Open Journal of Nursing, 2026, 16(3), 172-181
https://www.scirp.org/journal/ojn
ISSN Online: 2162-5344
ISSN Print: 2162-5336

Intraoperative *In-Situ* Cardiac Arrest Simulation to Improve Technical and Non-Technical Skills in Operating Room Staff

Thomas Pallaria, Joanna Jacinto*, Kira Pinto

Department of Nurse Anesthesia, Rutgers University, Newark, NJ, USA
Email: *joanna.jacinto@gmail.com

How to cite this paper: Pallaria, T., Jacinto, J. and Pinto, K. (2026) Intraoperative *In-Situ* Cardiac Arrest Simulation to Improve Technical and Non-Technical Skills in Operating Room Staff. *Open Journal of Nursing*, **16**, 172-181.
https://doi.org/10.4236/ojn.2026.163011

Received: December 1, 2025
Accepted: March 9, 2026
Published: March 12, 2026

Abstract

Purpose of Project: This quality improvement project was designed to improve technical and non-technical skills of operating room staff members in the management of intraoperative cardiac arrests at a large academic medical center in New Jersey. **Methodology:** Participants were divided into two rooms with identical equipment to take part in an intraoperative cardiac arrest simulation. Key action items (KAIs) were timed and noted to measure technical skills. Teamwork performance was assessed and rated. A 15-minute debriefing and education session was held post-simulations. A subsequent simulation day occurred. Data comparing the results from day one and day two were compared and analyzed. **Results:** A time decrease was found in five out of six key action items, from day one to day two of the simulations. The independent samples t-test ($t(10) = 2.092$, $p = 0.025$) was statistically significant and demonstrated that the simulation was most likely the case of the time decrease. The key action item that resulted in the greatest time improvement was "first defibrillation shock", with a decrease of 123 seconds. The assessment of teamwork performance between day one and day two did not produce consistent results. **Implications for Practice:** The time improvement of key action items, from day one to day two of the simulations, demonstrated better performance of the participants in the management of cardiac arrests. The time to "first defibrillation shock" decreased by approximately two minutes, equating to better neuronal tissue preservation and patient outcomes in a real-life scenario.

Keywords

Intraoperative Cardiac Arrest, Cardiac Arrest Simulation, Simulation

1. Introduction

Intraoperative cardiac arrests (ICAs) are low-frequency, high-mortality and morbidity situations. Due to the rarity of occurrence, staff are often not adequately prepared to respond effectively. Simulation training has proven to be valuable in preparing staff for crisis situations, such as ICAs. This quality improvement project (QIP) facilitated a cardiac arrest simulation involving the operating room (OR) staff at a large academic medical center in New Jersey (NJ) to measure technical and non-technical skills during ICA management.

2. Background and Significance

In-hospital cardiac arrests are a major contributor to patient morbidity and mortality, with a current estimated annual incidence rate of 300,000 [1]. While a relatively small number of these cardiac arrests occur in the OR, about 5.7 per 10,000 cases, the consequences can be devastating [2]. Mortality increased to 35.7% in admissions involving ICA versus 1.3% [2]. Patient outcomes are dependent on the efficient and skillful response of hospital staff.

The intraoperative setting is unique due to the already present interdisciplinary team required to complete cases; therefore, it is vital that OR staff understand role responsibilities and concepts of teamwork, along with skill and knowledge to be proficient in managing adult emergencies.

3. Clinical Question

How can an intraoperative *in-situ* cardiac arrest simulation improve technical and non-technical skills in OR staff?

4. Aims and Objectives

Aim: To improve technical and non-technical skills in OR staff during an ICA.

Objective #1: To decrease the time from onset of crisis to the announcement of patient crisis, between the initial and subsequent simulations.

Objective #2: To decrease the time to role assignment between the initial and subsequent simulations.

Objective #3: To decrease the time to first compression between the initial and subsequent simulations.

Objective #4: To decrease the time to first defibrillation shock between the initial and subsequent simulations.

Objective #5: To enhance teamwork performance that will be evaluated using the Team Emergency Assessment Measure (TEAM) scale at initial and subsequent evaluation.

5. Methods

5.1. Design

This project was a quality improvement initiative at a large academic medical center in NJ.

5.2. Population

OR registered nurses, surgical technologists, and anesthesia providers who attended the weekly hour-long OR education training on two dates over a six-week period.

5.3. Methodology

Staff members (40) were divided into two groups of 20 and asked to enter one of two simulation rooms. Each active simulation group was comprised of an anesthesia provider, five nurses, and two surgical technicians. The rest of the staff members spectated while the simulations took place. Participants were rotated through the simulations to ensure everyone had an opportunity to participate. The initial 15-minute ICA *in-situ* cold simulations took place in two rooms with identical equipment (Figure 1). Data were collected from the first simulations that were held in each of the two rooms. Hemodynamic parameters were displayed and coordinated through the iPhone Operating System application "Simpl" and were displayed on electronic devices. Mannequins were used to simulate the patient in prone position. Two expired emergency carts were provided by the pharmacy. Participants performed roles in accordance with their assigned OR roles.

A 59-year-old woman with significant cardiac history and diabetes is anesthetized, positioned, and draped for a lumbar microdiscectomy in the prone position. Ten minutes after the incision is made, the patient develops ventricular tachycardia (VT) followed by ventricular fibrillation (VF) cardiac arrest.

The perioperative team responds by
- coordinating a safe and efficient repositioning of the patient into the supine position to optimize chest compressions,
- providing interventions to address cardiac arrest in accordance with the established checklist and algorithm,
- following the facility's protocols for crisis management, and
- exhibiting effective technical and nontechnical skills for managing an intraoperative crisis.

The patient returns to clinical baseline. The simulation is concluded when an appropriate member of the team verbalizes the next step in the patient's plan of care.

Figure 1. AORN simulation scenario. Simulation scenario describes the patient in surgical prone position and developing ventricular tachycardia followed by cardiac arrest [3].

Technical skills were evaluated and timed by an Association of periOperative Registered Nurses (AORN) certified checklist (Figure 2). Of the 16 checklist items, six were used, as the tool was modified to align with the scope and objectives of this project (see Figure 3). One task ("Roles and actions to be taken are assigned") resulted in missing data and thus was not included in the final analysis. Non-technical skills were evaluated by the TEAM scale (**Figure 4**). A debriefing/education session was held post initial simulation for 15 minutes regarding education on the aims and objectives of this project.

Action/Treatment Checklist	Time	Skill met	Skill not met
Crisis and the need to reposition the patient is announced			
Call for help and the emergency cart is made			
Crisis manager is identified			
Roles and actions to be taken are assigned			
Incision is packed and/or covered			
Equipment and personnel are effectively coordinated and the patient is safely repositioned			
Float personnel (ie, anesthesia professional, perioperative RN) are in the room			
Emergency cart is in the room			
Patient is positioned supine on the gurney with backboard			
First chest compression is delivered			
Defibrillator is on and pads are connected			
First defibrillation shock is delivered			
Crisis checklist is utilized			
Crisis interventions on the checklist are implemented			
Emergency cart is effectively managed			
Jet-syringe is correctly assembled and medication is administered			
Professional interdisciplinary communication is effectively employed: • Commands and requests are clear • Commands and requests are confirmed (ie, no closed loop communication is used) • Personnel are addressed directly (ie, no "thin air" statements are used)			

Figure 2. AORN simulation checklist. Checklist for simulation from *Association of PeriOperative Registered Nurses* by M. Karasin and L. Salimone (2023) [3].

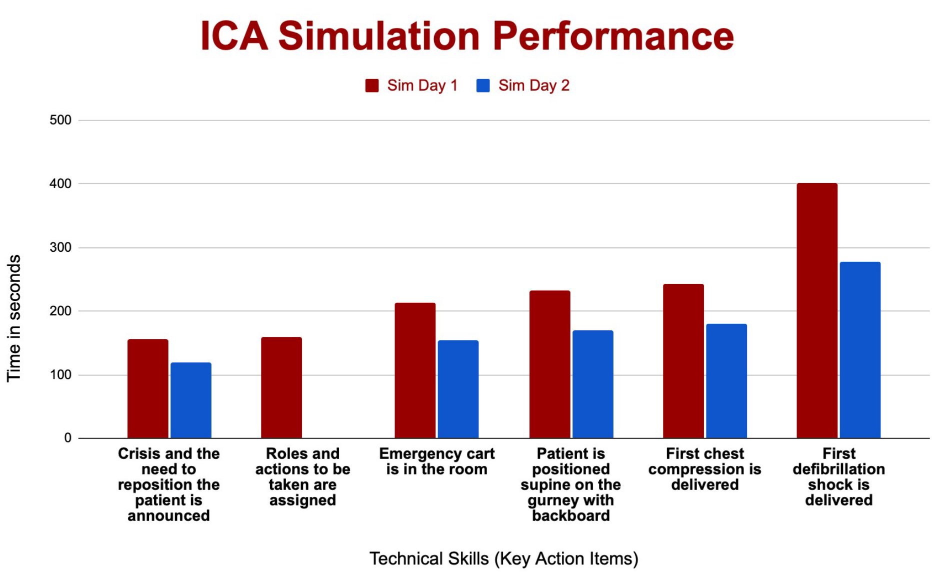
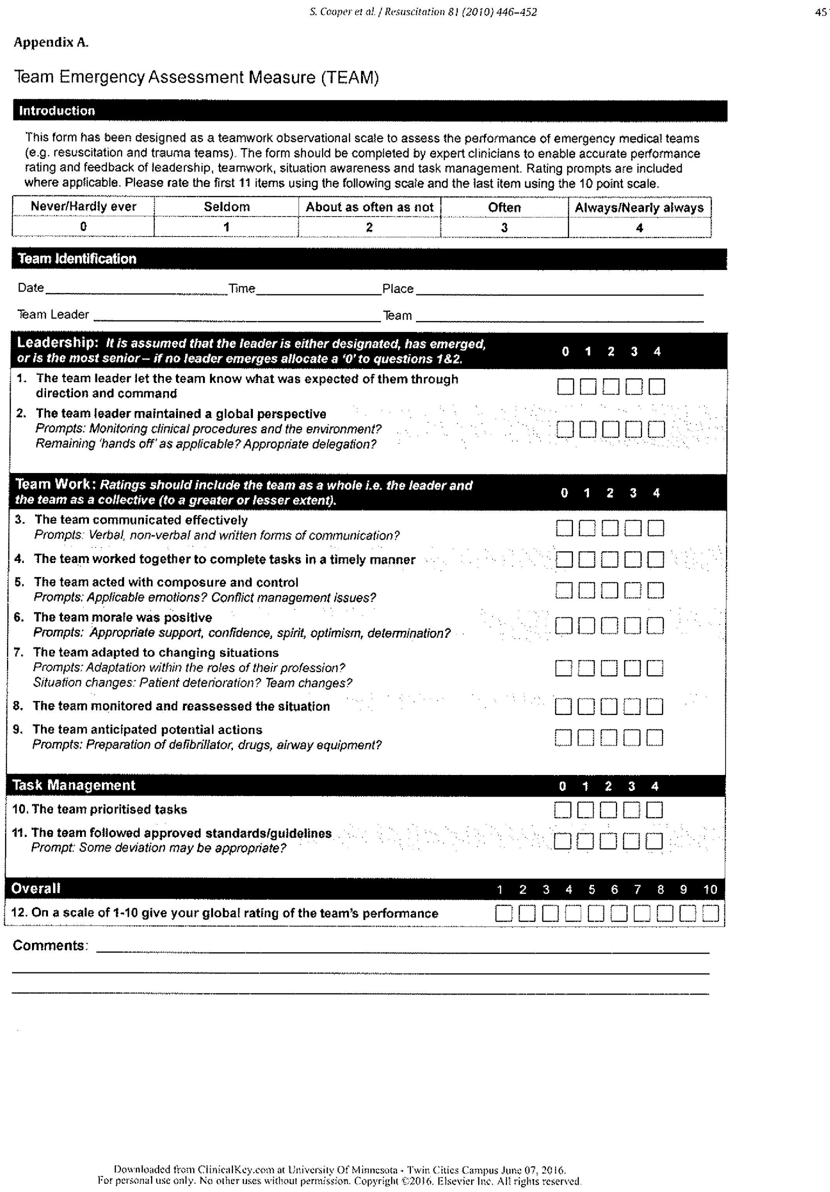


Figure 3. ICA skills results. Participants were able to accomplish key action items faster on day two of the simulations, except for "Roles and actions to be taken are assigned".

A follow-up *in-situ* cardiac arrest simulation was held six weeks later, to evaluate participant knowledge retention and compare data from the first to the second simulation.



S. Cooper et al. / Resuscitation 81 (2010) 446–452 451

Appendix A.

Team Emergency Assessment Measure (TEAM)

Introduction

This form has been designed as a teamwork observational scale to assess the performance of emergency medical teams (e.g. resuscitation and trauma teams). The form should be completed by expert clinicians to enable accurate performance rating and feedback of leadership, teamwork, situation awareness and task management. Rating prompts are included where applicable. Please rate the first 11 items using the following scale and the last item using the 10 point scale.

Never/Hardly ever	Seldom	About as often as not	Often	Always/Nearly always
0	1	2	3	4

Team Identification

Date ______ Time ______ Place ______

Team Leader ______ Team ______

Leadership: *It is assumed that the leader is either designated, has emerged, or is the most senior – if no leader emerges allocate a '0' to questions 1&2.*	0	1	2	3	4
1. The team leader let the team know what was expected of them through direction and command	☐	☐	☐	☐	☐
2. The team leader maintained a global perspective *Prompts: Monitoring clinical procedures and the environment? Remaining 'hands off' as applicable? Appropriate delegation?*	☐	☐	☐	☐	☐
Team Work: *Ratings should include the team as a whole i.e. the leader and the team as a collective (to a greater or lesser extent).*	**0**	**1**	**2**	**3**	**4**
3. The team communicated effectively *Prompts: Verbal, non-verbal and written forms of communication?*	☐	☐	☐	☐	☐
4. The team worked together to complete tasks in a timely manner	☐	☐	☐	☐	☐
5. The team acted with composure and control *Prompts: Applicable emotions? Conflict management issues?*	☐	☐	☐	☐	☐
6. The team morale was positive *Prompts: Appropriate support, confidence, spirit, optimism, determination?*	☐	☐	☐	☐	☐
7. The team adapted to changing situations *Prompts: Adaptation within the roles of their profession? Situation changes: Patient deterioration? Team changes?*	☐	☐	☐	☐	☐
8. The team monitored and reassessed the situation	☐	☐	☐	☐	☐
9. The team anticipated potential actions *Prompts: Preparation of defibrillator, drugs, airway equipment?*	☐	☐	☐	☐	☐
Task Management	**0**	**1**	**2**	**3**	**4**
10. The team prioritised tasks	☐	☐	☐	☐	☐
11. The team followed approved standards/guidelines *Prompt: Some deviation may be appropriate?*	☐	☐	☐	☐	☐

Overall	1	2	3	4	5	6	7	8	9	10
12. On a scale of 1-10 give your global rating of the team's performance	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Comments: ______

Figure 4. TEAM scale. Team Emergency Assessment Measure scale used to assess non-technical skills [4].

5.4. Data Collection and Analysis

Technical skills were evaluated and timed by a checklist from the AORN. Non-technical skills were evaluated by the TEAM scale. Data from the initial and subsequent simulations were input into the Statistical Package for the Social Sciences (SPSS) v30 software for analysis. Data were compared using an independent samples t-test as participants were not matched pre- to post-simulation.

6. Results

6.1. Quantitative Data

All data collected from each simulation were entered into Microsoft Excel and analyzed using SPSS software. There were six KAIs used to measure technical skills. The times to each KAI (in seconds) were measured and averaged between simulation Groups A and B on day one and simulation Groups A and B on day two. The average time in seconds in simulation day one was 242.82 seconds (*SD* 87.41); the mean score of simulation day two was 177.55 seconds (*SD* 55.341). Because there were different participants in simulation day one (preintervention) and simulation day two (postintervention), an independent samples t-test was performed to assess statistical significance on differences in seconds among 11 technical tasks ($t(10) = 2.092$, $p = 0.025$). With the traditional cut-off of $p < 0.05$, the results indicate statistical significance. **Figure 3** shows individual means on six key technical functions.

The KAI that resulted in the greatest time improvement was "first defibrillation shock is delivered". On day one, the time average for "first defibrillation shock is delivered" was 401 seconds (s), while day two demonstrated an average time of 278 s, generating a time decrease of 123 s. A time decrease of at least 36 s was noted in five out of six KAIs from day one to day two, with the exception of the KAI, "roles and actions to be taken are assigned". On day two, the recorder did not witness the code leader assign roles, therefore, no time could be recorded for comparison. The KAI that only exhibited a 36-second decrease was "crisis and the need to reposition the patient is announced".

6.2. Qualitative Data

Teamwork performance was rated using the TEAM scale, which used a 10-point Likert scale from 0 - 4 and ranged from "Never/Hardly ever" to "Always/Nearly always". A comments section was available for the observer to freehand notes (**Figure 3**). Independent observers rated the overall teamwork performance upon completion of the simulation for Groups A and B on day one and day two. A total of four different independent observers were present, one for each group. Observers across the board noted improvements from day one to day two on leadership direction and command, the team's ability to adapt to changing situations, and monitoring and reassessing the situation. Overall, the "global rating" of team performance increased from day one to day two. The simulation groups remained consistent in score, from day one to day two, when rated on the leader's ability to maintain a global perspective (4 out of 4) and the teams' approach to following approved standards/guidelines (3 out of 4). Performance was noted to decrease, from day one to day two, according to the observers, in the teams' ability to communicate effectively, work together, act with composure, maintain positive morale, anticipate potential actions, and prioritization. Observers commented on leadership with, "The CRNA took charge and was great at communication", "CRNA did great as a leader, great direction", and "Failure to identify roles of staff". Comments regarding teamwork performance were noted as "No closed loop communication".

Positive comments expressed by staff post-simulation included, "I feel more prepared", "We need more hands-on training like this", "This was great". Negative comments expressed by the staff post-simulation included, "The sim groups need to be smaller", "I wish we could have run through it again a third time", "I couldn't hear the vitals and they were hard to see". The nurse educators of the facility commented, "I can't believe how much better they got!" and "Look at how confident they look this time", when referring to the staff performance on day two of the simulation.

7. Discussion and Implications for Practice

This QIP was designed to improve technical and non-technical skills during the management of an ICA using simulation-based education. The four objective measures of the project focused on decreasing time in seconds to KAIs (announcement of patient crisis, role assignment, first delivery of chest compression, and first delivery of defibrillation shock) from the initial simulation to the subsequent simulation. The fifth and final objective was to enhance teamwork performance.

Statistical significance, at a p-value of 0.025, showed that the simulation succeeded in reducing time to KAIs during cardiac arrest. Three out of four technical objectives were met with a time decrease of 36 s or greater. As the objectives reflect how quickly the team can achieve return of spontaneous circulation (ROSC), the decrease in KAI times demonstrates how the simulation improved patient management during ICA. The only objective not met with a time decrease was "role assignment". During the day two simulation, one observer did not witness the leader explicitly assign roles. However, during that simulation, roles were naturally adopted by the participants, therefore assignment by the leader was not necessary. Nevertheless, a time for this KAI on day two simulation was not recorded for comparison. Training and experience may influence individuals' tendency to assume certain roles during crisis situations, which may explain the natural role adoption observed during the second simulation following experience gained from the initial simulation. The participants also seemed to demonstrate situational awareness when they implicitly took on roles to perform the necessary actions. Situational awareness refers to the ability to understand the environment and is frequently discussed as an important individual element of successful teamwork [5]. Natural role adoption may occur during real-life complex scenarios; however, situational awareness, proper communication, and effective leadership are necessary to fill any teamwork gaps to identify and assign roles that may be missed.

The greatest achievement in time reduction occurred in time to "first defibrillation shock is delivered". Rapid defibrillation is the single most important treatment in the survival of witnessed ventricular fibrillation/tachycardia and can often achieve ROSC before any other intervention is needed [6]. Neuronal death begins to occur at approximately five to 10 minutes (300 - 600 s) following ischemia from cardiac arrest. On day one, Groups A and B reached "first shock to defibrillation" at 401 s, which could potentially result in ROSC with brain anoxic injuries [7]. On day two, the time reduction of 123 s equates to the achievement of ROSC approximately two minutes faster. Consequently, this time improvement would increase neural tissue preservation when compared with day one results.

The final objective of this project was to enhance teamwork performance during cardiac arrest management. Effective teamwork is vital during crisis management and is associated with faster defibrillation [5]. Poor teamwork, on the other hand, can compromise patient safety and lead to poor outcomes. Post simulations, observers collectively rated a decrease in the execution of essential teamwork elements from day one to day two, while noting an overall improvement in teamwork performance. These inconsistencies rendered the TEAM scale ineffective in evaluating team performance for the purposes of our simulations. The same independent observers could not be present for the second day of simulations, compromising observer consistency. Additionally, the rating system allowed for subjective interpretation. These factors affected the results of the scales, leading to score discrepancy.

Perceived competency and comfort levels using the defibrillator are shown to increase following education through simulations [8]. Comments expressed by participants and the nurse educators were positive regarding their experience with the simulations. Upon reflection, participants highlighted the simulations' ability to provide hands-on training and ease comfort levels. Participants conveyed a general feeling of better preparedness for cardiac arrest management. These comments are consistent with those from participants in aforementioned simulation studies.

There were several limitations and weaknesses in our QIP. Participant recruitment was reliant on staff scheduling, which only garnered around 40 participants. Subsequently, we were unable to ensure the same personnel participated in the second simulation. However, most of the staff were able to at least observe during the first simulation and debriefing. Time limitations restricted the number of simulations that could be executed as they were carried out during the weekly one-hour staff meetings. OR availability prevented more than two simulation rooms from running at the same time. Therefore, these time and space constraints only allowed for four total simulations to be performed. Different observers were used to rate team performance, using the TEAM scale, on day one and day two of the simulations. This prevented continuity in the assessment of the TEAM scale from day one to day two simulation, contributing to inconsistent results.

Our QIP possessed a considerable number of strengths. The first simulation was performed blind by the staff, who were unaware of the ICA scenario, to emulate a real-life crisis that cannot be predicted. The simulation narrative and checklist were obtained through the AORN organization, which provided a credible and well-constructed format for the scenario. The OR was set up to reproduce an actual case, in order to provide an immersive experience for the participants. Participants were able to open actual code carts. Jet-syringe medications were available for participants to assemble during the simulation. Defibrillators with the ability to charge and deliver shocks were present, along with pads. Vital signs were displayed around the room on multiple devices with audible alarms to notify participants of hemodynamic changes.

8. Conclusion

In conclusion, ICAs are low-frequency, high-mortality and morbidity situations. As previously aforementioned, due to the rarity of occurrence, staff are often not adequately prepared to respond effectively. Simulations were instituted that resulted in an improvement in performance in the KAIs of the AORN technical skills checklist from baseline simulation to subsequent simulation. A time reduction of approximately two minutes to defibrillation from recognition of deadly arrhythmia would result in improved patient outcomes. Therefore, this QI project has shown that simulations have better prepared staff for the management of ICAs.

Availability of Data and Materials

Any data and materials pertaining to this article can be requested by contacting the corresponding author.

Authors' Contributions

J.J., K.P., and T.P. contributed to the body of this manuscript. Data and analysis were performed by J.J.

Acknowledgements

The authors would like to thank the staff members at Rutgers University for their support in the development of this article. A special thank you must go to Dr. Barbara Niedz for her invaluable guidance and expertise.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Holmberg, M.J., Ross, C.E., Fitzmaurice, G.M., Chan, P.S., Duval-Arnould, J., Grossestreuer, A.V., *et al.* (2019) Annual Incidence of Adult and Pediatric In-Hospital Cardiac Arrest in the United States. *Circulation: Cardiovascular Quality and Outcomes*, **12**, e005580. https://doi.org/10.1161/circoutcomes.119.005580

[2] Fielding-Singh, V., Willingham, M.D., Fischer, M.A., Grogan, T., Benharash, P. and Neelankavil, J.P. (2020) A Population-Based Analysis of Intraoperative Cardiac Arrest in the United States. *Anesthesia & Analgesia*, **130**, 627-634. https://doi.org/10.1213/ane.0000000000004477

[3] Karasin, M. and Salimone, L. (2023) Perioperative Simulation Scenarios: VT/VF Cardiac Arrest with Patient in Prone Position. Association of Perioperative Registered Nurses. https://www.aorn.org/docs/default-source/aorn/education/staff-development/simulation-scenarios/00446_cardiacarrest_simulation_scenario_v2.pdf?sfvrsn=42ae38f0_0&la=en&hash=7F10B2D50B29C790D67B9DF663BA40B4

[4] Cooper, S., Cant, R., Porter, J., Sellick, K., Somers, G., Kinsman, L., *et al.* (2010) Rating Medical Emergency Teamwork Performance: Development of the Team Emergency Assessment Measure (TEAM). *Resuscitation*, **81**, 446-452. https://doi.org/10.1016/j.resuscitation.2009.11.027

[5] Hosseini, M., Heydari, A., Reihani, H. and Kareshki, H. (2022) Elements of Teamwork in Resuscitation: An Integrative Review. *Bulletin of Emergency and Trauma*, **10**, 95-102.

[6] Spearpoint, K.G., McLean, C.P. and Zideman, D.A. (2000) Early Defibrillation and the Chain of Survival in 'In-Hospital' Adult Cardiac Arrest; Minutes Count. *Resuscitation*, **44**, 165-169. https://doi.org/10.1016/s0300-9572(00)00158-1

[7] Dreier, J.P., Major, S., Foreman, B., Winkler, M.K.L., Kang, E., Milakara, D., *et al.* (2018) Terminal Spreading Depolarization and Electrical Silence in Death of Human Cerebral Cortex. *Annals of Neurology*, **83**, 295-310. https://doi.org/10.1002/ana.25147

[8] Ngo, D.Q., Vu, C., Nguyen, T., Sotolongo, P., Talati, M., Zahabi, N., *et al.* (2020) The Effect of Mock Code Blue Simulations and Dedicated Advanced Cardiac Life Support Didactics on Resident Perceived Competency. *Cureus*, **12**, e11705. https://doi.org/10.7759/cureus.11705