Using In-Situ Simulation for Extracorporeal Cardiopulmonary Resuscitation (ECPR) Guideline Development.

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Abstract

The use of simulation in healthcare is an important pedagogical approach in education and training. In-situ simulation can provide an immersive experience in an authentic clinical environment for training healthcare professionals in both technical and non-technical skills. This article discusses an innovative approach to utilising in-situ simulation for the development of clinical practice guidelines. Interprofessional collaboration during this process promotes safe, effective, and team-based care as part of guideline development.

Background

There has been an ongoing drive to improve patient safety since the publication of 'To Err Is Human', which emphasised harm reduction strategies, including the recommendation that hospital systems utilise technology and simulation to implement processes of care (Kohn, 2001). Across healthcare systems, there has been significant drive for developing a safety-first culture at the organisational level (Nieva, 2003). Organisations such as the World Health Organisation and Institute for Healthcare Improvement have safety and harm reduction as part of major policies (Andermann et al., 2011) (Classen et al., 2011) (WHO, 2017). If system failures are the primary causes of error rather than individual mistakes, the need for collaboration and interdisciplinary training in the clinical environment is paramount (Courtenay et al., 2013).

Evidence based practice guidelines are required to ensure effective and safe working practices in the complex and evolving healthcare environment (Vincent et al., 1998). However, research has highlighted a lack of evidence-based safety protocols being implemented in health systems, supporting the need for electronic software for record keeping, clinical notes and medical order (Landrigan et al., 2010). According to WHO (2014), the implementation component of the guideline process should be at the forefront of planning, along with consideration of the drivers and barriers to change.

Simulation in healthcare is an important training component in both workplace and higher education settings across healthcare professions (Hayden et al., 2012) (Marzano et al., 2014). Much of simulation research focuses on skill or knowledge acquisition, however system performance can also be analysed (LeBlanc et al., 2011). The future of simulation could become embedded in systems of care, making healthcare more effective, efficient and safe (LeBlanc et al., 2011). Simulation modelling is used in industries such as aerospace, defence, and manufacturing to predict the performance of prototypes in the real world (Brailsford et al., 2009). In particular, simulation in the aviation and defence industries have demonstrated enhanced procedural skill training and safety development processes (Courtenay et al., 2013) (Reader and Cuthbertson, 2011).

However, ICU must ensure team training and skill development is tailored around their specific needs, not replicated safety examples from aviation (Reader and Cuthbertson, 2011). LeBlanc et al. (2011) propose the utilisation of simulation for analysing safety and risk, in terms of technology, human factors and work environment performance. Utilising high fidelity simulation in actual clinical environments, can enhance the learning and can subsequently enhance the quality of evaluation feedback during education sessions (Mileder, 2014). Using in-situ workplace training, a study reported that a latent safety threat was identified at a rate of one in every 1.2 simulation sessions performed (Patterson et al., 2012). The term "translational simulation" to describe the targeted use of in-situ simulation to improve the performance and processes of patient care (Brazil, 2017).

Pronovost (2013) has highlighted the gap between clinical practice and guidelines, and safety measurements identifying that clinicians often fail to follow published guidelines. These clinical guidelines are increasing in number and length, and do not necessarily prioritise the most important therapies in each clinical setting, emphasises the importance of human factors when developing clinical focused resources (Pronovost, 2013). The difficulties of translating evidence into practice can arise at different levels in the health-care system, at the level of the patient, the health-care team, the health-care organisation and the wider environment (Grol and Grimshaw, 2003).

Knowledge Translation

Translating evidence-based knowledge and implementing this knowledge into practice is recognised as a difficult process due to the complexity of health care systems (Titler, 2010). Furthermore, embedded practices mired in a 'because it has always been done this way' philosophy are difficult to displace and so the de-implementation of practice can be a lengthy process (Morris et al., 2011) (Niven et al., 2015). Engaging interprofessional teams as part of a social system of change could increase adoption levels and develop a 'from the floor' hierarchy of guideline development. Engagement can assist translation of best practice into the clinical arena and avoid the slow translation of research into practice (Morris et al., 2011). The importance of communication and collaboration across interprofessional healthcare teams is essential (Brock et al., 2013). Teamwork is vital in the critical care environment, where procedures are often complex and require a multi-disciplinary approach (Pronovost, 2013). Simulation can provide a focal point for all these strategies and in doing so can assist teams in identifying and understanding the key focus points of leadership, situational awareness monitoring, mutual support, and communication during the development process (201, 2016).

Extracorporeal Membrane Oxygenation (ECMO) Guideline Development Process

ECMO is a modified cardiopulmonary bypass circuit that can provide short term respiratory or cardiac support (MacLaren et al., 2011). Extracorporeal Cardiopulmonary Resuscitation (ECPR) is an approach to cardiac arrest management which involves the use of veno-arterial ECMO during cardiopulmonary resuscitation which provides artificial circulation as an alternative to conventional ventilation and external cardiac massage (Stub et al., 2015). ECMO is considered an emerging healthcare intervention with improved technology, cannulation techniques and survival rates (Napp et al., 2017). The Alfred ICU is a quaternary referral centre, providing state services for heart & lung transplantation, artificial heart technology, extra-corporeal membrane oxygenation (ECMO), burns and hyperbaric medicine. The 45-bed intensive care admits more than 2800 patients per year. The integrated ICU patient supported ECMO service established in 2003 has treated over 500 patients, and in recognition of this expertise was awarded Extracorporeal Life Support Organisation (ELSO) Platinum Centre of Excellence in Life Support.

The ECPR guideline development process involved engagement of clinical ECMO experts and the identification of key stakeholders and key phases of the project. In view of the clinical challenges and time critical

situation of the ECPR procedure, coupled with team allocation and related human factors, it was decided a simulation approach best suited the development of the ECPR guideline. ECPR is an emerging 'high risk, low volume' practice that currently lacks an extensive evidence base and thus remains controversial. The framework for the ECPR guideline utilised the expert consensus guidelines from Extracorporeal Life Support Organisation (ELSO, 2017) to enable evidence-based recommendations to be incorporated into the draft guideline. Then a simulation prototype of the ECPR process was developed with involvement of the multidisciplinary expert group. This small group of enthusiasts started the process by testing equipment, creating specific role descriptions and modifying the ECPR environment, to provide a first draft of the guideline. Specific team-based protocols specific to the local institution were incorporated into the ELSO recommendations.

Multidisciplinary Team ECPR Guideline Development

Phase 1: Project Team & Draft Guideline

- ECMO nurse consultant
- ICU ECMO specialist medical consultants

Phase 2: Simulations & Guideline Developments

- ECMO trained nurses and educators
- ICU consultants and senior registrar team
- ICU liaison team (nursing and medical)
- Emergency medicine consultants (for ECPR process outside the ICU)

Phase 3: Simulations & Guideline Developments

- ICU nursing and medical team members
- Regular collaborative training sessions on formal study days and quick team based simulation sessions held during shifts.

Phase 4: Final guideline & Guideline Committee Review

Phase 2 and 3 simulations were delivered using a simulation manikin and relevant ECMO equipment utilising both in-situ and sim centre learning situations (See Fig. 1). In-situ simulation was more practical in terms of the fidelity and testing the ECPR procedure in the workplace environment. In-situ simulation also enabled greater participation and feedback opportunities from on-duty clinical nurses and doctors. The use of in-situ simulation can assist in clinical work and time pressures, resources and training efficiency (200, 2008). The simulation sessions became a beta testing ground to create iterative updates from an initial draft to the submission version provided to the hospital guideline committee.

Repeated multi-disciplinary nursing and medical simulation training of equipment, environmental and human factors resulted in numerous updates and amendments to the draft guideline process. Direct feedback from participants to the facilitators during the simulation sessions were then reviewed by the project team for consideration of amendment to the guideline. Various factors were identified through simulation testing which

Figure 1: ECMO Simulation Set Up.

may not have otherwise been discovered until well after guideline implementation due to the comparatively low frequency of ECPR in clinical practice. The major themes identified were 'role definition' and 'task allocation', which when recognised can simplify the coordination of the complex multi-disciplinary ECPR team processes. ECPR roles identified in training, included the traditional advanced life support roles, ECMO–specific cannulation and console operator roles, and an overall team leader. ECPR is thus a resource intensive procedure compared to a standard cardiopulmonary resuscitation approach. A designated ECMO team available at all hours was not financially feasible, so the ECPR team includes a varied combination of ICU and ED personnel depending on the location and timing of the hospital cardiac arrest. This meant there was a need for role cards highlighting key responsibilities and providing a cognitive aid so that even team members who have not worked together before can function effectively in a stressful ECPR situation on the ward, in the ED, or in the ICU (See Fig. 2 for team leader role card). The role cards are designed to be a cognitive aid and support tool, and not a replacement for formal clinical competency assessments. Subsequently, a similar simulation process has been used for the development of a re-sternotomy guideline which again is a 'high risk, low volume' practice that involves technical skills, human factors and a practical component suited for simulation testing.

Education Themes from Training

Instead of time-consuming meetings and convoluted communication trails, a collaborative multi-disciplinary in-situ simulation process provides an effective basis for the guideline development process. It allows explicit evidence-based knowledge to be combined with the tacit knowledge of local experts at the bedside. For clinical practices such as ECPR, that are 'high risk and low volume', the simulation process enables adjustments in roles, equipment and environment to be rapidly identified and changes made to the guideline in a timely manner. Furthermore, repeated simulations can be used to iteratively hone and develop the guideline. Depending on the complexity of the procedure, equipment or resources, significant investment in

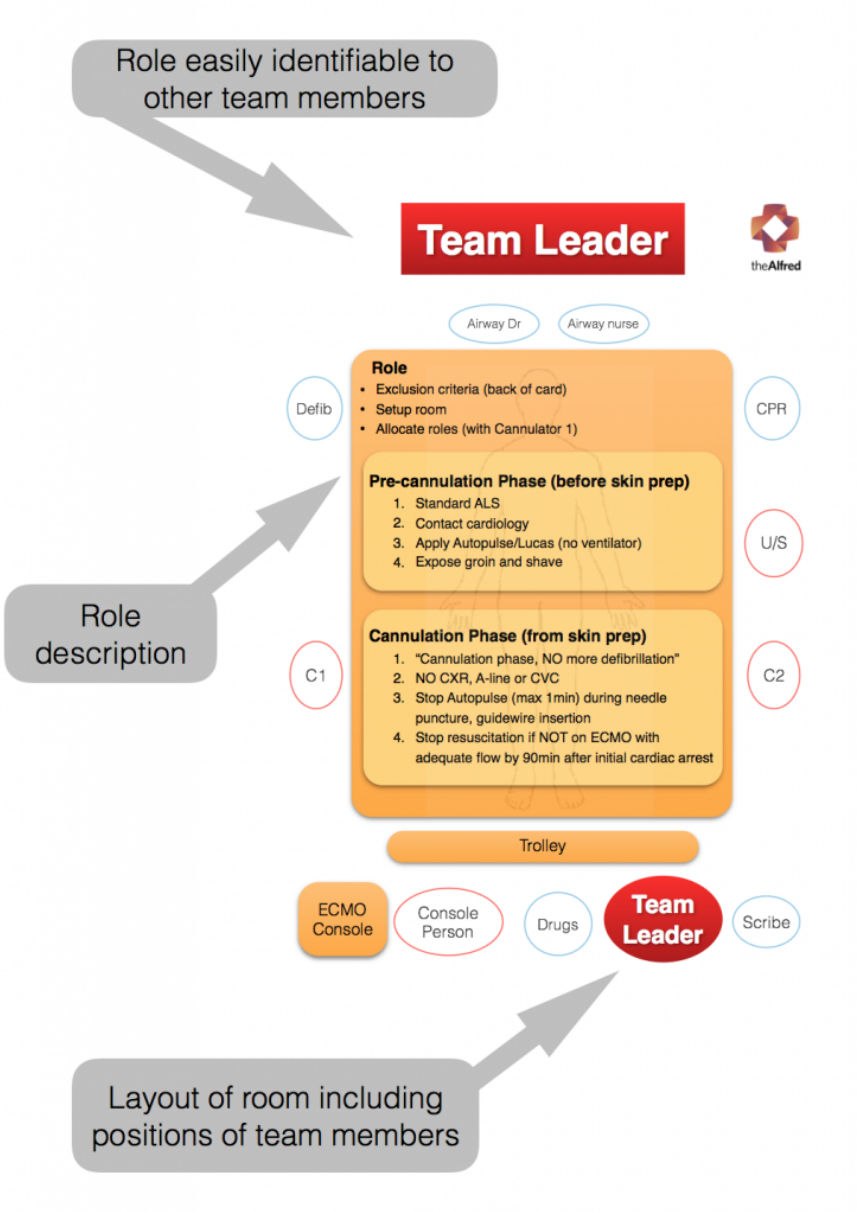

Figure 2: Features of the Team Leader Role Card by Nixon (2016)

equipment and human resources may be required. Involvement of relevant stakeholders in the simulations, helps ensure the resulting guideline is fit for purpose, and may improve interprofessional buy in and implementation. Collaborative team-based simulation in the workplace or learning environment is now considered part of routine interprofessional practice (Schmitt et al., 2013). However, whether for team training, research or evaluation, making effective use of simulation-based technologies requires robust, reliable and accurate assessment tools (Grand et al., 2013). An essential aspect of delivering effective simulation is the debrief, and the PEARLS approach helped provide a framework to facilitate the feedback process during training (Eppich and Cheng, 2015).

Identified ECPR Educational Themes

- Technical and hands on skills for ECMO cannulation and initiation of ECMO support.
- Situational awareness and avoidance of fixation errors.
- Understanding of roles in a changing environment, whether in ED, ward or ICU.
- Leadership and followership skills.
- Effective communication and teamwork.

Limitations

'Feedback, refine, feedback, refine' was the theme throughout the phased development and training but the process was both time and resource intensive, especially the human resource requirement. No extra funding for training hours was allocated so training was incorporated into already planned ECMO and cardiac study days, and the workplace collaborative in-situ simulation training for nursing and medical staff. The simulation sessions were reliant on ICU workflow and capacity, so sessions varied in the number and identity of attendees. As a result, attendees did not have input into every guideline iteration, instead they built upon the latest iteration regardless of who was present.

The Future

Simulation holds promise for wider usage in guideline development and implementation. As such, its scope extends beyond team training and can be used to promote adoption and adherence by engaging the members of the team at an early stage of the guideline development. This change process strategy may help communicate and disseminate practice changes. However, an evidence base supporting the effectiveness of such an approach needs to be developed, including implementation of practice. Further research is required on the efficacy, improved knowledge and confidence with the use of role cards in team simulation training.

Other technological advances may also benefit healthcare safety and education in the future. For instance, the use of virtual reality in recreating the physical environment to solve complex intervention training and testing in healthcare is an exciting alternative for education and workplace training. Gaming also allows the recreation of the environment to enhance training and development in a safe environment and has in-built features that encourage team engagement (Torrente et al., 2014). Rapid prototype development and 3D printing may also allow the production of equipment for 'hands on' testing of procedures in a cost-effective and timely method.

Summary

We have described an emerging use of simulation in the workplace, in which healthcare safety and education process is merged within the development of a clinical practice guideline. A simulation-based guideline development process was created and managed in a safe and controlled environment. The simulated aspect of 'real life' utilised the expertise of nursing and medical team members and provided an ideal environment to test new or update clinical guidelines. This approach enables a guideline to be tested across a range of healthcare wards and environments. As guidelines become more standardised due to accreditation and benchmarking requirements, simulation allows testing to ensure the specifics requirements of local environments are met as well as delivering evidence-based practice.

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