

Improving Infection Control Practices: A Module of Education of Nurses In-Training

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Abstract: In developing countries, nurses do receive infection control (IC) training before graduation. However, their actual IC performance is unfavorable. That could be due to the current ineffective education/training strategies. The aim of the present study was to assess the impact of applying nurses in-training education module on the knowledge and skills of nursing student in standard IC practices. An intervention pre-test-post-test study was carried out including all first grade nursing students (n= 58) in the Technical Nursing Institute (TNI), Faculty of Medicine- Cairo University- Egypt. Three-days training course included lectures about IC guidelines, practical demonstration and learning by doing under observation for: routine hand hygiene, cannula insertion, scoop technique, cleaning thermometers. The intervention was based on updated IC basic-curriculum and pre-test findings. Pretest for assessment of knowledge (using self-administered questionnaire) and skills (using checklist for recording observed performance in 4 demonstration stations) to have base-line scores. Post-test was done two days and six months after training. The three groups of data were analyzed using Wilcoxon and t test with 95% confidence level and $p < 0.05$. Results displayed that the mean knowledge scores of trainees showed significant improvement from the baseline level (53.2 ± 9.2) to be 89.7 ± 7.3 immediately and 74.2 ± 8.8 six months after training ($p < 0.001$). The mean skill scores of trainees showed significant improvement from the baseline level (52.3 ± 12.7) to be 81.7 ± 13.7 immediately after training. Six months after training the mean skill score was 55.3 ± 11.8 with statistically insignificant difference from the base line level ($p=0.77$). The skill types of lowest scores were those requiring multiple steps and invasive procedures. In conclusion: IC education of nurses in-training by observation has to be a continuous process at less than six months intervals to build up the capacity of nurses in sustaining standard IC practices.

Key words: Infection control curricula • Observation • Nurses in-training • Invasive procedures

INTRODUCTION

Education in infection control (IC) has been identified as essential strategy in any health care setting. Improving knowledge and behavior of health care workers (HCWs) who may act as sources of pathogenic agents in hospitals could reduce spread of hospital-associated infections (HAIs) [1]. As future practitioners in supporting IC, capacity building of nursing students to develop appropriate skills in IC is crucial for quality of health care [2]. Continuous training of nurses has been adopted by Egypt health system- but as sporadic activities [3].

Despite having international standards of practice in IC [4], developing countries are 20 times more at-risk of contracting HAI than developed countries [1]. In Egypt, the prevalence of health system-related infections such as hepatitis C virus infection is very high (14% among those

above 15 years of age) [5] and sepsis rate in a number of neonatal intensive care units reached as high as 70% [6]. Improving adherence to IC standard precautions has been the aim of many interventional studies focusing on behavioral changes of HCWs [7]. However, those studies were mostly conducted for officially practicing - not the undergraduate – nurses.

Nurses do receive IC training before graduation; however, their actual IC performance is still unfavorable especially during night shifts in critical health settings as neonatal emergency care units [8].

In the developed world, the objectives and structure of training curricula have been debated extensively especially regarding integration of special evidence-based topics related to patient safety [9, 10]. Moreover, surveillance and multistate surveys are usually conducted for immediate decision making for IC [11].

On the other hand, in developing world; including Egypt, there is no enough information about the educational needs of nurses in the area of IC [10]. The Egyptian Ministry Of Health and Population (MOHP), 2003, issued the "National Guidelines for Infection Control" [6]. The extent of integration of those guidelines in nursing education curriculum was not assessed.

Training in IC is implemented as an independent course for the first year nursing students in Technical Institute of Nursing - Cairo University (TIN-CU) -Egypt. The course includes both theoretical component and skill lab training. First year students TIN-CU will be graduated in two years. They will officially leading an independent IC practice. Therefore, there are needs to update strategies in IC training. The study conducted by Sherertz and colleagues [12], provided evidence that education of physicians-in-training could improve outcomes of IC in invasive procedures. Therefore, the presented study aimed at assessment of introduction of IC education of nurses-in-training on nursing students' knowledge and skills in standard IC practices.

MATERIALS AND METHODS

The study was conducted in TIN-CU and Public Health department – Faculty of Medicine - Cairo University (PH-FM-CU) over a period of nine months from Jun 2012 to Feb 2013. An intervention pretest-posttest design was used. The study participants were all first year (academic year 2011-2012) TIN-CU students who completed and passed the exam of the traditional TIN- IC course. Fifty eight students participated in pretest, training and posttest.

The Study Was Conducted in Six Phases: *Phase (1):* Assess students' existing IC curriculum (theoretical and practical components) using the national basic IC guidelines issued by Egypt Ministry Of Health and Population (EMOHP), 2003 [6], as a standard reference. Those guidelines were presented in ten chapters (importance of IC, hand hygiene, personal protective equipment (PPE), aseptic technique, environmental cleaning, disinfection and sterilization, waste management, isolation precautions, linen management, anti-microbial resistance). The national guidelines were then enlisted in 82 items so as to facilitate content and gap analyses to detect absent or incompletely represented items in the existing curriculum. *Phase (2):* Explore students' opinion regarding the existing IC course was done to help investigators tailoring the training strategies to suit the students' educational needs. Self-administered

questionnaire was used to cover aspects such as convenience of class rooms, sufficiency of the theoretical and practical components of the curriculum, easiness of the curriculum language, students' interest in learning IC and whether they received any extracurricular IC training. *Phase (3):* Assess students' baseline knowledge in IC: using a self-administered questionnaire which covered items related to the following areas: importance of IC, ways of infection transmission in hospitals, hand hygiene, personal protective equipment (PPE), aseptic technique, environmental cleaning, disinfection and sterilization, waste management, isolation precautions, linen management, anti-microbial resistance. Each area was coved by a number of questions proportionate to its weight in the national IC guidelines. All questions were close-ended. *Phase (4):* Assessing students' baseline skills in IC using standardized observation checklist. Assessment was performed in the institute's skill laboratory. Items of the checklist were related to four basic IC skill areas: routine hand hygiene, cannula insertion, scoop technique and thermometer cleaning. Each area was broken into steps. *Phase (5) (study intervention phase):* Training package was developed according to the results of Phase 1, 2 and 3. To motivate the students about attendance a declaration was made that participants will get an official certificate of attendance issued by the public health department and TIN-CU. Training course was conducted along three consecutive days. Guidelines were discussed followed; immediately, by their practical application through passing through for demonstration stations. Each theoretical session was immediately followed by educational observed practical application (in-training education) for each student. *Phase (6):* Post intervention assessment was done using the knowledge questionnaire and skill checklist. This assessment was done twice; two days after the training course then six months later (to measure retained knowledge and skills).

Data Management: For qualitative data (i.e. Nurses' IC curriculum) content analysis was done. For quantitative data (i.e. pretest and posttest questionnaires and observation checklists) scoring for items was done. For each question (or observed practical item), the student gets one mark if the answer (or performance) is correct and zero mark for the incorrect answer (or performance). For each student, we calculated the percent score in each IC area (subtotal score) and the total percent score for the whole questionnaire and observation checklist. Then we calculated the median percent scores (subtotal and total) for all students.

Data Analysis: The data were coded and entered using the SPSS (Statistical Package for Social Science) version 15.0 (IBM, SPSS, USA). The data was summarized using descriptive statistics. For quantitative variables, Wilcoxon Signed Ranks and t tests were used to detect significant differences between groups. P- Values less than 0.05 were considered statistically significant.

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Ethical Considerations: The study proposal was approved by the research ethics committee of the Public Health Department, Faculty of Medicine, Cairo University and the administration of the TNI, Cairo University. All the included students were treated according to the Helsinki Declaration of biomedical ethics. Verbal consent from each student was obtained after proper orientation of the students regarding the objectives of the study, the data confidentiality, as well as, the impact of the study (WMA Declaration of Helsinki, 2000).

RESULTS

Content Analysis of the Students' Existing IC Curriculum: The national basic IC guidelines EMOH, 2003, were categorized into 82 items. Fifty percent (n. = 41) of those items were missing in the TNI IC curriculum. The missing items were related to the following IC areas: Importance of IC, hand hygiene, PPE, aseptic technique, environmental cleaning, disinfection and sterilization, waste management.

Students' Perspectives Towards the Existing IC Course,

Figure (1): Less than half of the students agreed that IC curriculum teaching is easy and clear and less than third of them saw their curriculum as sufficient. About 41% of the students found difficulty in studying IC in English. Most of the students found that applying IC in lab was useful and those who disagreed attributed their dissatisfaction to the presence of too many students in the same lab, time was not enough for application and lack of enough equipment in the lab. The majority of the students were interested in IC course. More than 60% of the students agreed that the institute gives attention to IC.

Students' Knowledge in IC Throughout Three

Measurements: Table (1) illustrates the changes over two points of time after training (immediate and six-months post-training). Immediate measurements i.e. two days after training, the students demonstrated statistically significant ($p < 0.05$) improvement in knowledge score that reached a median percent of 100% in 12 out of the total 14 items. However the situation was different among ex-trainees six months after training. Sustainability of knowledge level was kept higher than the baseline with attrition in the level of IC knowledge regarding use of gloves ($p = 0.167$).

Student Skills in IC Throughout Three Measurements:

Table (2) demonstrates the median percent score for the four items of IC skills before and after training of nurses.

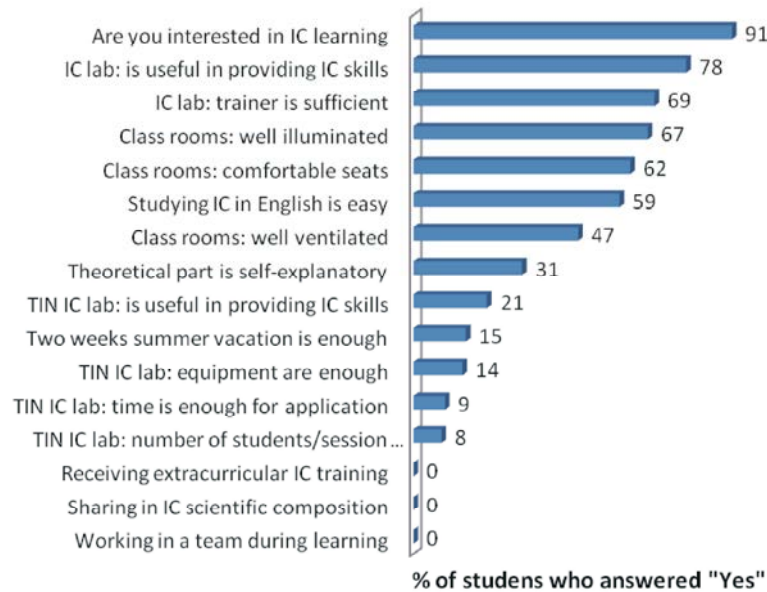


Fig. 1: Percent of the nursing students (n. = 58) according to their opinion about infection control (IC) course at the Technical Institute of Nursing (TIN), Cairo University, Egypt

Table 1: Knowledge percent scores in pretest, immediate posttest and second posttest among nursing students

Knowledge Items	Median percent score			P values*		
	Pre-test	Post-test A	Post-test B	P1	P2	P3
1.Importance of IC program	75.0	100.0	100.0	<0.001	0.042	0.001
2.Ways of infection transmission	50.0	100.0	100.0	<0.001	0.001	0.002
3.Proper hand hygiene method	33.3	100.0	66.6	<0.001	<0.001	0.002
4.Indications of hand hygiene	60.0	100.0	80.0	<0.001	<0.001	<0.001
5.Proper use of gloves	66.6	100.0	100.0	<0.001	0.167	0.003
6.Types of gloves	33.3	100.0	100.0	<0.001	<0.001	0.006
7.Risk assessment and management	50.0	100.0	83.3	<0.001	<0.001	<0.001
8.Aseptic technique	33.3	100.0	66.6	<0.001	0.009	<0.001
9.Isolation precautions	33.3	66.6	66.6	<0.001	0.008	0.077
10.Environmental cleaning	66.6	100.0	66.6	<0.001	0.002	0.008
11.Cleaning, disinfection and sterilization	50.0	100.0	50.0	<0.001	0.001	<0.001
12.Classification of equipment	62.5	75.0	62.5	<0.001	0.012	0.003
13.Waste disposal	66.6	100.0	91.6	<0.001	<0.001	<0.001
14.Needle stick injuries	50.0	100.0	66.6	<0.001	0.011	<0.001

P1 is between pretest and immediate posttest (A)

P2 is between pretest and sustainability posttest (B)

P3 is between immediate (A) and sustainability posttests (B)

*P1 was obtained by t test. P2 and P3 were obtained by Wilcoxon Signed Ranks test

Table 2: Skills percent scores in pretest, immediate posttest and sustainability posttest among nursing students

Skill Items	Median percent score			P values*		
	Pre-test	Post-test A	Post-test B	P1	P2	P3
Routine hand hygiene	57.5	90.0	75.0	<0.001	0.019	<0.001
Cannula insertion	52.9	79.4	47.06	<0.001	0.231	<0.001
Thermometer cleaning	83.3	100.0	83.33	0.080	0.777	0.001
Scoop technique	22.2	88.8	22.22	<0.001	0.140	<0.001

P1 is between pretest and immediate posttest (A)

P2 is between pretest and sustainability posttest (B)

P3 is between immediate (A) and sustainability posttests (B)

*P1 was obtained by t test. P2 and P3 were obtained by Wilcoxon Signed Ranks test

Table 3: Total knowledge and skills percent scores in pretest, immediate posttest and sustainability posttest among nursing students:

	Pre-test	Post-test A	Post-test B	P values*
	Mean (SD)	Mean (SD)	Mean (SD)	
Total knowledge percent score	53.2 (±9.2)	89.7 (±7.3)	74.2 (±8.8)	P1<0.001 P2<0.001 P3<0.001
Total skills percent score	52.3 (±12.7)	81.7 (±13.7)	55.3 (±11.8)	P1<0.001 P2=0.772 P3 <0.001

P1 is between pretest and immediate posttest (A)

P2 is between pretest and sustainability posttest (B)

P3 is between immediate (A) and sustainability posttests (B)

*P values were obtained by t test

Training was associated with statistically significant improvement in skill scores for the four items of IC two days after training ($p < 0.05$). Six months later, there was statistically significant decline in levels of skill scores for the four items (between the two posttest measurements) ($p < 0.05$). Routine hand hygiene was the only sustained skills six months after training. Other items demonstrated unsatisfactory low level six months after practical training.

Assessment of the Intervention (In-Training IC Education): Table (3) summarizes the outcome of the training of nursing students in IC (both knowledge and skills). Findings indicate that training succeeded in sustaining the updated knowledge about 14 IC items for six months. However, the training was not enough to keep momentum of improved skills for six months after training ($P=0.77$).

DISCUSSION

Acceptance of the nursing students, the future HCWs to IC standards and implementation of IC according to those standards have been recognized as efficient means to prevent and control HAIs [13]. Capacity building of nursing students is crucial being in contact with the patients for longer duration than the physicians. If nurses are not well educated and trained in IC, they will be more liable to transmit infections in the health care settings, subjected to occupational infections and injuries with subsequent reduction in the health care quality. Thus, IC programs should be innovative, educational, motivational and tailored to specific HCWs as nurses [14]. Empowering nurses to ensure application of IC standards was one of the strategies adopted by Management Sciences of Health agency in Egypt [15].

The current study was conducted to improve nursing students' knowledge and skills in IC. Situation analysis was done to build up on strengths and fill gaps in the current TIN-CU IC curriculum. Additionally, nursing students were partners in decision making through considering their perspectives towards the current TIN-CU IC curriculum and education methods. Additionally, the finding of the base-line survey for IC knowledge and skills was a third input that enriched the contents of the intervention module (in-training education of nurses).

The study showed that theoretical component of the current IC curriculum for first grade TIN-CU students is provided as an integral part of different educational topics. Therefore, there were no specific lectures assigned

to IC which could lead to students distraction, paying less attention to IC, unawareness of the importance of having written comprehensive IC curriculum. For 53% of nursing students, IC theoretical teaching was unclear and 68% of them found that basic IC curriculum was insufficient. Chalmers and Straub [16] found that inappropriate lecture formats led to students losing interest and concentration. Despite lectures can be an effective means of presenting new information to large groups in short periods of time, they can lead to boredom. It encourages a passive approach to learning and provides little opportunity for assessment, feedback or independent thinking.

The current study considered working with 58 nursing students was a good opportunity to implement the intervention with small groups. Ward and J. Deborah [14] showed that the use of small group and interactive methods for teaching and learning was preferred, in particular to encourage less confident students to participate more.

The current study succeeded in achieving significant and sustained improvement in knowledge regarding isolation precautions as they prevent the spread of infections in the hospital. Siegal *et al.* [17] stated that it is unacceptable for any future nurse to be unaware of the isolation precautions whether the standard (that should be followed with all patients) or the transmission-based (that should be followed with illnesses caused by certain germs).

The intervention in the current study emphasized the upgrading of knowledge in environmental cleaning and disinfection and sterilization as two out of 14 IC knowledge items. Retained information in this context was significantly high among ex-trainees [18].

The presented study showed that seven chapters from the national guidelines were tackled in the institute's original curriculum, yet some items (common ways of infection transmission, microbial flora of the skin, duration of hand hygiene, order of wearing and removing PPE, key processes of aseptic technique) were missing, despite their great importance. This importance stems from that in order to understand the objectives of different approaches to hand hygiene, knowledge about bacterial flora is essential for HCWs [19]. In addition HCWs must be aware of different ways of infection transmission and what the most common ways are in order to prevent spread of infections in health care facilities and thus protecting themselves and patients.

Aseptic technique is a collective term for methods that prevent the spread of infection to susceptible individuals. Although the principles of asepsis remain the

same, the components of the technique will vary depending on the degree of risk, so nurses' knowledge must be updated in risk assessment, planning appropriate nursing care and applying the principles that strengthen asepsis to prevent HCAs [20]. Such component of aseptic technique was emphasized during the current study intervention. The post-intervention evaluation of this component demonstrated statistically significant improvement and sustainability in knowledge among ex-trainees.

The current study considered presenting practical information in well-arranged steps is crucial for IC practices. Despite that types and indications of PPE were mentioned in the nursing curriculum, they were disorganized. The steps of donning and removing PPEs are the key to protect oneself and co-workers from contamination. Compliance to ordered steps should be a habit to practice the correct sequence of PPEs donning and removal [21].

The current study provided evaluation of the TIN-CU IC training using outcome indicators for IC knowledge assessment. Those indicators were presented as composite index for 14 IC items for the 58 students as mean score. The findings pointed out to low effectiveness of TIN-CU IC education and training, measured quantitatively as mean score of 53.21 ± 9.29 . Bangert [22] highlighted some principles for good practice in undergraduate education among which; the active way of learning as students do not learn much when just sitting in classes listening to teachers. Rather, they must talk about what they are learning, write about it, relate it to past experiences and apply it to their daily live. Also cooperation among students is required for good learning as learning is enhanced when it is more like a team effort than an individual learning. Prompt feedback on performance is essential as students need that feedback to benefit from courses. At various points during and at the end of training, students need chances to reflect on what they have learned and what they still need to learn.

The current study presented specific points that relate TIN-CU IC curriculum contents and the baseline level of knowledge among students. In the pretest, the students achieved the highest scores in importance of IC program, proper gloves usage and waste disposal. However their scores were worst in aseptic technique, isolation precautions and indications of different types of gloves. Such finding could be explained by the fact that topics/chapters on isolation precautions chapter as well as most of the theoretical points covering the aseptic technique are completely absent from their curriculum.

All knowledge items showed significant improvement ($p < 0.001$). The median percent score in each and every knowledge item reached 100% except the isolation precautions and medical equipment classification which though they showed significant improvement, yet their median percent scores were lower than the other items (isolation precautions 66.6% and medical equipment classification 75%). These results are consistent with a study conducted in Jordan showing a generally low level of infection prevention knowledge in nursing students with a pretest mean score $12.62/25 \pm 2.9$ indicating the lack of specific courses focusing on infection prevention in Jordanian nursing schools and deficits in the education provided to nursing students which often leaves students confused about which practices are appropriate [23]. Most nursing schools include the IC topic as a one-hour lecture within the clinical course, which may be insufficient. The educational program was effective in promoting participants' knowledge of infection prevention where the post-test mean score was $22.89/25 \pm 1.4$ confirming a statistically significant difference from the pre-test ($p < 0.001$) reporting that application of such programs are beneficial in promoting nursing students' knowledge of infection prevention [23].

In our study, the immediate post-test that showed significant improvement in IC knowledge could be partially explained by instrumental bias. The questionnaire form used before training was used again two days after training where participants could be focusing; throughout the training, on items mentioned in the pre-test [24].

In the sustainability post-test the total knowledge mean percent score was 74.22 ± 8.81 which is significantly lower than the immediate post-test ($p < 0.001$). This result is thought to be due to lack of any refreshment courses during the 6 months period which led to fading of some of the IC knowledge acquired. However, knowledge scores remained significantly higher than the pre-test scores ($p < 0.001$) which reflects the effectiveness of the interventional training course with retention of most of the IC knowledge gained during it. Such results are consistent with a study in which a post-education questionnaire; similar to the pre-education questionnaire, was administered to the enrolled nurses at intervals of 6, 12 and 24 months, there was significant difference in the pre-education and the first post-education responses. However, the improvement in nurses' answers declined in the post-education second assessment and still further dropped in the third post-education assessment (in the pre-education test only 10% of nurses achieved excellent grade which is = 31/50, in the first post-education test

84% achieved excellent grade, in the second post-education test 74% achieved excellent grade and in the last post-education test 30% achieved excellent grade). It was found that attending continuing education courses about hospital infection had a positive effect on infection control procedures and compliance with barrier techniques [25]. A study conducted in Taiwan showing the level of IC knowledge among nursing students over time with a pretest mean score $8.87/15 \pm 1.4$, the immediate post-test (one week after the intervention) mean score was $9.85/15 \pm 1.87$, the follow up posttest (after three months) mean score was $11.00/15 \pm 1.76$. The result of pair wise comparisons showed that there were statistically significant differences between pretest and follow-up ($p < 0.001$) and between posttest and follow-up ($p < 0.05$). This implies that the education intervention had a longitudinal effect on knowledge improvement. It also indicates that the systematically designed IC educational program effectively improved the students' understanding and substantive knowledge of standard IC [26].

Impact of the study intervention on IC skills delineated that pre-test assessment IC skills level of the nursing students was generally low with a mean percent score of 52.38 ± 12.78 . The highest scores were achieved in thermometer cleaning followed by routine hand hygiene. This is logical as thermometer cleaning is an easy non-invasive skill. Also it is considered a general skill, not related to medical or nursing students as most people have thermometers at their homes and know how to clean it and keep it after usage. Regarding routine hand hygiene, it is a non-invasive skill which is frequently practiced by the students, easy to be learned and it is mentioned twice in the students' original curriculum (both in the theoretical as well as the practical sections).

The students achieved the worst score in scoop technique because all items covering needle stick injury and proper recapping of needles were absent from the institute's original curriculum.

Cannula insertion is one of the aseptic techniques, more difficult, invasive and needs to be practiced repeatedly upon real patients or dummies. After conducting the IC training, the total skill mean percent score of the students in the immediate post-test was 81.78 ± 13.71 which is significantly higher than pretest ($p < 0.001$). Also, all skill items showed significant improvement ($p < 0.001$) except thermometer cleaning didn't show significant change ($p = 0.08$). In the sustainability post-test the total mean percent score was 55.36 ± 11.82 indicating significant decline from the immediate posttest

level ($p < 0.001$) and no significant change from their pretest level ($p = 0.772$). Though these were basic IC skills, yet they faded. This might be due to lack of practice during the 6 months period. Routine hand hygiene was the only skill that showed significant improvement between pretest and sustainability posttest ($p = 0.019$) as it is an easy, frequently practiced and non-invasive skill. Such results are consistent with Wu *et al.* [26] study in Taiwan in which the level of IC skills among nursing students decreased over time. The causes of skills fading in the later study was thought to be due to short duration of the students training which lasted only for 2 hours and was held 1 week before final examination period which lowered the students attendance and concentration. This factor wasn't present in our study but instead other factors might have led to fading of skills as confirmed by other studies [27]. The retention interval depends on the period of use/non-use after training, the task type (complicated; multiple steps, invasive vs. easy; few steps, non invasive), the individuals abilities as individuals with higher abilities consistently show less skill fade than their less able counterparts and the training method as it was found that the most successful form of training includes practice upon real patients and this was not applicable in our study.

Strengths of the Study: The strengths of this study are due to (1) collaborative efforts between the faculty of medicine and the TNI (2) focusing on training of nurses who spend more time in-medical settings with frequent contact with the patients (3) the topic of IC and patient safety is an important issue in Egypt health care system due to the high prevalence of VCH, (4) Follow up of nursing school cohort by three measurements in IC knowledge and skills could be adopted by medical education agencies for timely conduction of refreshing courses and periodic assessment of performance (5) fading out of gained skills after training raises the importance for on-the-job training especially for invasive procedures (6) The study included all the first grade nursing students and demonstrated how to deal with all students in a training course and follow them up over time.

Limitation of the Study: Despite the study conducted three measurements for IC knowledge and skills, the times of those measurements cannot guide training planners on the exact cut-off point of time at which skills scores start to decline.

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REFERENCES

1. Bello, A.I., E.N. Asiedu, B.O.A. Adegoke, J.N.A. Quartey, K.O. Appiah_Kubi and B. Owusu_Ansah, 2011. Nosocomial infection Knowledge and source of infection among clinical health care students in Ghana. *Internal Journal General Medicine*, 4: 571-574. Make references like this study.
2. World Health Organization (WHO), 2014. Country Cooperation Strategy for WHO and Egypt 2010–2014. Document EM/ARD/037/E/R/12.10. Printed by WHO Regional Office for the Eastern Mediterranean, Cairo
3. World Health Organization (WHO), Ministry of Health and Population (MOHP) Egypt, Partnership for Maternal, Newborn & Child Health, World Bank and Alliance for Health Policy and Systems Research, 2014. Success factors for women's and children's health: Egypt. 2014. Geneva: World Health Organization, ISBN 978 92 4 150902 2.
4. WHO, 2014. Available at http://www.who.int/csr/bioriskreduction/infection_control/publications/en/
5. Egypt Demographic and Health Survey (EDHS). Ministry of Health and Population Cairo, Egypt, El-Zanaty and Associates Cairo, Egypt. The DHS Program ICF International Rockville, Maryland, U.S.A. 2008, Egypt.
6. Egyptian Ministry Of Health and Population (EMOHP), 2003. National guidelines for Infection Control: Part I: Standard Precautions: Aseptic techniques. Retrieved on 15-3-2013 from: <http://www.drguide.mohp.gov.eg/NewSite/elearnin/g/InfectionControl/infctrpl1.asp>
7. Duerink, D.O., H. Farida, N.J.D. Nagel kerke, H. Wahyono, M.Keuter, E. S. Lestari, U. Hadi and P.J. Van den Broek, 2006. Preventing Nosocomial Infections: Improving compliance with standard precautions in an Indonesian teaching hospital. *Journal of Hospital Infection*, 64: 36-43.
8. Abdel-Wahab, F., M. Ghoneim, M. Khashaba, A.H. El-Gilany and D. Abdel-Hady, 2013. Nosocomial infection surveillance in an Egyptian neonatal intensive care unit. *Journal of Hospital Infection*, 83: 196-199.
9. World Health Organization (WHO), Year??. Patient Safety Curriculum Guide: Multi-professional Edition. 2011. ISBN 978 92 4 150195 8.
10. Kyriacos, U., S. Jordan and J. Van Den Heever, 2005. The biological sciences in nursing: a developing country perspective. *Journal of Advanced Nursing*, 52: 91–103. doi: 10.1111/j.1365-2648.2005.03555.x
11. Magill, S.S., J.R. Edwards, W. Bamberg, Z.G. Beldavs, G. Dumyati, M.A. Kainer, R. Lynfield, M. Maloney, L. McAllister-Hollod, J. Nadle and S.M. Ray, 2011. Multistate Point-Prevalence Survey of Health Care Associated Infections, 2014. *New England Journal of Medicine*. 370, no. 13: 1198-208.
12. Sherertz, R.J., E.W. Ely, D.M. Westbrook, K.S. Gledhill, S.A. Streed, B. Kiger, L. Flynn, S. Hayes, S. Strong, J. Cruz and D.L. Bowton, 2000. Education of physicians-in-training can decrease the risk for vascular catheter infection. *Annals of Internal Medicine*, 132(8): 641-8.
13. Ayub, A., A. Goyal, A. Kotwal, A. Kulkarni, A. Kotwal and A. Mahen, 2012. Infection control practices in health care: Teaching and learning requirements of medical undergraduates. *Medical Journal Armed Forces India*, 69: 107-112.
14. Ward and J. Deborah, 2011. The infection control education needs of nursing students: an interview study with students and mentors. *Nurse education today*, 31.8: 819-824.
15. Chris McDermott, Waleed El-Feky and Dr. Madiha Said Mohamed AbdulRazik, 2015. End of Project Performance Evaluation for USAID/Egypt: Improving the Performance of Nurses in Upper Egypt, evaluation final report. USAID. Social Impact, Inc.
16. Chalmers, C. and M. Straub, 2006. Standard principles for preventing and controlling infection. *Nursing standard*, 20(23): 57.
17. Siegel, Jane D., Emily Rhinehart, Marguerite Jackson, Linda Chiarello and Health Care Infection Control Practices Advisory Committee. 2007. guideline for isolation precautions: preventing transmission of infectious agents in health care settings.", 2007. *American Journal of Infection Control*., 35.10: S65-S164.

18. CDC, 2011. Health care-associated Infections: Laundry: Washing Infected Material. Retrieved on 9-2-2013 from: <http://www.cdc.gov/HAI/prevent/laundry.html>
19. Boyce, John M. and Didier Pittet, 2002. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. American Journal of Infection Control., 30.8: S1-S46.
20. Xavier, G., 1999. Asepsis. Nursing Standard. Continuing Professional Development- Infection Control. Article 495. 13, 36, 49-53.
21. Beam, E.L., S.G. Gibbs, K.C. Boulter, M.E. Beckerdite and P.W. Smith, 2011. A method for evaluating health care workers' personal protective equipment technique. American Journal of Infection Control., 39: 415-420.
22. Bangert, A.W., 2004. The Seven Principles of Good Practice: A framework for evaluating on-line *teaching*. The Internet and Higher Education, 7: 217-232.
23. Al-Hussami, M. and M. Darawad, 2013. Compliance of nursing students with infection prevention precautions: Effectiveness of a teaching program. American Journal of Infection Control., 41: 332-336.
24. Fisher andrew, John Laing and John Stoeckel. Handbook for family planning operations research design. Second eds. New York, New York Population Council.
25. Suchitra, J.B. and N.L. Devi, 2007. Impact of education on knowledge, attitudes and practices among various categories of health care workers on nosocomial infections. Indian Journal of Medical Microbiology, 25.3: 181.
26. Wu, Li-Min, Chi-Chun Chin and Chung-Hey Chen, 2009. "Evaluation of a caring education program for Taiwanese nursing students: A quasi-experiment with before and after comparison.". Nurse education today. 29.8: 873-878.
27. Arthur, David and Sally Thorne, 1998. Professional self-concept of nurses: a comparative study of four strata of nursing students in a Canadian university. Nurse Education Today, 18.5 380-388.