obtain views and attitudes of operations personnel who have used the various protocols and the impact crew dynamics had on cardiac arrest events. Participants had positive views on the new HP-CPR protocol. They felt it was easy to use and the well-defined roles and responsibilities provided guidance and accountability. Mixed views were found regarding crew consistency, work ethic, and generational issues during a cardiac arrest. Most participants felt 5-6 people were an adequate number of personnel needed for OHCA. The information gathered by this study could assist the department, as well as OHPs in further updates to the HP-CPR protocol or guide future studies on crew dynamics, bystander intervention, or individual intervention effectiveness.

References

1. American Heart Association. Cardiac arrest. American Heart Association. Retrieved from https://www.heart.org/en/health-topics/cardiac-arrest. Accessed July 10, 2021.
2. Cleary MA, Flanagan KW. *Acute and emergency care in athletic training*. Human Kinetics; 2020.
3. Gonzales L, Oyler BK, Hayes JL, Escot ME, Cabanas JG, Hinchey PR, Brown LH. Out-of-hospital cardiac arrest outcomes with "pit crew" resuscitation and scripted initiation of mechanical CPR. *Am J Emerg Med.* 2019;37(5):913-920. doi: 10.1016/j.ajem.2018.08.031
4. *American Heart Association advanced cardiac life support provider manual*. First American Heart Association Printing; 2020.
5. McHone AJ, Edsall J, Gunn J, Lineberry E. Implementation of a team-focused high-performance CPR (TF-HP-CPR) protocol within a rural area EMS system. *Adv Emerg Nurs J*. 2019;41(4):348-356. doi: 10.1097/TME.0000000000000259
6. *American Heart Association basic life support provider manual*. First American Heart Association Printing; 2020.

7. Global Resuscitation Alliance. Improving survival from out-of-hospital cardiac arrest: Acting on the call. 2018. Retrieved from https://www.globalresuscitationalliance.org/wp-content/pdf/acting_on_the_call.pdf. Accessed July 10, 2021.
8. Miller MG, Berry DC. *Emergency response management for athletic trainers*. 2nd ed. Wolters Kluwer; 2016.
9. Bonnes JLRM, Brouwer MA, Navarese EP, Verhaert, DVM, Verheugt, FWA, Smeets, JLRM, de Boer, MJ. Manual cardiopulmonary resuscitation versus CPR including a mechanical chest compression device in out-of-hospital cardiac arrest: A comprehensive meta-analysis from randomized and observational studies. *Ann Emerg Med*. 2015;67(3):349-360.e3. doi: 10.1016/j.annemergmed.2015.09.023
10. Del Rios M, Weber J, Pugach O, Nguyen H, Campbell T, Islam S, Spencer LS, Markul E, Bunney EB, Vanden Hoek T. Large urban center improves out-of-hospital cardiac arrest survival. *Resuscitation*. 2019;139:234-240. doi: 10.1016/j.resuscitation.2019.04.019
11. Gates S, Quinn T, Deakin CD, Blair L, Couper K, Perkins GD. Mechanical chest compression for out of hospital cardiac arrest: Systematic review and meta-analysis. *Resuscitation*. 2015;94:91-97. doi: 10.1016/j.resuscitation.2015.07.002
12. Myat A, Song KJ, Rea T. Out-of-hospital cardiac arrest: Current concepts. *Lancet*. 2018;391(10124):970-979. doi: 10.1016/S0140-6736(18)30472-0
13. Tang L, Gu WJ, Wang F. Mechanical versus manual chest compressions for out-of-hospital cardiac arrest: A meta-analysis of randomized control trials. *Sci Rep*. 2015;5(15635):1-8. doi: 10.1038/srep15635
14. Wang HE, Schmicker RH, Daya MR, Stephens SW, Idris AH, Carlson JN, Colella R, Herren H, Hansen M, Richmond NJ et al. Effect of a strategy of initial laryngeal tube insertion vs endotracheal intubation on 72-hour survival in adults with out-of-hospital cardiac arrest: A randomized clinical trial. *JAMA*. 2018;320(8):769-778. doi: 10.1001/jama.2018.7044
15. Longest BB, Darr K. *Managing health services organizations and systems*. 6th ed. Health Professions Press, Inc; 2014.
16. Tamarac Fire Rescue. High-Performance CPR. Joint EMS Protocols. Retrieved from https://www.jointemsprotocols.com/content/hp-cpr, 2019. Accessed July 10, 2021.
17. Porzer M, Mrazkova E, Homza M, Janout V. Out-of-hospital cardiac arrest. *Biomedical Papers of the Medical Faculty of Palacky University in Olomouc*. 2017;161(4):348-353. doi: 10.5507/bp.2017.054
18. Pearson DA, Nelson RD, Monk L, Tyson C, Jollis JG, Granger CB, Corbett C, Garvey L, Runyon MS. Comparison of team-focused CPR vs standard CPR in resuscitation from out-of-hospital cardiac arrest: Results from a statewide quality improvement initiative. *Resuscitation*. 2016;105:165-172. doi: 10.1016/j.resuscitation.2016.04.008
19. Dubé M, Jones B, Kaba A, Cunnington W, France K, Lomas, K, Novick RJ, Robertson K, Coltman C, Ferlan A. Preventing harm: Testing and interpreting health care protocols using systems integration and learner-focused simulations: A case study of a new postcardiac surgery, cardiac arrest protocol. *Clin Simul Nurs*. 2020;44:3-11. doi: 10.1016/j.ecns.2019.10.006
20. Cheng A, Nadkarni VM, Mancini MB, Hunt EA, Sinz EH, Merchant RM, Donoghue A, Duff JP, Eppich W, Auerbach M et al. Resuscitation education science: Educational strategies to improve outcomes from cardiac arrest. *Circulation*. 2018;138(6):e82-e122. doi: 10.1161/CIR. 0000000000000583
21. Yeung J, Meeks R, Edelson D, Gao F, Soar J, Perkins GD. The use of CPR feedback/prompt devices during training and CPR performance: A systematic review. *Resuscitation*. 2009;80(7):743-751. doi: 10.1016/j.resuscitation.2009.04.012
22. Cheng A, Magid DJ, Auerbach M, Bhanji F, Bigham BL, Blewer AL, Dainty KN, Diederich E, Lin Y, Leary M et al. Part 6: Resuscitation education science: 2020 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2020;142(16_Suppl_2):S551-S579. doi: 10.1161/CIR.0000000000000903
23. Sullivan N. An integrative review: Instructional strategies to improve nurses' retention of cardiopulmonary resuscitation priorities. *Int J Nurs Educ Scholarsh*. 2015;12(1):1-7. doi: 10.1515/ijnes-2014-0012
24. Forsyth DR. *Group dynamics*. 6th ed. Wadsworth Cengage Learning; 2014.
25. Gencer H. Group dynamics and behavior. *Univers. J. Educ. Res*. 2019;7(1):223-229. doi: 10.13189/ujer.2019.070128
26. Wakeman D, Langham MR. Creating a safer operating room: Groups, team dynamics and crew resource management principles. *Semin Pediatr Surg*. 2018;27(2):107-113. doi: 10.1053/j.sempedsurg.2018.02.008
27. Cartwright, D. Achieving change in people: Some applications of group dynamics theory. *Hum Relat*. 1951;4(1):59-65.
28. Vuurberg G, Vos JAM, Christoph LH, de Vos R. The effectiveness of interprofessional classroom-based education in medical curricula: A systematic review. *J Interprof Educ Pract*, 15:157-167. doi: 10.1016/j.xjep.2019.01.007

29. Babiker A, Husseini ME, Nemri AA, Frayh AA, Juryyan NA, Faki, MO, Assiri A, Saadi MA, Shaikh F, Zamil FA. Heath care professional development: Working as a team to improve patient care. *Sudan J Paediatr*. 2014;14(2):9-16.
30. *American Heart Association advanced cardiac life support provider manual*. First American Heart Association Printing; 2016.
31. Patterson PD, Weaver MD, Weaver SJ, Rosen MA, Todorova G, Weingart LR, Krackhardt D, Lave JR, Arnold RM, Yealy DM et al. Measuring teamwork and conflict among emergency medical technician personnel. *Prehosp. Emerg. Care*. 2012;16(1):98-108. doi: 10.3109/10903127.2011.616260
32. Calder LA, Mastoras G, Rahimpour M, Sohmer B, Weitzman B, Cwinn AA, Hobin T, Parush, A. Team communication patterns in emergency resuscitation: A mixed-methods qualitative analysis. *Int J Emerg Med*. 1017;10(24):1-9. doi: 10.1186/s12245-017-0149-4
33. Kolbe M, Boos M. Laborious but elaborate: The benefits of really studying team dynamics. *Front Psychol*. 2019;10(1478):1-15. doi: 10.3389/fpsyb.2019.01478
34. Resuscitation Academy. Fort Lauderdale Fire Rescue strengthens its out-of-hospital chain of survival. Resuscitation Quality Improvement. Retrieved from https://rqipartners.com/our-network/prehospital-organizations/. Accessed July 10, 2021.
35. Hughes AM, Patterson PD, Weaver MD, Gregory ME, Sonesh SC, Landsittel DP, Krackhardt D, Hostler D, Lazzara EH, Wang X et al. Teammate familiarity, teamwork, and risk of workplace injury in emergency medical services teams. *J Emerg Nurs*. 2017;43(4):339-346. doi: 10.1016/j.jen.2016.11.007
36. Edler J, Eberman L, Kahanov L, Roman C, Mata H. Athletic trainers' knowledge regarding airway adjuncts. *Athl. Train. Educ. J*. 2015;10(2):164-169. doi: 10.4085/1002164
37. An M, Kim Y, Cho WK. Effect of smart devices on the quality of CPR training: A systematic review. *Resuscitation*. 2019;144:145-156. doi: 10.1016/j.resuscitation.2019.07.011
38. Physio Control. Better data means better CPR. CODE STAT™ 11 Flyer. Retrieved from https://www.strykeremergencycare.com/globalassets/assets/data-solutions/code-stat_11_flyer.pdf, 2018. Accessed July 10, 2021.
39. Weston BW, Jasti J, Lerner EB, Szabo A, Aufderheide TP, Colella MR. Does an individualized feedback mechanism improve quality of out-of-hospital CPR? *Resuscitation*. 2017;113:96-100. doi: 10.1016/j.resuscitation.2017.02.004
40. Zhou XL, Wang J, Jin XQ, Zhao Y, Liu RL, Jiang C. Quality retention of chest compression after repetitive practices with or without feedback devices: A randomized manikin study. *Am J Emerg Med*. 2020;38(1):73-78. doi: 10.1016/j.ajem.2019.04.025