Effects of a Multi-Intervention Multimedia Infection Controlmoduleon Critical Care Nurses' Knowledge and Practice of Prevention and Control of Healthcare-Associated Infections

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Abstract

Aim: This studypurpose is to assess the effectiveness of the MIMIC module in improving the levels of adult critical care nurses' knowledge and practice towards prevention and control of Healthcare-Associated Infections.

Background: The Healthcare-Associated Infections are crucial health problem affecting healthcare system worldwide. While many educational programs and other interventions were developed, the nursing awareness and practice of IPC precautions are still inadequate for handling Healthcare-Associated Infections.

Method: A one-group pretest-posttest quasi-experimental design was used and the MIMIC module was implemented as three 2-hour theoretical sessions for each of the three groups of adult critical care nurses and four 30-minute practical sessions for each of the four selected ICUs. Self-administered questionnaire was distributed at two points of time, immediately before and three months after the MIMIC module, in order to assess the effectiveness of the module.

Results: A total of 121 adult critical care nurses participated in the study. Following the MIMIC module, the participants' level of knowledge towards prevention and control of Healthcare-Associated Infections indicated a statistically significant improvement, $F(1, 120)= 632.679$, $p < .001$, $\eta p2 = .844$ with large effect size. And a statistically significant improvement in levels of practice after implementation of the MIMIC module, $F(1, 120)= 113.089$, $p < .001$, $\eta p2 = .492$with large effect size.

Conclusion: The MIMIC module is a promising module which can be implemented as Continuing Nursing Education to improve adult critical care nurses' knowledge and practice to prevent and control of Healthcare-Associated Infections.

Keywords: *Infection Prevention and Control; Healthcare Associated Infections; Intervention Mapping; Social Cognitive Theory; intensive care unit; critical care nurse; tertiary care hospital.*

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Background

Healthcare-Associated infections (HAIs) are critical problem impacting the health care system, patients and healthcare workers (HCWs). The impacts

of HAIs are identifiedwith increasing rates of morbidity and mortality, prolonged length of stay (LOS), the development of Multidrug Resistant Organisms (MDROs), and the increase in cost of care that contribute to the economic burden on the healthcare sector[1-3]. The World Health Organization (WHO) defined HAI as an infection acquired by a patient in a hospital or any other healthcare facility during the process of care that was not present or incubated at the time of admission [4]. The HAIs that affect healthcare systems worldwide butaremore prevalent in developing than in developed countries. According to WHO estimates, 10% of patients in developing countries acquire at least one of the HAIs during hospital stay compared to 7% in developed countries [5].The HAIs are most prevalent in intensive care units (ICUs) than in other wards in the hospital[6, 7].The high prevalence rates of HAIs in ICUs are due to various risk factors, the ICU environment that can serve as reservoir for infectious agents[8, 9], the use of invasive devices in the treatment of critically ill patients[10, 11], thecritical health condition of ICU patients[12, 13], in addition to the long duration of antibiotic treatment of critically ill patients [6].A systematic review study showedthe highest recorded cases of HAIs were in ICUs in Europe and Asia [14]. In a systematic review study by Ling et al. conducted in Southeast Asia, it was reported thatthe pooled prevalence of HAIsin ICUs was 9% between 2000 and 2012, and that the HAIs mortality rate was between 7% and 46%. Whereas in Malaysia, the mortality rate of device-associated infections (DAIs) was estimated to be 6.5% among ICUs' patients.And the LOSat the hospitalwere increased between 5 to 21 daysfor patients with HAIs in Southeast Asia. While in Malaysia, the HAIs extended the patients' LOS at the hospital by 10 days[15].

The evidence-based knowledge and knowledge-based practice are vital preventive methods of HAIs. Thus, theCenter for Disease Control and Prevention (CDC) developed guidelines for Infection Prevention and Control (IPC) standard precautions practices ashand hygiene, Personal Protective Equipment (PPE), sharps safety, safe injection practice, and respiratory hygiene / cough etiquette[16]. Inadequate knowledge and practice of IPC precautions contributes to an increase in HAIs [6, 17, 18]. Despite the CDC guidelines issueda decade ago, various studies have been conducted and reported inadequate levels of knowledge and practices regarding IPC precautions.For instance, inadequate levels of knowledge and practice towards IPC precautions were reported among nurses in various studies, one conducted in Palestinian Hospitals [19], another study in Eastern Nigeria [20], another study in Iran[21], another study in Yemen [22], another study in Ethiopia [23], and another study regarding compliance with IPC standard precautions in Brazil and Hong Kong[24].

The investment in the development of IPC interventions is very useful and cost-effectivecompared to HAIs treatment [25]. Various interventions were developed and implemented, and their efficacy were assessed againstthe levels of knowledge and practiceof IPC standard precautions. A study in Iran developed a multicomponent education program regarding HAIs targeting nurses in ICU [26], another study in Spaindeveloped a multifaceted program to tackle the problem of Acinetobacter Baumannii endemic targeting HCWs in ICU [27], another study in Italy applied a multimodal intervention for HAIs prevention and control targeting HCWs in ICU[28], another study in Mexico implemented a multidimensional hand hygiene approach aimed at HCWs in ICU [29], another study in Indonesia developed a multifaceted program of hand hygiene directed at physicians and nurses in ICU [30]. However, the contents of these interventions,that were developed to improve specific IPC precaution,reveal a new room for improvement to enhance awareness and compliance toward IPC precautions.We developed a comprehensive multi-intervention IPC moduleto meet the needs of the adult critical care nurses,with the adoption of differentinstructional media,in order to maximize the effectiveness of the interventions toimprove awareness and enhance IPC practice[31]. The purpose of this study is to assess the effectiveness of the developed multi-intervention module on the knowledge and practice levels of adult critical care nurses towards the prevention and control of HAIs prevention, in ICUs.

Methods

Setting

This study was conducted in a tertiary care hospital in rural state in the northeast of Peninsular Malaysia. Four adult ICUs were included in this stud: Medical ICU, Surgical ICU, Neuro ICU, and Cardiothoracic ICU. The ICUs were selected by purposive sampling

methods taking in consideration the nature of ICU with respect to the HAIs to cover the four common types of HAIs (Central Line-Associated Blood Stream Infections (CLABSI), Catheter-Associated Urinary Tract Infections (CAUTI), Ventilator Associated Pneumonia (VAP), and Surgical Site Infections (SSI)). In addition to the willingness of their adult critical care nurses to participate in the study.

Study design

A one-group pretest-posttest quasi-experimental studywas conducted between 17 June to 30 November 2020. It was an open-label study since it did not include a control group and the researchers and the participants were aware of the study interventions. It was not possible to have a control groupas it was difficultto make two comparable groupswith respect to the nature of the interventions and the ICU characteristics, in addition to the risk of contamination biasdue to the long duration of the interventions.

Study Sample

All critical care nurses of the selected ICUs were invited to participate in this study. A structured questionnaire wasshared onlinewith the nurses in the specified ICUs (N=135). Only 121 nurses responded to the questionnaire and were included in the final analysis to assess their knowledge and practice levels before and after the implementation of the multi-intervention module. However, all the 135 nurses in the specified ICUs were invited to participate in the module sessions.

Study Instrument

A structured questionnaire was adopted from previous study conducted by Alrubaiee etal. to assess the knowledge and practice levels toward HAIs prevention and control among nurses in Yemen [22]. The questionnaire consisted of three sections:

Section 1 relates to demographic data which includes: age, sex, qualification, in-service training courses regarding HAIs prevention and control, work experience, and type of ICU.

Section 2 relates to knowledgeonHAIs prevetnion and control which consists of 30 items; hand hygiene (5 items), PPE (5 items), safe injection practice (4 items), routine hospital cleaning (4 items), reprocessing of patient equipment (4 items), safe linen handling (4 items), and safe waste handling and disposal (4 items). Each item was assessed with "Correct", "Incorrect", and "I don't know".

Section 3 relates to practice on HAIs prevetnion and control which consists of 15 items; precautions to prevent HAIs (9 items) and actual action to prevent HAIs (6 items). Each item was assessed with "Yes", "No", and "I don't know".

Scoring system

Thescores of knowledge and practice of adult critical care nursesin the prevention and control of HAIs were assessed by calculating the right responses. The right response was given a score of 1, while the wrong or "I don't know" responses were given a score of 0.

Pilot study

The study questionnaire was shared online with 35 of the adult critical care nurses (100% response rate) selected randomly from the specified ICUs nurses and Cronbach's alpha was used to assess the internal consistency reliability. The pilot subjects were also asked for their feedback on the clarity of the questionnaire items and any other comments. In addition to assessing the time required to complete the questionnaire.The accepted Cronbach's alpha cut-off point was determined to be good with a value of 0.7 and above[32].The average timerequiredto complete the questionnaire was found to be14.06 minutes. The Cronbach's alpha for the knowledge and practice sections were 0.847 and 0.776, respectively. All the questionnaire items were clearly understood, no clarification was neededand no comments were made by the pilot subjects.

Study Interventions

The Multi-Intervention Multimedia Infection Control (MIMIC) module was developed by using the Intervention Mapping (IM) protocol and Social Cognitive Theory (SCT) based on the needs of the adult critical care nurses. And to ensure that it is suitable for the adult critical care nurses and the objectives for which it was developed, the MIMIC module was validated by a panel of seven experts in the field of infection control, nursing education, medical education, microbiology,

and environmental healthusing theFuzzy Delphi Method (FDM).The MIMIC module consists of three interventions:

First intervention:Infection Control Education Program (ICEP). The ICEP focuseson providing a comprehensive education program for the prevention and control of HAIs. The education program consists of six different themescategorized under three main constructs, the first being fundamentals to understand IPC,that coverthree themes; (i) microbiology of infection, (ii) body defence mechanism, and (iii) administration of hospital infection control. The first construct concerns on enhancing self-confidence of the adult critical care nurses and improving their IPC practices[33-35]. The second construct related to IPC principleswhich includes: (i) standard precautions of IPC, and (ii) transmission-based precautions of IPC. While the third construct covered the definitions, prevention, assessment, and control of theHAIs (CLABSI, CAUTI, VAP, and SSI). The ICEP themes were explained with illustrations in *Nursing Guide to Infection Prevention and Control*, 9 posters, and 12 brochures.

Second intervention: Infection Control Monitoring System (ICMS). It is complementary to the HAIs surveillance system applied in the hospital.The ICMS consists of two components: the monitoring forms and the statistical tool for the CLABSI, CAUTI, VAP, and SSI. The digital formsaimed atenhancingnursing documentation and facilitatingpractices for theprevention andcontrol of HAIs. In addition to the role of the HAIs statistical tool,that facilitate the performance of monthly and annual HAI-related statistics reflecting compliance with the IPC precautions.

Third intervention: Infection Control Supporting Environment (ICSE). The ICSE is concerned withensuring an appropriate environment that facilitates the practice of IPC precautions. It consists of ensuring the availability of hand hygiene ana PPE supplies at the point of care,the requirements for waste management, the distribution of visual aids (posters) atprominentplaces , and the availability of quick access information sources (e.g. brochures).

TheMIMIC module wasimplemented between 13 July and 25 August 2020. In order to ensure the attendance of the maximum number of the adult critical care nurses in the MIMIC sessionsand incoordination with the Hospital Infections and Epidemiology Control Unit and the Nursing Department, the nurses were distributedinto three groupsaccording to their duty-shift time and their ability to attend the MIMIC'stheoretical sessions. Each group had three 2-hour theoretical sessionsthat held at the education room in the hospital, covering the ICEP and ICMS interventions. While for the practical section of the MIMIC module, each of the specified ICU had four 30-minute on-site training sessions in conjunction with theoretical sessions and coveredthe IPC precautions.The ICSE was implemented by making some improvements and changes to the specified ICU environments, in coordination with the hospital managements.The improvements and changes included ensuring availability of hand hygiene supplies, PPE, and waste management requirements at the point of care, the distribution of the developed MIMIC module posters at prominent placesand made the MIMIC module brochures available at the nursing station in each of the specified ICUs.In addition to the *Nursing Guide to Infection prevention and control*, ICMS manual, and ICSE guideline.

The instructional methods of the MIMIC module were extracted from the SCT and included consciousness raising, persuasive communication, modeling, feedbak, advance organizer, tailoring, and facilitation. In order to optimising the effectiveness of the MIMIC module, multimedia were used and included: printed materials, PowerPoint Presentation, visual reminders, digital HAIs monitoring forms, and graphic calculators. In addition to sharing MIMIC module sessions notes via e-mail.

Data collection

At the beginning of the study, an informative e-mail was sent to all head nurses and adult critical care nurses in the specified ICUs explaining the study and its purposes and the scope of their participation. The levels of knowledge and practice of the adult critical care nurses were assessed twice, once immediately before the implementation of the MIMIC module and for the second time 3 months after the MIMIC moduleviathe structured questionnaire.In compliance with the safety precautions declaredduring the COVID-19 pandemic that prohibited physical meeting, theself-administered questionnaire linkwas shared online with the adult critical care nurses

in the specified ICUs via their e-mails and,in orderto ensure high response rates, the questionnaire link was shared via the "WhatsApp" with the head nurses of the specified ICUs to sharewith their staff. In addition to the role of the Hospital Infection and Epidemiology Control Unit in motivating the adult critical care nurses to respond to the study questionnaire.

Data Analysis

Data entry and analysis were done using the Statistical Package for Social Science (SPSS) V 26. Frequency and percentage was used in qualitative data analysis. While mean and standard deviation was used to analyze numerical data. The One-way repeated measures ANOVA was used to compare the difference between means for knowledge and practice scores before and after MIMIC module. A p-value of <0.05 was considered significant. The cut-off point for the partial eta squared (ηp2) were determined to be .01, .06, and .14 for small, medium, and large effect size, respectively [36].Assumptions for performing ANOVA were checked and met. Bonferroni *post hoc* tests wereconducted to assess if there werestatistically significant differences between the four selected types of ICU in knowledge and practice scores mean.

Ethical Consideration

The study was approved by the Human Research Ethics Committee of XXX (approval code: XXX/JEPeM/19070440) and carried out in accordance with the guidelines for research ethics set out in the Helsinki Declaration of1964. Participants were assured their decision whether to participate or not will not affect their career.Their acceptance of their participationwas obtained through the signing of the study consent form.

Results

Participants demographics

Out of 135adult critical care nurses in the selected ICUs, 121 nurses responded to the study questionnaire at the two points of time (pre- and post-intervention), representinga response rate of 89.6%. The data in Table 1 indicate that the female nurses were the highest proportion of respondents with 86%, and almost two-thirds (67.8%) of respondents were in the 30-41 age group. The majority of respondents (90.1%) had Diploma qualification and more than half(57%) had experience more than 5 years and less than 15 years as a nurse.While 50.4% of respondents had experience more than 5 years and less than 15 years as a critical care nurse.Regarding workshops in prevention and control of HAIs, the results showed that 81.8% of the respondents attended HAIs relativeworkshops and 57% of them attended the workshops before one year and more. While the results showed that all respondents (100%) had experience with HAIs cases, and the experience of the majority (87.6%) was with VAP patients. The demographic data for both pre- and post-intervention were the same as for the same respondents details, except for the HAIs' workshops, since all respondents participate in MIMIC module sessions. In addition to increased experience with HAIs cases.

Table: 1 The distribution of the adult critical care nurses according to demographic characteristics (n= 121)

Demographic details	Total n (%)
Age	
18-29	31 (25.6%)
30-41	82 (67.8%)
42-52	8 (6.6%)
Sex	
Male	17 (14%)
Female	104 (86%)
Qualification Level	

Cont... **Table: 1 The distribution of the adult critical care nurses according to demographic characteristics (n= 121)**

Diploma	109 (90.1%)
BScN	12 (9.9%)
Experience as a nurse	
≤ 5 years	17 (14%)
> 5 years and < 15 years	69 (57%)
≥ 15 years	35 (28.9%)
Experience as a critical care nurse	
≤ 5 years	27 (22.3%)
> 5 years and < 15 years	61 (50.4%)
≥ 15 years	33 (27.3%)
Workshops about "hospital-acquired infections prevention and control"	Pre-test / post-test
No	22 (18.2%) / 0
Yes	99 (81.8%) / 121 (100%)
Last course you attended	Pre-test / post-test
Less than one year	30 (24.8%) / 121 (100%)
One year and more	69 (57%) / 0
Not Applicable	22 (18.2%) / 0
Experience with patients having hospital acquired infection	
Yes	121 (100%)
No	0
Experience according to the HAIs type	Pre-test / post-test
CLABSI	49 (40.5%) / 61 (50.4%)
CAUTI	65 (53.7%) / 74 (61.2%)
SSI	85 (70.2%) / 93 (76.9%)
VAP	106 (87.6%) / 111 (91.7%)

Effect of MIMIC module on adult critical care nurses' knowledge leveltowards prevention and control of HAIs

Thequestionnaire responses of pre- and post-intervention were analyzed and the results indicate an increase in the mean knowledge scoreover time.As presented in Table 2, One-way (within subjects)repeated measuresANOVAshowed a statistically significant effect of the MIMIC module on knowledge scores, $F(1, 120)= 632.679$, $p < .001$, $\eta p2 = .844$ with large effect size, indicating that 84.4% of the knowledge scores variation was described bythe implementation of the MIMIC module.

Table: 2*:* Mean, standard deviation and repeated measures analysis of variance for MIMIC module effect on knowledge scores (n=121)

	Pre-intervention		Post-intervention				
	M (95% CI)	**SD**	**M (95% CI)**	**SD**	**F(1, 120)**	**Sig. P value**	**Partial Eta Squared (ηp2)**
Knowledge Scores	18.68 [18.27, 19.08]	2.255	25.83 [25.44, 26.21]	2.151	632.679	< .001*	.844**

One-way repeated measures ANOVA within-subject results for the pre- and post-intervention knowledge scores.
The Sphericity andnormal distribution assumptions are reviewed and met.
*The mean difference is significant, P< .05.
**large effect size of the MIMIC module on improving the knowledge score, ηp2 = .844

As shown in Table 3, the one-way (between-subjects) repeated measures ANOVA indicated that the effect of the MIMIC module did not differ significantlybetween the four selected ICUs, $F(3, 117)= .321$, $p = .810$, ηp2 = .008 with small effect size, indicating that .8% of the knowledge scores variation was describedby the type of ICU.

Table 3*:* Mean, standard deviation and repeated measures analysis of variance for MIMIC module effect on knowledge scores within the four selected ICUs (n=121)

	Pre-intervention		Post-intervention				
	M (95% CI)	**SD**	**M (95% CI)**	**SD**	**F(3, 117)**	**Sig. P value**	**Partial Eta Squared (ηp2)**
Medical ICU	19.31 (18.66, 19.96)	1.804	25.53 (24.96, 26.38)	2.342	.321	.810*	.008**
Surgical ICU	19.04 (18.08, 20.00)	2.375	25.08 (24.25, 25.90)	2.038			
Neuro ICU	18.48 (17.68, 19.27)	2.470	26.13 (25.45, 26.80)	2.102			
Cardiothoracic ICU	17.74 (16.85, 18.63)	2.050	26.57 (25.76, 27.37)	1.854			

One-way repeated measures ANOVA between groups (four ICUs) results for the pre- and post-intervention knowledge scores.
The Sphericity, normal distribution and homogeneity of variance (between groups) assumptions are reviewed and met.
*The mean difference is not significant, P> .05.
**small effect size of the ICU type on improving the knowledge score, ηp2 = .008

Effect of MIMIC module on adult critical care nurses' practice level towards prevention and control of HAIs

The analysis showed an increase in the mean practice score over time. As presented in Table 4, One-way (within subjects) repeated measures ANOVA showed a statistically significant effect of the MIMIC module on practice scores, $F(1, 120)= 113.089$, $p < .001$, ηp2 = .492with large effect size, indicating that 49.2% of the practice scores variation was described by the implementation of the MIMIC module.

Table: 4 Mean, standard deviation and repeated measures analysis of variance for MIMIC module effect on practice scores (n=121)

	Pre-intervention		Post-intervention				
	M (95% CI)	**SD**	**M (95% CI)**	**SD**	**F(1, 120)**	**Sig. P value**	**Partial Eta Squared (ηp2)**
Practice Scores	8.79 [8.53, 9.05]	1.449	10.83 [10.55, 11.11]	1.564	113.089	< .001	.492
One-way repeated measures ANOVA within-subject results for the pre- and post-intervention practice scores. The Sphericity and normal distribution assumptions are reviewed and met. *The mean difference is significant, P < .05. **large effect size of the MIMIC module on improving the practice score, ηp2 = .492							

As shown in Table 5, the one-way (between-subjects) repeated measures ANOVA indicated that the effect of the MIMIC module was significantly differ between the four selected ICUs, $F(3, 117)= 6.805$, $p< .001$, ηp2 = .149 with large effect size, indicating that 14.9% of the practice scores variation was described by the type of ICU.

Table 5: Mean, standard deviation and repeated measures analysis of variance for MIMIC module effect on practice scores within the four selected ICUs (n=121)

	Pre-intervention		Post-intervention				
	Mean score [95% CI]	**Standard Deviation**	**Mean score [95% CI]**	**Standard Deviation**	**F(3, 117)**	**Sig. P value**	**Partial Eta Squared (ηp2)**
Medical ICU	9.63 [9.16, 10.09]	1.289	10.97 [10.49, 11.45]	1.332	6.805	< .001*	.149**
Surgical ICU	8.88 [8.26, 9.51]	1.558	11.38 [10.78, 11.99]	1.499			
Neuro ICU	8.20 [7.78, 8.62]	1.305	10.43 [9.94, 10.91]	1.517			
Cardiothoracic ICU	8.57 [8.01, 9.12]	1.273	10.70 [9.89, 11.50]	1.869			
One-way repeated measures ANOVA between groups (four ICUs) results for the pre- and post-intervention practice scores. The Sphericity, normal distribution, and homogeneity of variance (between groups) assumptions are reviewed and met. *The mean difference is significant, P < .05. **large effect size of the ICU type on improving the practice score, ηp2 = .149							

A *post hoc* Bonferroni analysis was performed to determinewhich instances of mean practice scores difference was statisticallysignificant among the four selected ICUs. The pairwise comparisonsindicated that the mean practice score difference between the Medical ICU andthe Neuro ICU was significant (p value < .001), and the mean practice score difference between the Surgical ICU and the Neuro ICUwas significant (p value = .010). While the pairwise comparison between the Medical ICU and the Cardiothoracic ICU, the Medical ICU and the Surgical ICU, the Surgical ICU and the Cardiothoracic ICU, and Neuro ICU and Cardiothoracic ICU indicated not significant differences in mean practice scores (p value = .106,p value = 1.00,p value = .509, and p value = 1.00, respectively). This implies that the MIMIC module had a significant effect on practice levels in the Medical ICU and the Surgical ICU.

Discussion

The aim of this study was to assess the effectiveness of the developed MIMIC module on the levels of knowledge and practice towards prevention and control of the HAIs among the adult critical care nurses. Out of 135 of nurses in the four selected ICUs, 121 nurses responded to the study questionnaire, indicatinga response rate of 89.6%,making the findings from the sample representative of the overall population of the four selected ICUs. In her book, Ann bowling described 75% of the response rate as good in health-related research[37]. In Another study,the minimum acceptable response ratewas determined to be 60% to minimize non-response bias[38].The high proportion of the respondents were females (86%) as they constitute the vast majority of the nurses in the four selected ICU (80.7% of the total nurses in the four selected ICUs were females). This result is somewhat consistent with the findingof a study conducted in Middle-East Hospital that reported the majority of respondents (66.7%) were female nurses [39]. Another study from Palestine showed more than half of respondents (56.1) were female nurses[19]. While our study result were inconsistent with what reported in a study conducted in Yemen that reported the majority of respondents (61.2%) were male nurses [22].High percentage (81.8%) of respondents attended workshops in prevention and control of HAIS. However, we revealed the need to engage all the respondents in HAI-related workshops and training programs asthe results showed 57% of them attended a HAI-related workshops before one year and more, in addition to 18.2% of respondents did not attend any workshops.

The MIMIC module was developed toprovide an evidence-based knowledge that facilitate knowledge-based practice.The adult critical care nurses' levels of knowledge and practice towards prevention and control of HAIs were assessed immediately before and three months after the MIMIC module. The results showed an improvement in the scores of respondents. The analysis of the knowledge and practice means variance between pre- and post-intervention tests showed the significant effect of the MIMIC module on improving the adult critical care nurses'knowledge and practice levels. limited studies have focused on the development and implementation of a comprehensive multi-intervention module or program related to the prevention and control of HAIs and directed at adult ICU nurses.Considering the differencesof the interventions used, the findings of this study are compatible with other studies findings that adopted a multi-intervention, multidimensional, multimodal, ormultifaceted IPC programs [27-30, 40-45].

Furthermore, this study is one of the fewin South-East Asiaconcerned with the provisionof a multi-intervention and comprehensive module related to the prevention and control of HAIs and developed on the basis of the needs of adult critical care nurses using the IM protocol and the SCT.And to the best of the researchers' knowledge, this study is the first of its kind in Malaysia. The MIMIC module is characterized by a comprehensive multi-component education programon IPC precautions and other themes that have shown their efficacy in enhancing self-confidence and risk perception among critical care nurses to improve HAIs prevention andcontrol practices. The ICMS intervention of MIMIC module helped as a source of knowledge that facilitate daily IPC practices and facilitates the prevention, assessment, and control of HAIs. While the third intervention (ICSE) provided a supportive environment for IPC practice. It is a promising module which can be implemented as Continuing Nursing Education (CNE).

Although this study has shown the efficacy of the MIMIC module in improving the levels of adult critical care nurses' knowledge and practice toward prevention and control of HAIs, there are a some of limitationsthat

need to be identifiedas having an influence on its results. The generalizability of the findings of the MIMIC modulemay be compromised by the fact that the study was performed on a small scale of nurses in one hospital, multicenter study is needed to determine the efficacy and scalability of the MIMIC module in various types of ICU in different hospitals. Another limitation is that the pretest-posttest design makes it hard to assess the sustainability and durability of knowledge and practice improvements for the prevention and control of HAIs which calls forlong-term follow up periods assessment. Since the multi-intervention module applied, it is difficult to assess the impact of each particular intervention.

Conclusion

To improve adult critical care nurses awareness and ability to prevent and control of HAIs, a comprehensive module is needed. This study contributed to implementing an integrated IPC module with multi-intervention that was not limited to IPC precautions and HAIs bundles of care, but also to other themesthat have proved to facilitate in the acquiring of evidence-based knowledge and the promotion of knowledge-based practice by enhancing adult critical care nurses' self-confidence and risk perception. Thus, we recommend the introduction of the MIMIC module into the Continuing Nursing Education (CNE) programs to ensure that all nurses have an equal opportunity to improve their knowledge and practice levels of prevention and control of HAIs.

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Competing Interest

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