Developing an Infection Prevention and Control Educational Program for Critical Care Nurses:Intervention Mapping Protocol and Social Cognitive Theory

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Abstract

Aim: This study aims to apply the Intervention Mapping protocol and Social Cognitive Theory in the development of an infection prevention and control education program aimed at critical care nurses.

Background: Education programs have been widely used to improve awareness toward infection prevention and control, but the development of an integrated theory- and evidence-based education program tailored to critical care nurses has not yet been discussed.

Subject and Methods: Data are from the Hospital Universiti Sains Malaysia infection control records. The 6-step Intervention Mapping protocol and the Social Cognitive Theory were used to develop an infection prevention and control education material tailored to critical care nurses. The educational material was also influenced by Previous literature, hospital infection control committee, and in-charge nurses of intensive care unit.

Results: The educational material was tailored to target knowledge, self-efficacy, and risk perception that identified as the individual determinants of critical care nurses health behavior during assessment phase. In addition to physical environment and organizational support that determined as external determinants. A matrix of change objectives was mapped out for each health behavior determinant, teaching methods, and their practical applications.

Conclusion: Applying the Intervention Mapping protocol and the Social Cognitive Theory is effective in developing educational material tailored to critical care nurses to improve their self-confidence and promote knowledge-based practice in infection prevention and control.

Keywords:*Infection Prevention and Control; Healthcare Associated Infections; Intervention Mapping; Social Cognitive Theory; intensive care unit; critical care nurse; Hospital Universiti Sains Malaysia.*

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Background

Intervention Mapping (IM) protocol is a framework that facilitates the development of an evidence-based education materials for an intervention program in health promotion and disease prevention fieldsand grounded on health behavior theoriesand enhance

their implementation[1, 2], and used to bridge the gap between the behavioral theories and their application in health promotion interventions [2]. Although the IM protocol is widely used in the development of health promotion programs, but it can also be used in the development of any intervention requiring change in behaviour [3]. The significance of the application of the IM Protocol is to describe the intervention developed and the effects of health behaviour theory adopted to promote the achievement of the objectives identified. In addition to developing strategies to ensure sustainability of the intervention program. The adopted health behaviour theory is Social Cognitive Theory (SCT), a multidimensional model that focuses on enhancing self-efficacy, perception of actions consequences, and environmental factors in order to achieve the desired change in individual's behaviour [4]. The application of IM protocol based on SCT to develop an education material for Infection prevention and control (IPC) intervention program that satisfy the needs of critical care nurses to reduce healthcare associated infections (HAIs) has not been addressed before.

HAIs are critical health problem defined as an infection that the patient acquires after 48 hours of being hospitalized [5]. The World Health Organizations (WHO) estimates that hundreds of millions of patients worldwide are affected by HAIs annually and indicated high risk in the developing countries, with 10% of hospitalized patients acquire at least one HAI at any time compared to 6-7% in developed countries [6]. The impacts of HAIs can be described as increased mortality and morbidity rates, prolonged length of stay, developing of multidrug resistant organisms (MDROs), and increased economic burden [7, 8].

Patients who are admitted in intensive care units (ICUs) are at high risk to acquire HAIs which is associated with their critically ill conditions, the need for invasive devices in their care (urinary catheters, endotracheal tubes, and central venous catheters), comorbidities, and impaired immune system [9]. According to the WHO healthcare-associated infections fact sheet, the HAIs in intensive care units is 2-3 times higher in low and middle-income countries compared in high-income countries [10]. The largest portion of care in ICUs are provided by the critical care nurses who are known to be the vast majority of the healthcare team who have a daily direct contact with patients. Many studies have touched upon the important role of nursing staff in the transmission of HAIs[11-13]. An IPC program targeting critical care nurses at the ICU will help in preventing HAIs and improve the quality of health care [14]. Low knowledge level is a major contributor to high HAIs rates worldwide [8, 15]. And the need for educational programs is now critical to improve the knowledge and practice levels of IPC among nurses [16].

Various studies conducted in Hospital Universiti Sains Malaysia (HUSM) have identified the need for an IPC program to tackle the HAIs problem. One study reported that 74% of HUSM healthcare professionals in critical care units have more than 50 colony-forming units (CFUs) of microorganisms on their hands and concluded that there is a need for a program to promote effective hand hygiene techniques [17]. Another study revealed the need to update the IPC protocols of HUSM and emphasized on the need for post-operative follow-up system to prevent SSI, especially in high risk patients who had open heart surgery and diabetic patients [18]. And as the development of MDROs, especially in ICUs, is a critical health issue, a study reported that 13.6% of the total mortality rate in critical care units in HUSMwere related to Carbapenem Resistant Acinetobacter (CRA) [19], which is make the development of an effective and comprehensive education program to understand the proper use of antibiotics is a crucial need.

The majority of the studies conducted educational programs to improve the awareness in one or more competencies of IPC (e.g. hand hygiene) [20-22], but studies that focus on the development of an integrated educational program that covers multicomponent of IPC competencies, in addition to the fundamentals to understand IPC and satisfying the requirements of critical care nurses are very limited.

The contribution of this paper is to describe the

development of tailored educational material for an intervention program directed at critical care nurses at HUSM. Another contribution of this study is to expand the scope of IM protocol application to include the development of education materials to be used in an IPC intervention program and the use of Social Cognitive Theory (SCT) to improve critical care nurses awareness and their compliance toward IPC.

Materials and Methods

The education material has been developed in conjunction with the WHO's guidelines on health education [23] and using the Intervention Mapping (IM) protocol [1]. In addition to Social Cognitive Theory (SCT) that enhances health behaviour change by applying theory-based teaching methods.

Step 1: Needs Assessment

The education material will be used in an intervention program aimed at adult critical care nurses at HUSM and, thus, in order to identify the needs and capacities of the hospital and the target group, the assessment phase consisted of three strategies:

First strategy: Assessment of HUSM infection control system

The assessment of HUSM infection control system was performed by using the Centers for Disease Control and Prevention (CDC) IPC Assessment Tool for Acute Care Hospitals [24]. The assessment tool focused on assessing the applied infection control program and infrastructure.

Second strategy: Healthcare-Associated Infections Prevalence Rates

The hospital infection control records were reviewed and a one-year prevalence rates of HAIs were obtained and analyzed from 1st of January 2019 to the 31st of December 2019 for HUSM adult ICUs (neuro ICU, medical ICU, surgical ICU, and cardiothoracic ICU).

Third strategy: Cause and Effect Analysis of the Problem

A cause-and-effect is a method used to identify potential causes of the problem under study, which can then be organized in a structural format called the "fishbone diagram" [25]. This method is unique in that it encourages both creative thinking and brainstorming in the process of breaking down the problem to find its solutions.

The assessment phase findings were discussed with the Hospital Infections and Epidemiology Control Unit staff and the ICUs infection control link nurses who were invited to brainstorming sessions to identify the main and sub-causes of the problem in the ICUs at HUSM.

Step 2: Setting of objectives

The aim of step 2 of the IM protocol is to establish a framework for the development of the proposed education material that will be used in an intervention program by determining what will improve as a result of the intervention [1]. This step is achieved by working on the overall objective of the education material which is to increase knowledge and practice levels toward IPC among critical care nurses to reduce HAIs. A set of performance objectives (POs) was then identified from the overall objective and established on the basis of the findings of the needs assessment (step 1) and taking into consideration the viability of carrying out the IPC education program activities with the available HUSM resources. After determining the POs, a matrix of change objectives (COs) was created to link the POs to the identified determinants of critical care nurses behavior.

Step 3: Program design

The third step of IM protocol involves the identification of the theory-based instructional methods that can contribute to the attainment of behavior change objectives and the practical applications that can operationalize these methods [1].

The methods to be applied to different aspects of the developed education material have been based on Social Cognitive Theory (SCT), a commonly used theory of behavior change that has been applied in health

promotion and disease prevention [4, 26, 27].The SCT is a multidimensional model wherein beliefs in individual abilities act together with objectives, perceptions of the outcomes of particular action, and environmental factors in determining individual's behavior [4].

Step 4: Program development

The fourth step of IM protocol concerns on the development of the educational material. In this step, the teaching methods and their practical applications which addressed in step 3 will be used for attaining the objectives identified in step 2 to ensure development of the education material that suits the critical care nurses and meet their needs which determined in step 1 [1]. The educational material resources were based on web-based content published by CDC, WHO, Malaysian Ministry of Health (MMOH), and the Association for Professionals in Infection Control and Epidemiology (APIC). In addition to literature on relevant topics.

Step 5: Program implementation

The fifth step in IM protocol focuses on how to adopt, implement, and sustain the education-intervention program [1]. It is a crucial step that should be properly considered during the development of the education material in order to ensure that it will be translated into practice and to fulfill the purposes of the program.

Step 6: Evaluation plan

In step 6, the IM protocol focuses on developing an evaluation plan for the process and effectiveness of the educationprogram [1].

Process evaluation

The Hospital Infections and Epidemiology Control Unit and the Nursing Department were engaged in the development of the education material and the outcomes of each step were discussed and evaluated with them.

Effectiveness

The main goal of the developed education material is to improve the knowledge and practice levels of critical care nurses toward IPC. We determined the interventional study design, and the data collection and analysis methods to assess the effectiveness of the education material to the target group.

Results

Step 1: Needs Assessment

In this phase, High HAIs prevalence rates confirmed the need to develop an IPC education material aimed at critical care nurses to improve their awareness and practice. The brainstorming sessions, taking into consideration the findings of the qualitative studies reviewed, the HUSM infection control assessment, and HAIs prevalence analysis, ended in the description of the causes of the study problem in the fishbone diagram (Figure 1).

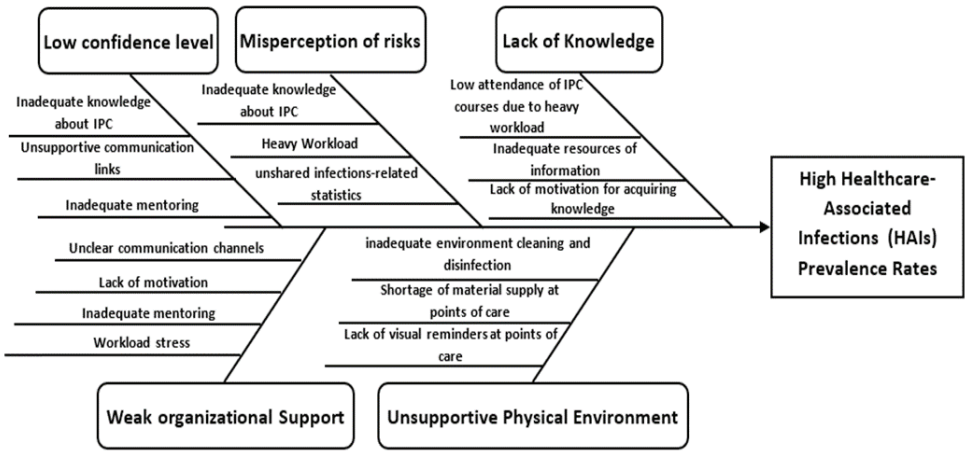

Figure 1 Fishbone diagram of the study problem

The changeable determinants of IPC practices that identified in needs assessment phase and as supported in the qualitative studies [28-33] were knowledge, self-efficacy, and risk perception at the individual level. Whereas at the external level, changeable determinants were physical environment, and organizational support. The resulting information served to determine the needs to develop an education material for an intervention program to counter the HAIs in HUSM.

The needs assessment findings were summarized into logic model of the health problem (HAIs), shown in Figure 2. This model outlined the causes of the HAIs identified by the needs assessment and the key determinants of behavior related to individual and external levels [1].

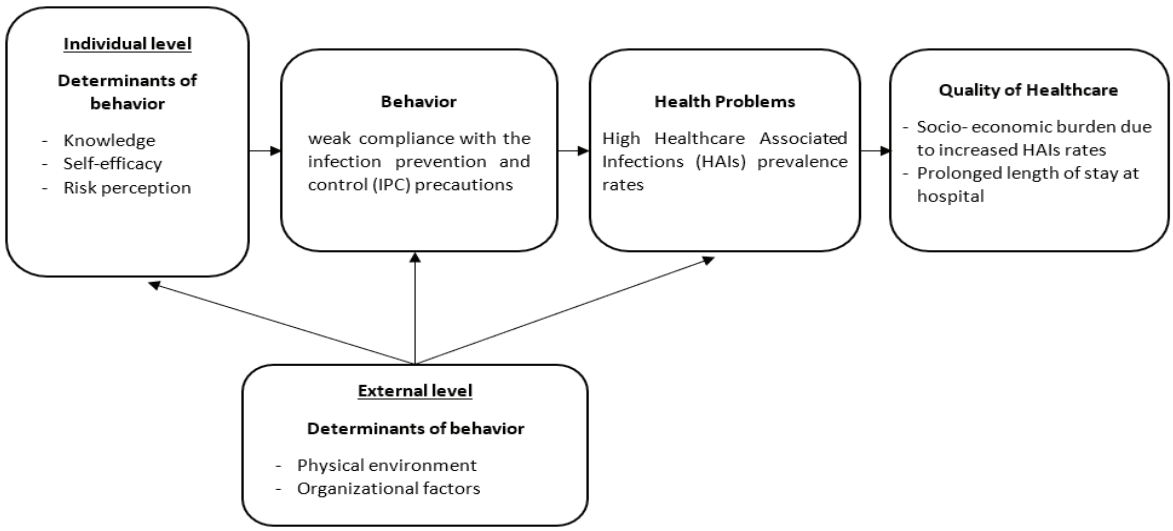

Figure 2: Logic model of the health problem (HAIs) based on needs assessment

Step 2: Setting of objectives

The education material objective is to increase knowledge and practice levels toward IPC among critical care nurses to reduce HAIs. This objective has been subdivided into POs(Table 1). The POs were formulated on the basis of the WHO's guidelines on health education [23] and debated with the HUSM infection control committee. To change the behavior of critical care nurses, a matrix of change objectives (COs) was established by combining the POs with the relevant important and changeable determinants of behavior

Step 3: Program design

The appropriate theory-based methods, based on the adopted SCT, for each of the individual and external determinantsare then determined through discussion with theHospital Infections and Epidemiology Control Unit at HUSM to ensure that they fit the education material context and characteristics of the critical care nurses. The determined theory-based methods included: consciousness raising, persuasive communication,advance organizers, tailoring, modeling, feedback, empowerment, facilitation, and developing new organizational network linkages

Step 4: Program development

The education material named as *Nursing Guide to Infection Prevention and Control* and it consists of three main constructs explained over six different chapters (Table 1).A glossary of IPC terminology that was added at the beginning of the developed material and arranged alphabetically. For learners to construct knowledge, they require to integrate new knowledge with knowledge that are in their cognitive structure [34], so that the educational material developed based on the results of critical care

nurses needs assessment in step 1 [1]. And in order to facilitate understanding and building new knowledge, the educational material takes the form of contextual strands that are strongly integrated in such a way as to ensure tackling complex tasks in IPC.

After developing and designing the needed material, thetopics were discussed with the Hospital Infections and Epidemiology Control Unit at HUSM to ensure its suitability and applicability to the critical care nurses. Then, the material was reviewed by the research team in terms of content's relevancy and clarity, spelling, and using of infographics.

Table: 1 Nursing Guide to Infection Prevention and Control Framework

Content	Performance Objectives(POs)	Teaching method
1. Microbiology of Infection 1.1. Types of microbes 1.2. Pathogenesis 1.3. Factors affecting the establishment of infection in the body 1.4. Chain of infection	1. Perform assessment of appropriateness of prescribed antibiotic in light of culture and sensitivity test results 2. Prevent susceptible patients from acquiring pathogenic microorganisms 3. limit the spread of antimicrobial resistant infections 4. Promote nursing staff role in IPC	Consciousness raising Persuasive communication Advance Organizers Tailoring
2. Body Defence Mechanism 2.1. Body defence lines 2.2. Adaptive immunity 2.3. Sources of infections	1. Describe the difference between innate immunity and adaptive immunity 2. List the classic signs of inflammation	Consciousness raising Persuasive communication Advance Organizers Tailoring
3. Administration of hospital infection control 3.1. IPC program 3.2. Infection control team 3.3. Infection control committee	1. Explain the scope of responsibilities and skills required of competent of infection control team personnel 2. Identify the liaison links of nursing staff in infection control issues 3. Reduce nursing staff stress 4. Promote nursing staff role in IPC	Consciousness raising Persuasive communication Advance Organizers Tailoring Facilitation Developing new organizational network linkages
4. Principles of IPC standard precautions 4.1. Definition of IPC 4.2. Hand Hygiene 4.3. Personal Protective Equipment (PPE) 4.4. Respiratory hygiene / cough etiquette 4.5. Safe injection practice 4.6. Waste management 4.7. Sharps safety 4.8. Decontamination of medical devices and environment at healthcare facilities 4.9. Transport of patients 4.10. Management of visitors	1. Identify the means by which communicable diseases are transmitted 2. Identify the components of standard precautions 3. Implement a targeted IPC practice to break the chain of infection links 4. Identify what, when, and how standard precautions should be performed 5. Ensure nursing staff safety 6. Promote nursing staff role in IPC 7. Ensuring an adequate clean and hygienic environment 5. Ensuring supportive environment for hand hygiene compliance	Consciousness raising Persuasive communication Advance Organizers Tailoring Modeling Empowerment Feedback Facilitation Developing new organizational network linkages

Table 1: *Continue,:* **Table: 1 Nursing Guide to Infection Prevention and Control Framework**

Content	Performance Objectives (POs)	Teaching method
5. Principles of IPC transmission-based precautions 5.1. Contact precautions 5.2. Droplet precautions 5.3. Airborne precautions	1. Identify the components of transmission-based precautions 2. Implement the transmission-based precautions to prevent or reduce the risk of healthcare associated infections 3. Identify what, when, and how standard precautions should be performed 4. Ensure nursing staff safety 5. Promote nursing staff role in IPC 6. Ensuring an adequate clean and hygienic environment 7. Ensuring supportive environment for hand hygiene compliance	Consciousness raising Persuasive communication Advance Organizers Tailoring Modeling Empowerment Feedback Facilitation Developing new organizational network linkages
6. Healthcare Associated Infections 6.1. Central line-Associated Bloodstream Infections (CLABSI) 6.2. Catheter Associated Urinary Tract Infections (CAUTI) 6.3. Ventilator Associated Pneumonia (VAP) 6.4. Surgical Site Infections (SSI)	1. Explain the common HAIs 2. Implement assessment strategies for early detection of HAIs 3. Implement the bundles of care to prevents HAIs 4. Ensure nursing staff safety 5. Promote nursing staff role in IPC 6. Ensuring an adequate clean and hygienic environment 7. Ensuring supportive environment for hand hygiene compliance	Consciousness raising Persuasive communication Advance Organizers Tailoring Modeling Empowerment Feedback Facilitation Developing new organizational network linkages

Step 5: Program implementation

To optimize adoption and implementation, an introductory meeting will be scheduled prior to commencement of the education program with the higher management of the HUSM, Hospital Infections and Epidemiology Control Unit, and Nursing Department. This meeting will be arranged to provide a brief overview of the education material and its' components, the role of the higher management, Hospital Infections and Epidemiology Control Unit, and Nursing Department, and to facilitate communication and collaboration between them and the research team. Another vital element of any education-intervention program, once implemented, is to improve its' sustainability [(1)]. So that, in coordination with the Hospital Infections and Epidemiology Control Unit, and Nursing Department, the education-intervention program will be part of continuous nursing education (CNE) program and the participants will be granted continuing professional development (CPD) points, in addition to adopting the educational material as a part of periodic validation of IPC competencies for critical care nurses.

At the critical care nurses level, to improve adoption, the HUSM represented by the Nursing Department and Hospital Infections and Epidemiology Control Unit will inform the participants about the educationprogram and the importance of their participation, and an attractive posters will be designed that will briefly explained the education program. In addition to the participant consent form that will contain description of the education

program and its' effects on improving their knowledge and practice toward IPC and how that will improve the quality of health care and protect the health of patients, healthcare workers, and visitors, and scope of critical care nurses participations. The consent form will be distributed on critical care nurses to sign and grant their agreement to participate in the education program. The program instructor will motivate the participants during the program sessions to improve implementation. In order to improve sustainability by the critical care nurses, counselling via email or telephone will be provided by the instructor and the Hospital Infections and Epidemiology Control Unit.

To ensure adoption and implementation of the developed education material to be used for an intervention program in the way that fulfill the purposes of what it designed for and to ensure participation of all critical care nurses, a guideline for the implementation of the education programis mapped out and will be provided to the Hospital Infections and Epidemiology Control Unit, and Nursing Department.

Step 6: Evaluation plan

Process evaluation

The developed educational material was discussed and reviewed with the Hospital Infections and Epidemiology Control Unit and Nursing Department and they affirmed that the development process adopted resulted in the appropriateness of the education material to be used as an education program with respect to the objectives defined in step 2 and the assessment findings (step 1) of critical care nurses' needs and the implemented infection control system.

Effectiveness

According to the education material development objective, which determined on the basis of the needs assessment in step 1, the hypothesis will test whether the knowledge and practice toward IPC among critical care nurses improved after applying the education program compared to before the program.

The effectiveness of the developed education material will be evaluated in one group pre- and post-test quasi experimental study. The total of 138 adult critical care nurses of medical ICU, surgical ICU, neuro ICU, and cardiothoracic ICU will be included in the study. A closed-ended and valid questionnaire which developed according to the WHO IPC precautions will be used to assess the impact of the educational material as an intervention program on the knowledge and practice of the targeted group. It will be assessed two times, before and 3 months after the implementation of the education program.

The difference between pre- and post-test will be analyzed through repeated measures ANOVA. The analysis will be done by using the Statistical Package for the Social Sciences (SPSS) Ver 26 with CI-95% and P value ≤ 0.05.

Discussion

IM protocol is now widely being used to plan, implement, and evaluate interventional programs for disease prevention, and that will increase, significantly, the uptake of these programs [2].

This study is one of the few focusing on the development of education material for an intervention program in the field of IPC at healthcare setting targeting critical care nurses. It describes the development, implementation, and evaluation of an educational material to be used for an intervention program to improve the levels of IPC of critical care nurses based on evidence-based knowledge, using the IM protocol [1].

Our study has come out with results that assure the usefulness of IM protocol for designing IPC education material. The significance of IM protocol arises from identification of individual and external determinants of IPC practice which was the start point of developing education material. The needs assessment indicated the importance of individual factors such as having adequate knowledge, self-efficacy, and risk perception as well as external factors that reflected by the physical environment and organizational support in changing

their behavior and promoting their compliance with IPC precautions. Taking these determinants into account, it helped in developing the *Nursing Guide to Infection Prevention and Control* material which aims to enhance the self-confidence of critical care nurses by acquiring evidence-based knowledge for practice of IPC and clarifies the risks of incompliance with the precautions of IPC. The developed education material also focuses on the role of suitability of hospital environment and providing of organizational support on facilitating the IPC practice. For example, in order to clarify the individual determinants, the critical care nurses role in the prevention of MDROs development as a result of incorrect prescription of ineffective antibiotics can be viewed as having confidence to review the prescribed antibiotic in the light of the results of culture and sensitivity test and the confidence to discuss with the attended physician in case of incorrect prescription of antibiotic. The self-efficacy of critical care nurses is based on their knowledge in microbiology of infection and their perception of the risk of developing MDROs. Clear understanding of the microbiology of infection reflects on enhancing implementation of IPC practices and ensuring patients and healthcare workers safety [35]. The external determinants can be described, for example, as the suitability of the hospital environment and availability of IPC supplies at the point of care in addition to the motivation of critical care nurses to minimize the stress of work to ensure better practice of IPC precautions.

The findings of the needs assessment (step 1) were consistent with the barriers that many studies concluded to IPC compliance by healthcare staff [28-33].

IM protocol recommends that the development of an education material for an intervention program should be on the basis of health behavior theory to plan and implement the education-intervention program [1]. Health behavior theory helps to determine the teaching methods to be applied to ensure achievement of performance objectives (POs) and change objective (COs) and suit the target group and ensure their adoption and implementation of the education-intervention program. Consciousness raising, persuasive communication, advance organizer, tailoring, modeling, feedback, empowerment, facilitation, and developing new organizational network linkage were the planned teaching methods to be used in implementation of the *Nursing Guide to Infection Prevention and Control* which were extracted from the Social Cognitive Theory [36].

The usefulness of Social Cognitive Theory (SCT) in *Nursing Guide to Infection Prevention and Control* material development and implementation is in consistence with the results of many studies. One systematic review study revealed that the SCT was the most frequently used framework in driving healthcare practice behavior change [37]. In our study, the focus is to improve the critical care nurses belief in their ability to execute IPC precautions that based on cognitive (personal) factors of acquiring evidence-based knowledge through well-developed education material, and this is supported by SCT [36]. The SCT focuses on understanding of individual behavior as the function of their perceptions that affected by variant cognitive variables which include knowledge, perception of threats, expectations of outcomes, motivation, and social pressure [38].

The strategies that have been used to ensure adoption, implementation, and sustainability of the education-intervention program depend on keenness of the research team to involve the higher management, hospital infections and epidemiology control unit, and the critical care nurses in the process of development the education material. At the critical care nurses level, they will be encouraged by the Nursing Department and the Hospital Infections and Epidemiology Control Unit to participate in the education-intervention program as it will be adopted as periodic validation program of IPC competencies, and the importance of the education-intervention program will be explained through attractive posters and the distribution of participant consent forms that contains description of the program and its importance, in addition to motivating them during the implementation of the program by the research team.

Conclusion

In this study, IM protocol facilitate understanding of actual critical care nurses needs and the barriers to compliance with IPC precautions. And It is effectively enhancing the development of an integrated educational material that satisfy the needs of critical care nurses across three interlinked contextual strands, including: fundamentals to understand IPC, principles of IPC, and specific IPC.

The teaching methods that extracted from the adopted SCT, facilitate the development of education content that will enhance achievement of the desired individual's behaviour change. The application of IM protocol based on SCT was successfully guide the development of critical care nurse-oriented, feasible, and an integrated education material to be used in an intervention program to improve awareness and increase compliance with IPC to reduce the HAIs.

Ethical Approval

The study has been approved by the Human Research Ethics Committee of HUSM (approval code: HUSM/JEPeM/19070440) and carried out in compliance with the research ethics guidelines outlined by the 1964 Helsinki Declaration.

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Competing Interest

The authors declare no competing interest. This study was funded by Research University (Individual) Grant (RUI grant No.: 1001.PPSK.8012373) of USM. The funder had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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