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Using simulation and inter-professional education to teach infection prevention during resuscitation

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Abstract

Introduction: During resuscitations, healthcare professionals (HCPs) find balancing the need for timely resuscitation and adherence to infection prevention (IP) measures difficult. This study explored the effects of an innovative teaching method, using in-situ simulation and inter-professional education to enhance compliance to IP through better inter-professional collaboration.

Methods: The study was conducted in the Surgical Intensive Care Unit (SICU) in a 1200-beds teaching hospital. HCPs working in the SICU were conveniently allocated to the intervention or control group based on their work roster. The intervention group attended an in-situ simulated scenario on managing cardiac arrest in an infectious patient. The control group completed the standard institution-wide infection control eLearning module. Outcomes measured were: (a) attitudes towards inter-professional teamwork [TeamSTEPPS Teamwork Attitudes Questionnaire (TAQ)], (b) infection prevention knowledge test, (c) self-evaluated confidence in dealing with infectious patients and (d) intensive care unit (ICU) audits on infection prevention compliance during actual resuscitations.

Results: 40 HCPs were recruited. 29 responded (71%) to the pre- and post-workshop questionnaires. There were no significant differences in the TeamSTEPPS TAQ and infection prevention knowledge score between the groups. However, ICU audits demonstrated a 60% improvement in IP compliance for endotracheal tube insertion and 50% improvement in parenteral medication administration. This may be attributed to the debriefing session where IP staff shared useful tips on compliance to IP measures during resuscitation and identified threats that could deter IP compliance in SICU.

Conclusion: Learning infection prevention through simulated inter-professional education (IPE) workshops may lead to increased IP compliance in clinical settings.

Keywords: *Inter-Professional Education, Simulation Infection Control, Resuscitation, Inter-Professional Teamwork*

Practice Highlights

- Use of a simulated scenario to improve infection prevention during resuscitation.
- Improving attitudes towards inter-professional collaboration amongst healthcare professionals.
- Evaluating the efficacy of a simulated scenario through clinical audit.

I. INTRODUCTION

Adherence to infection prevention is paramount in the intensive care unit (ICU) as hospital acquired infections in the critically ill are associated with increased morbidity, mortality, length of stay and healthcare cost (Gandra & Ellison, 2014). However, during resuscitations, healthcare professionals (HCPs) may experience difficulty in balancing the need for resuscitation and adherence to infection prevention guidelines, resulting in suboptimal compliance to basic infection prevention measures (Steinemann et al., 2016). Moreover, resuscitation is a time-critical endeavour that requires good collaboration in a team comprising of different HCPs fulfilling different roles with different priorities, and lapses in teamwork may arise in a team

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comprising of HCPs with different roles and priorities (Barr, Koppel, Reeves, Hammick, & Freeth, 2009).

Inter-professional education (IPE) is defined as "occasions when two or more professions learn with, from and about each other to improve collaboration and quality of care" by the Centre for Advancement of Interprofessional Education (CAIPE) (Steinert, 2005). It is known to improve patient safety through improving communication, understanding and knowledge to encourage active participation from different HCPs (Oandasan, 2007; Wong, Lee, Allen, & Foong, 2020). Research has shown that active collaboration amongst HCPs in the workplace resulted in improved patient outcomes and provider satisfaction (Wagner, Parker, Mavis, & Smith, 2011). Previous studies had investigated the outcomes of using IPE workshops to teach infection prevention in non-emergency clinical settings or using standardised patients, and concluded that knowledge and confidence in infection prevention and inter-professional teamwork had improved (Mundell, Kennedy, Szostek, & Cook, 2013).

Currently, infection prevention education in our institute is didactic and web-based. Although this method is effective in disseminating information, there are no opportunities to learn with different HCPs or apply knowledge to real-life scenarios. On the basis that resuscitation is traditionally taught using simulation and has been proven to be highly effective (Perkins, 2007), we developed an IPE simulation workshop on infection prevention during resuscitation.

We hypothesised that the in-situ simulation workshop involving different HCPs will result in improved attitudes towards inter-professional teamwork and improved compliance to infection prevention guidelines, compared to our standard institutional infection control (IC) education.

II. METHODS

A. Study Population

We conducted a non-randomised experimental study amongst HCPs working in the Surgical Intensive Care Unit (SICU) of the Singapore General Hospital (SGH). All HCPs working in the SICU were eligible to participate in the study. There were no exclusion criteria. Informed consent was obtained from all participating HCPs. Information on participants' profession, the year they obtained their professional qualification, the number of years they had worked in critical care and prior experience in simulation training were collected. HCPs from Anaesthesiology, Nursing, Physiotherapy, Pharmacy, Speech and Language Therapy, Dietetics and Infection Prevention were involved. A working day was picked to run the workshop and HCPs on duty that day were allocated to the intervention group, while those there were not on duty were assigned to the control group.

B. In-Situ Simulation Workshop

Participants in the intervention group (n=25) underwent a two-hour in-situ simulation workshop in the SICU on the scenario of a cardiac arrest in an infectious patient (Annex A). The training faculty comprised of HCPs from various professions such as Anaesthesiology, Nursing, Physiotherapy, Pharmacy, Speech and Language Therapy, Dietetics and Infection Prevention. Each workshop consisted of HCPs from five to seven different professions. The learning outcomes of the workshop were (i) to practice infection prevention precautions for transmission-based infections during resuscitations and (ii) to improve attitudes towards inter-professional teamwork during a crisis situation.

The workshop was designed based on Kolb's experiential learning theory (Kolb & Fry, 1975), which is a four-stage learning cycle consisting of (i) concrete experience, (ii) reflective observation, (iii) abstract conceptualisation and (iv) active experimentation. Concrete experience was facilitated through in-situ simulation where participants experienced real-life constraints of resuscitating an infectious patient. Following the simulation, a debrief was held by the faculty that facilitated reflective observation and abstract conceptualisation. Learning points discussed include (i) issues faced in adhering to infection prevention guidelines in a resuscitation setting, (ii) inter-professional teamwork and (iii) threats that could deter IC compliance in SICU. The final stage, active experimentation, was facilitated through actual application of learning points surmised from the workshop, and evaluated through real-time ICU audits.

C. Evaluation of Outcomes

Evaluation of the effectiveness and impact of the workshop was done in accordance with Kirkpatrick's evaluation framework (Kirkpatrick, 1994), which emphasised the need to go beyond the immediate reactions of participants by assessing them on four different levels, which are (i) Reaction, (ii) Learning, (iii) Behaviour and (iv) Results. "Reaction" was evaluated through the post-workshop questionnaire and participants' responses in the post-workshop debrief with regards to the effectiveness of simulated workshops in improving inter-professional teamwork and encouraging compliance to infection prevention guidelines. The second level, "Learning", was evaluated by discussing learning points of the workshop in the debrief, and

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getting participants to note down their most important takeaways regarding infection prevention and IPE in the post-workshop questionnaire. "Behavioural changes" were assessed through a real-time observational study that assessed participants' ability to observe proper infection prevention practices during actual resuscitations in the SICU. Results, the fourth level, were difficult to evaluate due to the small sample size that we recruited.

D. Outcomes of Study

There are two primary outcomes of this study: (i) attitudes towards inter-professional teamwork and (ii) infection prevention knowledge and practices.

Changes in attitudes towards inter-professional teamwork were assessed using the TeamSTEPPS Teamwork Attitudes Questionnaire (TAQ 1.0), based on scores in the following subcategories; Team Structure, Leadership, Situation Monitoring, Mutual Support and Communication (Appendix 1). Qualitative comments on key learning points with regards to teamwork were also collected during the debriefing sessions.

Changes in infection prevention knowledge and practice were assessed in five ways:

1. An infection prevention self-evaluation questionnaire on a 5-point Likert Scale (Appendix 2).

2. A multiple-choice quiz developed by the Institutional Infection Prevention Nurse Educators (Appendix 3A and 3B).

3. Questionnaire on effectiveness of the simulation (for participants in the intervention group only) (Appendix 4).

4. Qualitative feedback on the learning points concerning infection prevention. (Appendix 5).

5. Clinical audit data that evaluated compliance to infection prevention guidelines during resuscitations in the SICU. Two months after the simulation workshop, the data was collected by a trained hospital-based infection prevention team based on real-time observations. The audit checklist assessed proper use of personal protective equipment (PPE), hand hygiene, administration of parenteral medications and insertion of endotracheal tube (ETT).

Statistical analysis was performed using SPSS for Mac, Version 20.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were analysed using the t-test, and categorical variables were analysed using the Fisher and Chi square test. A p-value of less than 0.05 was taken to be statistically significant.

III. RESULTS

The study recruited a total of 40 HCPs. Of the 40 clinical staff working in the SICU asked to rank their responses, 29 (71%) responded to the pre- and post-workshop TAQ, self-evaluation of infection prevention knowledge and infection prevention knowledge quiz. Healthcare professions represented included doctors (31%), nurses (34%), pharmacists (10%), physiotherapists (10%), speech and language therapists (10%) and dieticians (3%).

The intervention and control groups were not significantly different in terms of the number of years post-graduation, years of working experience in critical care and the number of simulated training sessions they have attended, excluding basic cardiac life support (BCLS) and advanced cardiac life support (ACLS). Similarly, there were no significant differences in self-evaluation of infection prevention knowledge and infection prevention scores at baseline. However, we noted significantly higher scores in the control group in Team Structure (mean difference=2.76), Leadership (mean difference =3.8), and Communication (mean difference=2.54; Table 1).

	Intervention [Range] (n=16)	**Control [Range] (n=13)**	**P-value**
Mean no. of years since graduation	8.65 [4-23]	8.67 [5-20]	0.996
Mean no. of years in critical care	3.78 [0-10]	5.13 [0-15]	0.413
Mean no. of prior simulation training sessions (excluding BCLS/ACLS)	1.52 [0-15]	2.33 [0-12]	0.474
Self-evaluation of infection prevention knowledge	13.3 [10-20]	14.6 [8-19]	0.179
Infection prevention baseline MCQ scores	5.47 [5-6]	5.78 [5-6]	0.103
TeamSTEPPS Teamwork Attitudes Questionnaire 2.0			
Team Structure	23.04 [19-30]	25.80 [20-30]	0.046*
Leadership	24.13 [18-29]	27.93 [21-30]	0.009*
Situation Monitoring	23.43 [20-30]	25.73 [21-30]	0.100
Mutual Support	18.91 [15-26]	19.33 [15-27]	0.678
Communication	22.39 [19-29]	24.93 [20-30]	0.042*

Table 1. Baseline characteristics of the Intervention and Control groups

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A. Inter-Professional Teamwork

Within the intervention group, there were no significant changes between pre- and post-workshop TeamSTEPPS TAQ scores in most subcategories, with the exception of an improvement in post-workshop Mutual Support scores (mean difference=3.21), which translated to a 17.0% increase from baseline (Table 2). The lack of a significant change in most subcategories could possibly be due to the already high baseline scores prior to the workshop.

	Pre-workshop mean (SD) [Range] (n=16)	**Post-workshop mean (SD) [Range] (n=16)**	**Mean difference**	**P-value**	**Percentage increase/%**
Self-evaluation of infection prevention knowledge	13.57 (3.32) [10-20]	14.71 (1.90) [9-19]	1.14	0.230	8.4
Infection prevention quiz scores	5.85 (0.38) [5-6]	4.85 (0.69) [4-6]	-1.00	0.000	-17.1
Team Structure	24.14 (2.69) [19-30]	25.36 (2.50) [21-30]	1.22	0.058	5.1
Leadership	25.64 (2.76) [18-30]	25.9 (2.55) [24-30]	0.26	0.780	1.0
Situation Monitoring	24.71 (3.29) [18-30]	25.36 (3.10) [24-30]	0.65	0.272	2.6
Mutual Support	18.93 (2.43) [18-30]	22.14 (2.03) [18-28]	3.21	0.002	17.0
Communication	23.43 (2.56) [20-30]	23.86 (2.45) [22-30]	0.43	0.551	1.8

Table 2. Comparison of pre- and post-workshop scores within the intervention group

The intervention group also had greater percentage increases in the TAQ 2.0 Team Structure, Leadership and Communication sub-categories compared to the control group (Table 3).

	Intervention (n=16)		**Control (n=13)**		**P-value**
	Mean change (SD)	**Percentage change/%**	**Mean change (SD)**	**Percentage change/%**	
Change in scores for self-evaluation of infection prevention knowledge	1.14 (3.39)	8.4	0.78 (0.97)	5.2	0.758
Change in infection prevention scores	-1.00 (0.71)	-17.1	-1.63 (1.19)	-29.0	0.145
Change in scores for Team Structure	0.42 (1.86)	5.1	0.67 (1.45)	1.3	0.661
Change in scores for Leadership	-0.42 (2.35)	1.0	-0.09 (1.38)	-3.1	0.693
Change in scores for Situation Monitoring	1.00 (2.00)	2.6	0.27 (1.35)	2.6	0.323
Change in scores for Mutual Support	4.33 (2.19)	17.0	3.18 (3.82)	25.3	0.380
Change in scores for Communication	0.33 (3.17)	1.8	0.45 (2.34)	1.4	0.919

Table 3. Comparison of changes in pre- and post-workshop scores between the Intervention and Control groups

The most common learning point for IPE was the importance of learning the different roles and capabilities that different HCPs can play and the need to involve other HCPs to ensure an effective resuscitation effort. The learning points listed support change in perceptions related to interprofessional roles that the quantitative scale did not capture.

"The workshop improves knowledge of the roles that other healthcare professionals are able to perform, for example, a physiotherapist being qualified to help in CPR during resuscitation."

(Nursing participant, ID 16)

B. Infection Prevention Knowledge and Practices

Although there were no statistically significant differences between the groups, better infection prevention scores were noted in the intervention group. The intervention group had a percentage increase of 3.2% (8.4% vs 5.2%) in self-evaluated infection prevention knowledge. The questions on infection prevention knowledge were supposed to be of similar difficulty, and we avoided repeating the same set of questions, as we did not want participants to discuss or look up the answers. For both groups, there was a decrease in infection prevention knowledge scores post-workshop; however, there was a smaller decrease in the intervention group (-17.1%) compared to the control

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group (-29.0%) (Table 3). We speculate that this may be due to the post-workshop questions being more difficult compared to the pre-workshop questions. Another reason that may have contributed to the decrease in scores is the limited number of questions (n=6), which may have confounded our results.

The participants shared a rich diversity of infection prevention learning points during the debrief session. Examples included correct steps in the donning of personal protective equipment, strategies to clean the intravenous (IV) injection hub quickly and effectively, and identification of threats that deterred proper infection prevention compliance during the simulation such as the lack of a disposable dish on the resuscitation trolley to keep intravenous drugs and intubation equipment clean. The most common learning point for infection prevention was the importance of adhering to infection prevention practices during resuscitation such as the accurate administration of parenteral medications. The learning points listed support change in perceptions related to interprofessional roles that the quantitative scale did not capture.

"The importance of practicing infection prevention measures such as the need for changing soiled gloves in between administering parenteral medications, but yet not compromising on resuscitation."

(Physiotherapist, ID 8)

The clinical audit conducted after the simulation workshop showed that compliance rates in accurate parenteral medication administration improved by 50%, while compliance rates in ETT insertion improved by 60% post-workshop, compared to pre-workshop performance (Table 4).

	Pre-workshop		**Post-workshop**		**Percentage change in compliance rates/%**
	Number of instances of compliance	Number of instances of non-compliance	Number of instances of compliance	Number of instances of non-compliance	
PPE	24 (100%)	0 (0%)	24 (96%)	1 (4%)	-4
Hand hygiene	10 (100%)	0 (0%)	2 (100%)	0 (0%)	0
Parenteral medication administration	6 (50%)	6 (50%)	9 (100%)	0 (0%)	50
ETT insertion	2 (40%)	3 (60%)	10 (100%)	0 (0%)	60

Table 4. Comparison of compliance rates to infection prevention during real-time resuscitations pre- and post-workshop

IV. DISCUSSION

The study was designed, conducted and written before the COVID-19 pandemic. Since the pandemic, there had been some changes in infection prevention guidelines in aerosol general procedures such as tracheal intubation (Perkins, et al., 2020), which was not reflected in our study. Our study had highlighted the importance of using simulation and inter-professional collaboration to enhance infection prevention education, and these were also emphasised in many publications regarding infection prevention during the pandemic (Wong, et al., 2020). For example, there had been recommendations of using a buddy system for PPE donning and doffing, and using high fidelity simulation to prepare for the COVID-19 crisis (Bricknell, Hodgetts, Beaton, & McCourt, 2016). However, many of these publications were reviews and opinions rather than research studies (Foong, et al., 2020; Lim, Wong, Teo, & Ho, 2020).

To our knowledge, there are no publications on the use of in-situ simulation to teach infection prevention during resuscitations in an IPE setting. Current literature evaluating the impact of simulated IPE workshops in teaching infection prevention had mixed results with regards to the effectiveness of such workshops in improving attitudes towards inter-professional teamwork and enhancing compliance rates to infection prevention practices. In the study by Luctkar-Flude et al. (2016), there was significant improvement in infection prevention knowledge, but little change in inter-professional teamwork. Although knowledge related to aseptic technique improved significantly immediately post-workshop, long-term retention was poorer (Wagner, et al., 2011).

A. The Utility of Simulation in Improving Infection Prevention

Our results from the clinical audit conducted during actual resuscitations in the SICU demonstrated a large improvement after the workshop in accurate parenteral medication administration and ETT insertion. This finding supports the hypothesis that an inter-professional simulated workshop is more effective than traditional didactic web-based methods in improving adherence to infection prevention practices, which could be due to three added elements present in simulated workshops.

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Firstly, simulation provides interaction amongst different HCPs and enables collaborative learning in small groups (Dolmans, Michaelsen, van Merriënboer, & van der Vleuten, 2015). Secondly, the debriefing process promotes reflective learning and provides real-time feedback (Ziv, Wolpe, Small, & Glick, 2003). Thirdly, the learning is contextualized as participants learn infection prevention principles that are embedded in authentic clinical scenarios, and simulated cardiac arrest in an infectious patient is a common scenario that reflects the reality of practice (Morison & Jenkins, 2007).

Simulation also enables participants to discover innovative solutions, thereby enabling optimal adherence to infection prevention protocols while ensuring a timely resuscitation response with limited manpower. An example of one of the interesting solutions discussed include the designation of specific roles during resuscitation, such as assigning one HCP to be in charge of the airway and another to be in charge of administering intravenous drugs so as to avoid contamination.

B. Encouraging Inter-Professional Teamwork Through Simulation

Simulated scenarios with a focus on IPE also encourage active engagement and collaboration amongst participants, which had been demonstrated to result in improved attitudes towards teamwork (Huitt, Killins, & Brooks, 2015). During the debriefing process, study investigators facilitated the discussion to allow HCPs from different specialties to give feedback and volunteer information on how they could better contribute to the resuscitation effort and work more cohesively as a team, thereby enabling HCPs to discover more about the capabilities of their fellow colleagues. This discussion helps to create a sense of shared purpose within teams (Freytag, Stroben, Hautz, Eisenmann, & Kammer, 2017), which is a defining characteristic of an effective team (Drinka & Clark, 2000), and also reinforces the idea that a team can often achieve what an individual cannot.

In our debriefing, the participants noted the importance of learning the different roles and capabilities that different HCPs can play and the need to involve other HCPs to ensure an effective resuscitation effort, which can subsequently translate to a positive change in patient care and collaborative practice (Hammick, Freeth, Koppel, Reeves, & Barr, 2007). For example, the nursing and medical participants did not realise that physiotherapists, pharmacists and speech and language therapists are BCLS trained and can perform effective chest compression, and the medical participants did not realise nurses can perform cardiac defibrillation during a cardiac arrest. Better collaboration and understanding of other HCPs' roles can improve task delegation to fully maximise available manpower, and aids in crisis resource management.

C. Debriefing–An Essential Component of a Simulated Workshop

According to the experiential learning style theory (Kolb & Fry, 1975), reflective practice is an integral component that allows learners to fully integrate the learning experience. It allows HCPs to transit from merely experiencing the simulation to deriving critical learning points (Savoldelli, et al., 2006), as constructive discussion and feedback allow participants to better understand potential areas of improvement and reinforces proper infection prevention practice (Gerolemou, et al., 2014). The importance of feedback and discussion is aptly demonstrated in our study, with participants noting that accurate parenteral medication administration was one of their main takeaways from the debriefing process, and there being a subsequent 50% improvement in parenteral medication administration in our observational study.

An effective debriefing process was facilitated through the creation of a non-threatening environment by using open-ended questions, positive reinforcement, constructive feedback and active engagement of all HCPs present (Fanning & Gaba, 2007). While there are many debriefing tools present such as the Organ Specific Autoimmune Disease (OSAD) debriefing tool (Ahmed, et al., 2012), and Advocacy Inquiry (Gururaja, Yang, Paige, & Chauvin, 2008), we believe that the cornerstone of a successful debrief is through the creation of an environment that allows participants to freely voice their queries and concerns, and subsequent discussion to tease out relevant learning points that serve as important takeaway messages.

D. Other Observations

Interestingly, we noted significant differences in Team Structure and Leadership between the Intervention and Control groups in the pre-test questionnaire. This could be due to difference in number of years that the intervention and control groups have worked in SICU, with the intervention group having worked a mean number of 3.78 years compared to the control group's 5.13 years, although this difference was not statistically significant. Studies have shown that HCPs who have worked together for longer periods of time and on a daily basis are more likely to develop trust and confidence in their teams (Bosch & Mansell, 2015). Less-experienced healthcare staff may feel more uncomfortable with inter-professional teamwork compared to more experienced staff, further highlighting the importance of increasing exposure to IPE for younger HCPs.

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E. Challenges Encountered in the Implementation of a Simulated Infection Prevention IPE Workshop

The conception and organisation of an infection control workshop that incorporates both simulation and IPE improved our understanding of existing challenges to the development of a coherent curriculum and implementation of simulated workshops (Buckley, et al., 2012). There were numerous challenges encountered in the implementation of such workshops.

Examples include:

1) Simulated workshops are resource intensive. Monthly faculty meetings were held for five months before the workshop, and each workshop required the presence of a HCP from at least five different specialties. In addition, beds in the SICU had to be specially set aside for the workshop to take place.

2) Learning outcomes had to be crafted carefully to ensure that all HCPs could benefit from an effective IPE session.

3) Faculty development was crucial and the faculty was trained to ensure that the post-simulation debriefing could take place effectively and learning outcomes were met.

4) Scheduling conflicts were encountered as implementation of the workshop required HCPs with different work schedules to be present at the same time.

The effectiveness of the workshop could be better evaluated with multiple SICU audits of resuscitations pre- and post-workshop, as this would truly demonstrate translation of learning to real-life practice. However, it is difficult to coordinate logistically. Whenever a real-time resuscitation in the SICU occurred, our hospital-based infection prevention team had to be mobilised within a few minutes without advanced notice to the SICU to conduct the audit on infection prevention compliance during resuscitation, which proved to be challenging.

Nevertheless, these challenges can be resolved if HCPs are strongly committed to better healthcare and our study showed that it is possible to overcome the above-mentioned challenges (Byakika-Kibwika, et al., 2015). We hope that our experience would help shed light on future barriers to implementation of similar in-situ simulated IPE workshops.

F. Plans for the Future

Our study showed that simulation IPE workshops encouraged mutual support amongst different HCPs and improved infection prevention practices during resuscitation. However, implementation of the workshop was costlier and more labour intensive compared to current online video infection prevention education. Currently, we now run in-situ simulations in SICU every month on crisis resource management, and infection prevention is one of the important learning outcomes.

This workshop was conducted before the COVID-19 pandemic and there was no limitation on the maximum number of participants. In the future, with the SICU roster having changed to shift work, the workshop will only be conducted amongst HCPs within a particular shift to avoid cross-contamination with other shifts. A larger debrief room may be needed to allow for social distancing as well.

G. Limitations of our study

Limitations of our study include the small sample size, making it difficult to draw generalisations, as the study cannot show any statistically significant difference when comparing the control and intervention groups even though positive trends were observed. Furthermore, longer follow-up is required to evaluate long-term changes in behaviour, attitudes and retention of knowledge.

V. CONCLUSION

Our study showed that learning infection prevention through simulated IPE workshops is an innovative way to teach infection prevention and may lead to increased infection prevention compliance in clinical settings, as demonstrated by the clinical audit conducted. In light of the ongoing COVID-19 pandemic, use of a simulated scenario may help enhance infection prevention practices to limit the spread of transmission-based infections. Simulation may also help improve attitudes towards inter-professional teamwork and collaboration, which are crucial in resuscitations.

Notes on Contributors

Kah Wei Tan is a Medical Officer working with Ministry of Health Holdings (MOHH). Kah Wei Tan performed data collection and data analysis, reviewed the literature and wrote the manuscript.

Hwee Kuan Ong is a Senior Principal Physiotherapist in the Department of Physiotherapy, Singapore General Hospital. Hwee Kuan Ong performed data collection and data analysis and wrote the manuscript.

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developed the methodological framework for the study, designed the study, reviewed the literature and wrote the manuscript.

Ethical Approval

The study is approved by SingHealth Centralised Institutional Review Board (CIRB reference: 2016/3001).

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Declaration of Interest

There is no conflict of interest to declare.

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Appendix 1: TeamSTEPPS Teamwork Attitudes Questionnaire v2.0

		Strongly Disagree	disagree	Neutral	Agree	Strongly agree
		1	2	3	4	5
Inter-professional education						
Team Structure						
	1. It is important to ask patients and their families for feedback regarding patient care.					
	2. Patients are a critical component of the care team.					
	3. This facility's administration influences the success of direct care teams.					
	4. A team's mission is of greater value than the goals of individual team members.					
	5. Effective team members can anticipate the needs of other team members					
	6. High performing teams in health care share common characteristics with high performing teams in other industries.					
Leadership						
	7. It is important for leaders to share information with team members.					
	8. Leaders should create informal opportunities for team members to share information.					
	9. Effective leaders view honest mistakes as meaningful learning opportunities					
	10. It is a leader's responsibility to model appropriate team behaviour.					
	11. It is important for leaders to take time to discuss with their team members plans for each patient.					
	12. Team leaders should ensure that team members help each other out when necessary.					
Situation Monitoring						
	13. Individuals can be taught how to scan the environment for important situational cues.					
	14. Monitoring patients provides an important contribution to effective team performance.					
	15. Even individuals who are not part of the direct care team should be encouraged to scan for and report changes in patient status.					
	16. It is important to monitor the emotional and physical status of other team members.					
	17. It is appropriate for one team member to offer assistance to another who may be too tired or stressed to perform a task.					
	18. Team members who monitor their emotional and physical status on the job are more effective.					
Mutual Support						
	19. To be effective, team members should understand the work of their fellow team members.					
	20. Asking for assistance from a team member is a sign that an individual does not know how to do his/her job effectively					

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	21. Providing assistance to team members is a sign that an individual does not have enough work to do.					
	22. Offering to help a fellow team member with his/her individual work tasks is an effective tool for improving team performance.					
	23. It is appropriate to continue to assert a patient safety concern until you are certain that it has been heard.					
	24. Personal conflicts between team members do not affect patient safety					
Communication						
	25. Teams that do not communicate effectively significantly increase their risk of committing errors.					
	26. Poor communication is the most common cause of reported errors.					
	27. Adverse events may be reduced by maintaining an information exchange with patients and their families.					
	28. I prefer to work with team members who ask questions about information I provide.					
	29. It is important to have a standardized method for sharing information when handing off patients.					
	30. It is nearly impossible to train individuals how to be better communicators.					

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Appendix 2: Self-Evaluation of Infection Prevention Knowledge

	Strongly Disagree	disagree	Neutral	Agree	Strongly agree
	1	2	3	4	5
Self-evaluation of Infection Prevention knowledge					
1. I have good knowledge on Infection Prevention Precautions for standard and transmission based infection e.g. airborne, droplet and contact transmission.					
2. I am confident in adapting infection prevention guidelines during resuscitation of an acutely ill patient.					
3. I know other disciplines and professionals' roles and responsibilities during crisis management in a critical care setting.					
4. This workshop improves my skills and knowledge in infection prevention practices during crisis. (Post course only)					

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Appendix 3A: Infection Prevention Knowledge Test (Pre-Workshop)

MCQ test pre-workshop

1. Nurse Goh noticed that his blood pressure reading is 60/30mmHg. What should Nurse Goh do before attending to Mr Tan?
    a. No need to do anything as this is an emergency situation
    b. Perform hand hygiene before attending to Mr Tan
    c. Wear full PPE
    d. Put on gloves

2. During resuscitation, Nurse Lee performed suctioning on Mr Tan. What should Nurse Lee do when she is leaving the patient's room?
    a. No need to do anything as she was wearing gloves when attending to patient.
    b. Rinse hands with tap water after removing gloves
    c. Remove gloves, wash hands with soap and water
    d. Handrub on gloves and remove gloves after

3. Which statement below is WRONG?
    a. Staff are required to perform surgical handrub before urinary catheterisation
    b. Staff are required to change gloves once the gloves are soiled during resuscitation
    c. All staff are required to perform hand hygiene before attending to patient
    d. Staff are not required to perform hand hygiene if they wear gloves when attending to patient.

4. What precautions should you take before attending to a Clostridium Difficile patient?
    a. Wear a surgical mask
    b. Wear a N95 respirator
    c. Wear an isolation gown with gloves
    d. No precaution needed

5. What precautions should you take when you see an orange colour sticker next to the patient's name at the slot-o-vision?
    a. Droplet precautions
    b. Airborne precautions
    c. Contact precautions
    d. No precaution needed

6. What is the correct sequence to put on the PPEs before entering the isolation room for patient with droplet and contact precautions?
    a. Wear the isolation gown → Hand hygiene → Wear surgical mask → Wear gloves
    b. Hand hygiene → Wear surgical mask → Wear the isolation gown → Wear gloves
    c. Wear surgical mask → Wear the isolation gown → Hand hygiene → Wear gloves
    d. Hand hygiene → Wear gloves → Wear surgical mask → Wear the isolation gown

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Appendix 3B: Infection Prevention Knowledge Test (Post-Workshop)

MCQ test at post-workshop

1. Dr Lee is going to insert a urine catheter for Mr Tan for urine output monitoring. What should Dr Lee do before the procedure?
    a. Perform surgical hand rub using alcohol-based hand rub
    b. Wear full PPE to prevent blood and body fluid exposure.
    c. Perform hand hygiene using alcohol-based hand rub
    d. No need to perform hand hygiene as Dr Lee is going to wear sterile gloves during the procedure

2. During resuscitation, Dr Lee was tasked to insert another cannula for Mr Tan. What should Dr Lee do before performing IV cannulation?
    a. Wear gloves
    b. Remove gloves, perform hand hygiene and don on new pair of gloves
    c. Don new pair of gloves on top of current gloves
    d. Handrub on current pair of gloves.

3. Before you attend to a patient who is a MRSA sputum disperser, which of the following PPE should be worn?
    a. Isolation gown only
    b. N95 respirator, isolation gown and gloves
    c. Surgical mask, isolation gown and gloves
    d. Surgical mask and apron

4. What are the correct sequences to remove PPEs after performing dressing for a patient with multi-drug resistant organism (MDRO)?
    a. Remove isolation gown and gloves → Perform hand hygiene
    b. Remove gloves → Perform hand hygiene → Remove isolation gown → Perform hand hygiene
    c. Perform hand hygiene on gloved hand → Remove gloves → Remove isolation gown → Perform hand hygiene
    d. Remove gloves → Remove isolation gown

5. Which precaution would you practice when attending to a patient with suspect chickenpox?
    a. Airborne and contact precautions
    b. Droplet and contact precautions
    c. Contact precautions
    d. Airborne precautions

6. When you are wearing PPE, which are the following actions that you should AVOID?
    a. Attend to patient immediately
    b. Answering phone call
    c. Give parenteral medication
    d. Perform oral toilet

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Appendix 4: Subjective Evaluation of Workshop Effectiveness

	Strongly Disagree	~~disagree~~	Neutral	Agree	Strongly agree
	1	2	3	4	5
Workshop evaluation					
1. This workshop improves my skills and knowledge in infection prevention practices during crisis.					
2. The workshop improves my understanding on the roles of other healthcare professionals.					

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Appendix 5: Qualitative Feedback

1. Please tell me at least one thing new that you have learnt about infection prevention and/or resuscitation. Please put NA if you did not attend the workshop.

2. Please tell me at least one thing new that you have learnt about other healthcare professionals. Please put NA if you did not attend the workshop.

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