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ORIGINAL RESEARCH

Effect of simulation training on nurse leadership in a shared leadership model for cardiopulmonary resuscitation in the emergency department

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Abstract

Objective: Empowering a senior nurse in a shared leadership role has been proposed as a more efficient set up for the cardiac arrest team in ED. In this model, a senior nurse leads the cardiac arrest algorithm which allows cognitive off-loading of the lead emergency physician. The emergency physician is then more available to perform tasks such as echocardiography and exclude reversible causes. Simulation provides an opportunity for training and practice of this shared leadership model. We hypothesised that a structured simulation training programme that focused on implementing a nurse and doctor shared leadership model for cardiopulmonary resuscitation (CPR), would improve leadership and teamwork quality in the setting of cardiac arrest as measured by a Trauma Non-technical Skills (T-NOTECHS) teamwork scale.

Methods: Fifteen senior ED nurses participated in this pre-interventional post-observational study. Training consisted of a didactic course on team leadership and crisis resource management (CRM) followed by 4 × 10-min resuscitation scenarios with a structured debrief focusing on team leadership skills and CRM. The primary outcome was measured on scenarios 1 and 4 using a modified T-NOTECHS teamwork scale.

Results: A statistically significant increase in the T-NOTECHS scale was detected for the measures of leadership (P = 0.0028), CRM (P = 0.0001), adherence to New Zealand Resuscitation Council ALS algorithm (P = 0.0088) and situational awareness (P = 0.0002).

Conclusion: The present study shows that a short simulation training programme improved nurse leadership and teamwork performance in the setting of a shared leadership model for CPR in the ED which could easily be replicated in other departments.

Key words: *cardiac arrest, cardiopulmonary resuscitation, emergency department, shared leadership, simulation training.*

Key findings

- Simulation is an effective training tool for improving teamwork and senior nurse leadership skills in the novel setting of nurse and doctor shared leadership during CPR.
- To allow shared leadership models for cardiac arrest management to be introduced into emergency medicine practice, a sustainable training programme will need to be developed to allow nurses and doctors time to practice the shared leadership roles within this model and regularly update their leadership skills.
- This model could easily be replicated in other EDs with simulation scenarios used as the mechanism of training nurses in the shared leadership role.

Introduction

Cardiac arrest management in the ED is a complex task with high cognitive load. It is often a single emergency physicians' (EP) responsibility as team leader to facilitate and oversee multiple tasks. This can include following the cardiac arrest algorithm, identifying reversible causes, determining patient history and deciding when to cease resuscitation efforts. This process is cumbersome and can often leave little time to gather information and have important discussions with families. Strategies that reduce cognitive load and utilise shared mental models can lead to improvements in teamwork, team efficiency, patient safety and outcomes.[1–3]

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Empowering a senior nurse in a shared leadership role has been proposed as a more efficient setup for the cardiac arrest team in ED.[4] In a shared leadership model, a senior nurse leads the cardiac arrest algorithm allowing cognitive off-loading of the lead EP. The EP is then more available to perform tasks such as echocardiography, review clinical information, determine medical futility and exclude reversible causes.

Shared leadership models are a relatively new concept that have demonstrated improved team performance and improved outcomes.[1,5] It is a new genre leadership style involving dynamic and interactive processes that allow teams to achieve common goals with a more lateral hierarchical structure compared to more traditional vertical leadership styles.[1,2] Shared leadership styles can reduce variance in team performance, enhance team cohesiveness and improve team dynamics.[2] Benefits are more strongly observed when the work of the team is more complex[1] such as an in undifferentiated cardiac arrest.

Successful management of cardiac arrest is challenging and depends on the skill of the resuscitation team.[6] Leadership is a key determinant of technical performance in cardiac arrest situations and therefore training in leadership can improve resuscitation team performance.[6] Simulation training has been shown to improve multidisciplinary team performance during resuscitation,[7] as well as nurse leadership skills and confidence using algorithms.[8] The team leader has been shown to be an important factor in the success of a team when managing an emergency.[9] A number of studies have demonstrated that poor leadership contributes to medical errors and patient harm.[6,10–12]

Simulation provides an opportunity for training and practicing new models of leadership and teamwork.[13] Particularly, in the setting of resuscitation as it involves the creation of a safe training environment that can replicate real patient encounters and clinical events.[14] It allows training for situations that may occur infrequently such as cardiac arrest without compromising patient care and traumatising an inexperienced team member.[15] It gives the learner permission to fail allowing them to learn from mistakes.[16] Cases can be tailored specifically to the learner and immediate feedback can be provided. An algorithmic model such as advanced life support (ALS) for cardiopulmonary resuscitation (CPR) is ideal for teaching with *in situ* simulation. Most cardiac arrests do not have easily identifiable reversible causes. In this model, practice identifying and addressing these events will demonstrate the utility of a shared leadership model.

We hypothesise that a structured simulation training programme involving a shared leadership model for CPR, will improve teamwork

TABLE 1. *Modified Non-technical Skills (NOTECHS) assessment scale*

Score: 5	Score: 3	Score: 1
Leadership		
Clearly defined team leader Good time management All tasks completed Non-hierarchical	Individual defined but some tasks not complete	Identity of team leader not clear
Co-operation and resource management		
All team members clearly fill a role and perform designated tasks	Identity of all team members not clear Some do not perform assigned tasks	Unable to discern role identity of team members
Communication and interaction		
Clear communication with team leader as a hub, relayed to the scribe	Communication not always through team leader or not relayed rapidly to scribe	Unorganised or incoherent communication on many different levels
Assessment and decision-making		
Full adherence to NZRC ALS algorithm	Mild deviation from NZRC ALS algorithm	Major deviation from NZRC ALS algorithm
Situational awareness/coping with stress		
Untoward findings and distraction did not upset systematic and orderly flow. Team is calm and plans ahead	Untoward findings caused disruption but did not preclude task completion	Untoward findings or interruptions completely upset orderly assessment and task completion. Not anticipatory

ALS, advanced life support; NZRC, New Zealand Resuscitation Council.

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quality and the leadership skills of nurses during cardiac arrest management. The aim of the present study was to determine whether a simulation programme could improve team performance and nurse leadership skills in simulated cardiac arrest management in a way that could be easily implemented in the ED.

Methods

Study design

We performed this pre-interventional post-observational study looking at the effect of a simulation training programme on teamwork and leadership using a nurse and doctor shared leadership model in the setting of CPR. The present study did not meet the threshold for Health Disability & Ethics Committee (HDEC) review. Local approval was obtained from the department. Written informed consent was obtained from all participants.

Study setting

This simulation study took place in Wellington Regional Hospital, New Zealand with *in situ* scenarios taking place in both the ED and in the Simulation and Skills Centre at Wellington Hospital. Wellington Hospital is an urban tertiary teaching centre with an annual ED census of 75 000 patients.

Modified Trauma Non-technical Skills instrument

The Non-technical Skills (NOTECHS) assessment tool is a scoring tool that has been widely used to measure leadership and team performance in trauma and surgery.[17,18] For the present study we modified the Trauma Non-technical Skills (T-NOTECHS) assessment tool in order to assess leadership skills and team performance in our cohort.[17] This validated 5-point instrument assesses behavioural aspects in teamwork. Permission was obtained from Steinemann *et al.* to use the T-NOTECHS scale for the present study. The scale was modified by the authors to better reflect its use in cardiopulmonary arrest by including adherence to New Zealand Resuscitation Council (NZRC) ALS algorithm. This tool is not validated for the assessment of teamwork in cardiopulmonary arrest, but we felt the principles of teamwork in trauma could be extrapolated to this setting.

The modified T-NOTECHS score in the present study comprises five teamwork and leadership related domains. These variables are leadership, co-operation and resource management, communication and interaction, assessment and decision-making and situational awareness/coping with stress. Each item is scored on a 5-point Likert scale with a score of 1 indicating that the team did not demonstrate this target teamwork or leadership behaviour. A score of 5 indicates perfect teamwork or leadership behaviour in that domain. Detailed breakdown of the T-NOTECHS score used in the present study is displayed in Table 1. Literature examining the use of T-NOTECHS scales in simulated trauma settings demonstrated that inter-rater reliability was 0.44 using the intraclass correlation coefficient.[18] To our knowledge there is no prior literature investigating the use of T-NOTECHS for simulated cardiac arrest.

Study protocol

Fifteen senior ED nurses were recruited from Wellington ED. They were classed as senior if they had more than 5 years ED work experience. Most held a senior position within the department (e.g. associate charge nurse managers or patient flow coordinator). All nurses recruited had previously received NZRC ALS training. Recruitment involved providing nurses with detailed project information and requesting voluntary participation in the study.

The study participants together with ED doctors and other nurses involved were given a 1-h didactic lecture outlining the study protocol, team leadership and effective crisis resource management (CRM). The co-leadership model was presented, with the roles of the resuscitation team leaders divided between a lead doctor and lead nurse. The lead nurse is responsible for running the adult cardiac arrest (ALS) algorithm allowing the EP to focus on other responsibilities such as identifying the reversible causes. Full role responsibilities for the lead nurse and lead doctor are displayed in Table 2.

The study participants carried out the simulation training scenarios in teams which included a senior ED registrar in the shared leadership role, along with junior ED doctors, junior nursing staff and trainee interns. The participants then completed three phases:

Initial phase

Each study participant carried out the lead nurse role in the shared leadership model for a simulation

TABLE 2. *Team leader responsibility*

Lead nurse responsibilities	Lead doctor responsibilities
Ensure adherence to NZRC ALS algorithm	Identify reversible causes for cardiac arrest
Assign roles	Direct treatment of cause
Direct defibrillation	Liaise with specialty doctors
Direct administration of ALS drugs	Provide oversight to airway doctor
Liaise with lead doctor	Assume full lead on ROSC/special circumstances
	Liaise with family

ALS, advanced life support; NZRC, New Zealand Resuscitation Council; ROSC, return of spontaneous circulation.

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TABLE 3. *Individual initial and assessment phase Non-technical Skills (NOTECHS) assessment scores*

		Leadership		CRM		Communication and interaction		Adherence to NZRC ALS algorithm		Situational awareness, coping with stress		Total	
Nurse	Phase	Initial	Assess	Initial	Assess	Initial	Assess	Initial	Assess	Initial	Assess	Initial	Assess
1	Observer 1	5	3	3	5	3	5	5	5	5	5	21	23
	Observer 2	3	5	3	5	3	5	3	5	5	3	17	23
2	Observer 1	5	5	3	5	3	5	3	5	3	5	17	25
	Observer 2	3	5	3	5	3	5	5	5	3	5	17	25
3	Observer 1	5	5	5	5	3	3	5	5	5	5	23	23
	Observer 2	5	3	3	5	3	3	3	5	5	5	19	21
4	Observer 1	1	5	1	5	1	3	3	5	3	5	9	23
	Observer 2	1	5	1	3	3	5	5	5	1	5	11	23
5	Observer 1	3	5	3	5	5	3	5	3	3	3	19	19
	Observer 2	3	5	3	5	5	5	5	5	3	5	19	25
6	Observer 1	3	3	3	3	3	3	3	5	3	3	15	17
	Observer 2	3	5	1	5	1	3	3	5	3	5	11	23
7	Observer 1	3	5	5	5	5	5	3	5	3	5	19	25
	Observer 2	5	5	3	5	3	5	5	5	5	5	21	25
8	Observer 1	3	3	3	5	5	5	3	3	3	5	17	21
	Observer 2	3	5	1	5	3	3	1	3	3	5	11	21
9	Observer 1	3	5	3	5	5	3	3	5	3	5	17	23
	Observer 2	3	5	3	5	1	3	3	5	1	5	11	23
10	Observer 1	1	3	1	3	1	5	1	5	1	5	5	21
	Observer 2	3	3	1	3	1	5	1	3	3	5	9	19
11	Observer 1	3	3	3	1	3	1	3	1	1	3	13	9
	Observer 2	3	1	3	3	3	1	5	3	1	3	15	11
12	Observer 1	1	5	3	5	3	3	1	3	1	5	9	21
	Observer 2	1	5	3	5	3	3	3	5	1	5	11	23
13	Observer 1	3	5	5	5	3	3	3	5	5	3	19	21
	Observer 2	3	5	5	5	3	5	3	3	5	5	19	23
14	Observer 1	3	5	3	3	3	5	1	5	3	5	13	23
	Observer 2	3	5	3	5	3	3	1	5	3	5	13	23
15	Observer 1	3	3	1	3	1	1	3	3	1	3	11	13
	Observer 2	3	5	3	5	3	3	3	5	3	5	15	23
Total		84	130	80	132	84	110	88	130	84	136	454	638

ALS, advanced life support; CRM, crisis resource management; NZRC, New Zealand Resuscitation Council.

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TABLE 4. *Non-technical Skills (NOTECHS) assessment score comparison*

	Initial mean	Assessment mean	Mean difference (95% confidence interval)	Paired *t*-test results
Leadership	3.0	4.3	1.33 (0.53, 2.13)	t (14) = 3.568, P = 0.0031*
CRM	2.8	4.4	1.60 (1.02, 2.18)	t (14) = 5.870, P < 0.0001*
Communication and interaction	3.0	3.7	0.67 (−0.16, 1.50)	t (14) = 1.726, P = 0.1064
Adherence to NZRC ALS algorithm	3.1	4.3	1.20 (0.41, 1.99)	t (14) = 3.263, P = 0.0057*
Situational awareness, coping with stress	2.9	4.5	1.60 (0.79, 2.41)	t (14) = 4.262, P = 0.0008*

**P*-value <0.01 is statistically significant. ALS, advanced life support; CRM, crisis resource management; NZRC, New Zealand Resuscitation Council.

session with a full ED cardiac arrest team. Quality of teamwork was assessed by two consultant level independent observers using the modified T-NOTECHS scale displayed in Table 1. Participants were unable to take part in the simulation training phase until they had completed the initial phase.

Training phase

Study participants then completed two further training scenarios as team members but not necessarily as the team leader. This meant they could participate in simulations run by other nurses who were still in their initial phase allowing a more efficient use of scenarios and opportunity to observe other leadership styles.

Reassessment phase

Once the participants had completed the two scenarios in the training phase, they entered the reassessment phase. Each participant completed a final scenario using the shared leadership model and a further T-NOTECHS assessment carried out. This was then compared to the T-NOTECHS assessment completed during the initial phase.

Debriefing

Following each scenario, a formal debrief took place focusing on teamwork and effective leadership skills. This design allowed time efficient use of scenarios while still exposing participants to four scenarios each.

Results

The individual results for each nurse participant at the initial and reassessment phase are displayed in Table 3. For each participant, the mean of the two independent consultant raters was calculated for each measure at each phase. Paired *t*-tests were used to compare the (mean) initial and (mean) reassessment scores for each measure. As multiple analyses are conducted, we applied the Bonferroni correction to adjust for multiple comparisons. Therefore, results were statistically significant if the *P*-value was <0.01 (indicated by *). These results are detailed in Table 4.

A statistically significant increase in score was detected for the measures of leadership, CRM, adherence to NZRC ALS algorithm and situational awareness, coping with stress. On average, leadership scores increased by 1.33 units, CRM scores by 1.60 units, adherence to NZRC ALS algorithm by 1.20 units and situational awareness scores increased by 1.60 units.

We note that, on average, scores for communication also increased (by an average of 0.67 units), but this difference was not statistically significant.

Discussion

Our results support the hypothesis that simulation is an effective training tool for improving teamwork and senior nurse leadership skills in the novel setting of nurse and doctor shared leadership during CPR. To our knowledge, there have been no previous studies demonstrating the effectiveness of simulation training in this area. This project enabled us to trial a shared leadership model within the context of a simulation study, thus providing staff with practice, training and familiarity with a new leadership model while they carried out simulation based cardiac arrest management training.

Despite strong evidence for a positive relationship between shared leadership and team performance in other contexts,[1,2,5] there is limited literature describing shared leadership models in the healthcare setting. One study showed that there was a significant amount of spontaneous shared leadership in maternity teams, but this was not associated with an improvement in teamwork scores.[19] In contrast our study had defined leadership roles from the outset with designated responsibilities.

The four T-NOTECHS domains which showed significant improvement in the present study were: leadership; co-operation and resource management; assessment and

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decision-making and situational awareness/coping with stress. Our study results are attributable to the simulation training programme that was designed to facilitate the development of senior nurse team leadership skills within a shared leadership model. It is not possible to determine the effect of the shared leadership model itself on the improved T-NOTECHS score. It is likely the T-NOTECHS score would have been affected by the simulation training alone. It is also difficult to correlate the significance of point-based improvements using this style of assessment tool.

Regarding the domain of assessment and decision-making; adherence to the ALS algorithm is crucial to improve T-NOTECHS scores. Enabling a lead nurse to focus on this task allows the lead doctor to cognitively offload and focus on other areas of cardiac arrest management. The knowledge that their co-leader is focusing on their own responsibilities, allows and empowers the lead nurse to centre their decision-making around adherence to the algorithm. Additionally, considering both leaders have now cognitively offloaded some of the tasks that a solo leader is expected to oversee, both leaders will be coping with less stress and have more awareness of the overall situation.

It is interesting that the domain which showed the least improvement was communication and interaction. Again, this may reflect the statistical limitations of using a point-based assessment tool for a dynamic variable. Within the context of a new shared leadership model, perhaps this is the area that may need the most familiarisation and practice as it speaks to the inter-relationship between the shared leaders as well as the team. Team members may have been unclear about which leader they should communicate information to, and the shared leaders may have been challenged by the novelty of relating to each other in their shared lead roles. Further research would be needed to determine this.

It is also prudent to note that barriers to shared leadership involving doctors and nurses will need to be overcome. The institutional influence of hierarchy on team behaviour is the most notable impediment. Nurses may feel reluctant to speak up if they are working with a doctor. They may also feel overburdened by the apparent performance expectations. Expectation states theory explains how hierarchy within groups forms based on perceived competence performing a task.[20] If a team member is perceived by the group to be more qualified for a task, it is more likely to be deferred to that individual and less information will be offered relating to the task.[21] These hierarchies are especially important in the setting of multidisciplinary shared leadership models for CPR. Despite being highly competent, the nurse team leader may be less likely to initiate action when it is perceived that a more qualified group member is present. This may also affect the way other group members respond to the team leader. There is little data on how to overcome these factors in the resuscitative setting.

Feedback collected from scenario evaluation surveys showed that upon completion of the simulation training programme, nurses felt empowered and their confidence as a leader grew. The project seemed to enable more interprofessional collaboration and nurse empowerment across other aspects of care, particularly during resuscitation situations. Further research into nurse empowerment and how to overcome hierarchical barriers during team resuscitation is required to explore this further.

To allow shared leadership models for cardiac arrest management to be introduced into emergency medicine practice, a sustainable training programme will need to be developed to allow nurses and doctors time to practice the shared leadership roles within this model and regularly update their leadership skills. In our centre, following on from the present study, the shared leadership model for cardiac arrest management has been implemented in our ED. Ongoing inter-professional simulation training is undertaken to practice the model and to improve teamwork. Evaluations of teamwork, communication, leadership and adherence to the ALS are audited following each cardiac arrest and reviewed at 6 monthly intervals. Data are used to identify areas to focus future training.

The limitations of the present study include being a single-centre, non-blinded study with small numbers of participants. The use of the modified T-NOTECHS scale is unvalidated in this setting and the clinical correlation of score improvements is still to be determined. However, the present study demonstrates proof of concept and involves a setup that would be easy to replicate in other EDs. Further larger studies comparing shared and single leadership models during simulation and real-life events that compare patient outcomes are required to affirm the benefits of shared leadership in cardiac arrest management. Furthermore, wider benefits of nurse empowerment and interdisciplinary training is ripe for further qualitative review.

Conclusion

Our results support the hypothesis that simulation is an effective training tool for improving teamwork and nursing leadership in the novel setting of shared leadership for CPR. The present study looking at communication and teamwork performance using a shared leadership model for cardiac arrest management shows that a short simulation training programme improved teamwork performance. This model could easily be replicated in other EDs with simulation scenarios used as the mechanism of training nurses in the shared leadership role.

Author contributions

Project design by PA, BP, JP-C and DM; recruitment and data collection by PA, BP, JPC and DM; analysis and write-up by PA, BP, JPC, DM and AR; and final article review and agreement by all authors.

Competing interests

None declared.

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Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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