Data Article

Upgrading Knowledge and Skills of Nursing Students in Infection Control: An Interventional Study

Abstract

The general objective of this study is to improve nursing students' knowledge and skills in IC through the training course.An interventional study one-group pre-/post-test design was utilized to measure changes intheKnowledge and Skills of Nursing Students in Infection Control. A convenient sampling technique was used to select (58) nursing students in a private collegeat Saudi Arabia, in 2021 / 2022- academic years.The findings of the study showed that,

- All knowledge items showed significant improvement (p value<0.001), the median percent score in each and every knowledge item reached 100%
- After conducting the IC training, the total mean percent score of the students in the immediate post-test was 81.78±13.71which is significantly higher than pretest (p value<0.001), all skills showed significant improvement (p value<0.001) except thermometer cleaning didn't show the significant chanp-vap-value 0.080).y

Keywords: Upgrading Knowledge - Skills - Nursing Students Infection Control -

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Research objectives, methodology, result, and recommendation

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1. INTRODUCTION

Infection is considered nosocomial if it becomes evident 48 hours or more after hospital admission (National Health and Medical Research Council, 2019). Nosocomial infections extend patient's hospital stay and increase health care expenses and mortality (Carter et al., 2017). There is evidence that prevention and control of hospital-acquired infection is an important aspect of health care across the world (Heaton et al., 2020, p 161).

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Additionally, improving the knowledge and behavior of health care workers who could be transmittal to pathogenic agents in hospitals could reduce the spread of nosocomial infections **(**Lai et al., 2020, p6).To improve such practices, standard precautions combine measures to prevent nosocomial infections in patients and job-

related infections in health care workers (HCWs). Among which are hand hygiene, personal hygiene, safe handling of sharp objects and use of personal protective equipment (PPE) (Bouchoucha et al., 2021, p92).

Therefore, providing evidence-based successful strategies in the educational process could promote the performance of nursing students when they start an independent practice**.**

1.1 Problem statement

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 **(Abdel-Wahab et al., 2013).** Therefore, there are need to provide evidence-based methodology/strategies **i**n training practices for nursing students that build up in-depth understanding and behavioral changes to adopt the vital importance of IC practices in healthcare settings.

1.2. Aim of the study

The main purpose of this study is toimprove nursing students' knowledge and skills in IC through the training course. The specific objectives are:

1 -To understand their opinion about IC Teaching

2- To understand IC importance, ways of infection transmission, and hand hygiene

3- To understand risk assessment of IC and management and aseptic technique of IC

4 -To identify the correct steps in routine hand hygiene

1.3. Research questions

Hence, the problem of the study would be presented in answering the following research questions**:**

1- Do the undergraduate students have satisfactory Knowledge,ofInfection Control?

2- What is the effectiveness of IC trainingcourse?

2. Literature Review

nosocomial infections are a worldwide problem. In contrast to infections present or incubating at the time of start of care delivery, HCAIs represent infections acquired during delivery of health care for other conditions. (Health care associated infections (HCAIs, 2020)

2.1. IMPORTANCE OF INFECTION CONTROL

The term HCAIs replaced old ones such as nosocomial, hospital-acquired or hospital-onset infections. Most infections that become clinically evident after 48 hours of hospitalization are considered hospital-acquired. Infections that occur after the patient is discharged from the hospital can be considered healthcare-associated if the organisms were acquired during the hospital stay (Berry, 2010).

IC is the discipline concerned with preventing HCAIs, a practical (rather than academic) sub-discipline of epidemiology. It is an essential, though often under supported, part of the infrastructure of health care. IC addresses factors related to the spread of infections within the healthcare setting (whether patient-to-patient, patients-to-staff, staff- to- patients, or among-staff) (Abdel-Wahab F, et al , 2013)

ICalsoincludesprevention(viahandhygiene/handwashing, cleaning/disinfection/sterilization, vaccination, surveillance), monitoring/investigation of demonstrated or suspected spread of infection within a particular health-care setting (surveillance and outbreak investigation), and management (interruption of outbreaks). It is on this basis that the common title being adopted within health care is "Infection Prevention & Control."(IP&C) (WHO, 20 21)

2.3. Role of nursing in IC in different medical settings

Patients place their trust in their HCWs as they assume responsibility for their diagnosis, treatment and safety during all aspects of care. Improved nursing care with strict adherence to IC standards may prevent many adverse events, and nursing must take a stronger leadership role in this area. As nurses care for their patients most of the time, they are considered primarily responsible for their well-being and the main role they play in the health care team is to serve as a key guardian of patient safety (Baack, and Alfred,. 2013 , p283)

The nursing process is the tool to provide the health care needed by a patient in their particular health situation. Through systematic assessment of patient's needs for nursing care, planning, implementation and then evaluation of care, available resources will be used in the best way. All nurses should include an IC perspective in their practice. Patient factors such as resistance to infection, daily living activities and self-care abilities (physical and non-physical), cultural, religious or alternative health

care practices, communication, dependence/independence tendencies, and environmental factors may all be relevant to IC. IC requires planned good use of the resources of all those concerned nurses, patients, other staff, visitors (CDC ,2020).

The wide spread nursing shortage and nurses high turnover is a global issue. The ability of nurses to respond to patients' needs within the rapidly shifting environment of health care depends onthe way in which nursing work is organized in health care settings,the way in which nursing practice is regulated and the quality of care is assured the way in which HCWs are prepared, and, fundamentally, depends on the way in which nursing itself is defined (Labrague, et al , 2018).

2.3.1.Nursing and safety

Nurses being the main HCWs in hospitals, perform and control the majority of patient care procedures, they consistently double-check orders, confirm questions about medications, and report their concerns about patient safety. In a recent study conducted by Clarion Health Systems, a nurse had only an average of 20–50 min per patient, of direct patient contact, over a 12 hr period. The rest of the time was spent mainly in managing and coordinating the communication of patient information to other departments, physicians, and members of the health care team. However, time spent in managing communication and information is not sufficient to ensure a safe health care environment (Majidipour, et al , 2019).

According to ,The International Council of Nurses (ICN, 2021) Code of Ethics was established in 1953. It has been revised many times stating that "the nurse, in providing care, ensures that use of technology and scientific advances are compatible with the safety, dignity and rights of people.

2.3.2. Role of nursing staff

In today's complex health care environment the role of the nursing staff is demanding, challenging and stressful. All nurses should implement patient care practices according to IC standards. Nurses should be familiar with practices to prevent the occurrence and spread of infection, and maintain appropriate practices for all patients during their hospital stay. Nurses and related health personnel play a central role in health service delivery promotion, prevention, treatment and rehabilitation, where they may be the only frontline providers of health. Accordingly, health indicators,

mortality and morbidity dynamics are directly linked to nursing practice, in addition to medical and other levels of health services (Chau, 2010).

According to the (WHO, 2020), the senior nursing administratoris responsible for:

- Participating in the IC Committee.
- Promoting the development and improvement of nursing techniques.
- Continuous review of nursing policies, approved by the IC Committee.
- Developing training programmes for nursing staff members.
- Ongoing supervision of implementing the practices for prevention of infections in specialized areas such as the operating theatres, the ICUs, the maternity units and newborns.
- Monitoring of nursing staff adherence to policies

The nurse in charge of a wardis responsible for:

- Maintaining hygiene and aseptic techniques according to hospital policies and good nursing practice on the ward.
- Reporting promptly to the attending physician any evidence of infection in patients under the nurse's care.
- Initiating patient isolation and ordering culture specimens from any patient showing signs of a communicable disease, when the physician is not immediately available.
- Limiting patient exposure to infections from visitors, hospital staff, other patients, or equipment used for diagnosis or treatment.
- Maintaining a safe and adequate supply of ward equipment, drugs and patient care supplies ((WHO, 2020).

The infection control nurse (ICN)is a member of the infection control team (ICT) and responsible for:

- Identifying any HCAI.
- Investigation of the type of infection and infecting organism.
- Participating in training of personnel about how to prevent these infections.
- Participating in outbreak investigation.
- Development of IC policy and review and approval of patient care policies relevant to IC.
- Ensuring compliance with local and national regulations (WHO, 2020).

2.3.3. Infection Control Link Nurses (ICLNs)

ICLNs are a link or intermediary between the wards and the ICT. Their role is to provide information which help in early detection of outbreaks and to help increase awareness of IC issues in their ward. They should draw the attention of the ICNs to changes in practice or equipment, which could have implications for IC. They have been trained to collect surveillance data on HCAIs for the ICT. They should have sufficient clinical experience and standing to have authority with managers and colleagues. ICLNs should not be seen as a substitute for the ICN, they are ward-based staff who act under the supervision of the ICN as a resource and role model for colleagues. The ideal ICLN should be a keen, enthusiastic, motivated volunteer, with a special interest in IC. It is essential that they are ward-based and directly involved with patient care to be able to observe and influence colleagues practice. Good teaching and presentation skills are necessary. The ICLN should preferably be someone who can act as an 'opinion leader' as they should be effective in educating colleagues and implementing change at ward level (Mireille, et al , 2022).

vvvvvvv To sum it up, There was inadequate knowledge aboutIC among nurses and Lack of knowledge about the common risk factors for nosocomial, hospital

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3. Methods

The main purpose of this study is to improve nursing students' knowledge and skills in IC through the training course

3.1. Study design:

This studyincluded new training strategy that focused on both theoretical and practical training, An interventional one-group pre-/post-test design was used conductthe present study.

3.2.**Settings and Sample**

In the current study, the target population was the nursing students; Nursing students who were Second year and above were included in this studyNursing students who are below the Second year were excluded from the study.

A convenience sampling technique was used to recruit the participants from the eligible nurses. The questionnaire was distributed to all nursing students who included in the study. The total numbers of students who meet the inclusion criteria were 65, all of them received the questionnaire. The sample size wascalculatedusing(GPower).

to allowa percentage of correct answers to be estimated with a 95% confidence interval and margin – of – error of at most +/- 5% , a sample of 45 students were needed for this study. 58 students were recruited.

Instruments

The study was conducted in a private nursing college at SaudiaArabiain 2021 / 2022- academic years. The study sample included (58) students who were available on the day of data collection, who agreed to participate in the study who attend the training course and returned a completely filled questionnaires.

3.4. Study Intervention

Training package was designed according to the results of the baseline assessment and it was implemented through scheduled sessions. Theoretical and practical training course was designed to include all the basic IC knowledge and skills

3.5. Study Tool

Structure questionnaire sheet was designed for data collection by the researchers based on review of literature. It composed of two headings as the following:

1- Socio demographic criteria

2- it composed from three parts as the following: Distribution of the studied according to their opinion about IC Teaching , IC importance, ways of infection transmission &hand hygiene, risk assessment &management and aseptic technique, isolation precautions, environmental cleaning, cleaning, disinfection &sterilization and classification of equipments, waste disposal and needle stick injury

3.5.1. Validity of the Questionnaire

The questionnaire of this study was presented to a jury. The jury decided the questionnaire as being valid, gave their suggestions on each question of the test. The suggestions made by the members of the jury were incorporated in the final version

3.5.2. Reliability of the Questionnaire

The stability coefficient was calculated using Cronbach's alpha coefficient, which is the most appropriate method for calculating the stability of the weights used in the questionnaires. Cronbach's alpha coefficients of stability for all axes of the questionnaire were high, as they ranged in the period (0.88 -0.92), and the total stability of the study tool reached (0.98), which indicates the stability of the results of the study and the possibility of generalization and building on it.

3.6. Statistical analysis method:

The data was coded and entered using the statistical package SPSS version 22. The data was summarized using descriptive statistics: number and percentage values , mean and standard deviation and paired t-test was used to examine the effect of the training course.

3.7. Ethical Considerations

The current study method and protocol were reviewed and approved by the ethical committee.

The confidentiality of participants was protected by providing code number for each participant at the stage of data collection and analyses. In addition, the collected questionnaires were kept in a locked cabinet in order to keep the participants information private and confidential, and no one had an access to the data.

Participants were assured that their participation in the study was voluntary and they could withdraw from the study without penalties

. Verbal consent from each student was obtained after proper orientation of the students regarding the objectives of the study.

4. RESULTS

The results of this study are presented under the following two heading: demographic descriptions of the students and students' knowledge about **IC**

Table (1): Sample Characteristics (n=58)

Item	Total No=58 (100%)		
Age			
Mean±standard deviation	19.1±0.4	19.5± 0.7	19.2±0.6
Sex			
Male	23(60.5%)	17(85.0%)	40(69.0%)
Female	15(39.5%)	3(15.0%)	18(31.0%)
Nursing experience			
Yes	5(13.2%)	3(15.0%)	8(13.8%)
No	33(86.8%)	17(85.0%)	50(86.2%)

The majority of the nursing students were males, the mean age of the nursing students was 19.2±0.6 years. Only 13.8% of the students had previous nursing experience.

Table (2): Distribution of the students according to their opinion about IC Teaching

Item	Total No=58 (100%)
IC theoretical curriculum teaching is easy & clear	
Yes	28(48.3%)
IC theoretical curriculum is sufficient	
Yes	18(31.0%)
Difficulty of studying IC in English	
Yes	24(41.4%) 10(50.0%)
Useful application of IC in lab	
Yes	45(77.6%)
In case of answering no ,Why*	
Too many students in the same lab	12(92.3%)
Time is not enough for application	12(92.3)
Equipment in the lab are not enough	11(84.6%)
Trainer is inefficient	4(30.8%)
Interest to receive IC lectures	
Yes	53(91.4%)
Comfortable seats in lecture hall	
Yes	39(67.2%)
Well ventilated lecture Hall	
Yes	27(46.6%)
Well illuminated lecture hall	
Yes	39(67.2%)
Nursing Institute gives attention to IC	
Yes	38(65.5%)

Less than half of the students agreed that IC curriculum teaching is easy & clear and less than a third of them said that their curriculum was 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 no enough equipment in the lab. Very few students agreed that they had enough vacation between end of exams & beginning of summer course. The majority of the students were interested to receive IC lectures. Most of the students

were satisfied from the lecture halls seats as well as the illumination however less than half of them agreed that the halls were ill ventilated. More than 60% of the students agreed that the institute gives attention to IC.

Table (3): IC importance, ways of infection transmission &hand hygiene

	N=58 (100%)	P value
1-Importance of IC program		
Reduces the transmission of resistant strains	55(94.8%)	0.002
Protects the community from infections	58(100.0%)	_
Is not expensive	58(100.0%)	0.250
Cost effective	57(98.3%)	<0.001
2- Ways of infection transmission (from most to least common)		
Patient to patient	58(100.0%)	<0.001
Patient to HCW	58(100.0%)	<0.001
HCWto patient	54(93.1%)	<0.001
HCW to HCW	54(93.1%)	<0.001
3-Hand Hygiene		
Mention the proper hand hygiene method		
After caring for patients with diarrhea(hand wash)	51(87.9%)	<0.001
Requires less time(alcohol- based hand rub)	54(93.1%)	<0.001
Less dryness(alcohol- based hand rub)	50(86.2%)	<0.001
Indications of Hand hygiene		
Routine hand hygiene is indicated after dealing with traumatic wound	33(56.9%)	0.019
Antiseptic hand hygiene is indicated before caring for newborns	55(94.8%)	<0.001
Routine hand hygiene is indicated after glove removal	58(100.0%)	1.000
It is better not to use dryer after hand hygiene	51(87.9%)	<0.001
Hands of HCWs are responsible for most of infection transmission in hospitals	58(100.0%)	0.002

Regarding the importance of IC, significant improvement was found in reducing the transmission of resistant strains and being cost effective, no significant improvement was found in the other 2 items. Regarding ways of infection transmission and proper hand hygiene method, significant improvement was found in all items. Regarding hand hygiene indications, significant improvement was found in all items except routine hand hygiene is indicated after glove removal

Table (4): risk assessment &management and aseptic technique

	N=58 (100%)	P value
4-PPE(gloves)		
Proper use of gloves		
Gloves must be changed when moving from a contaminated site to a clean site on the same patient	53(91.4%)	0.063
Gloved hands can become contaminated	18(31.0%)	<0.001
Performing hand hygiene immediately after glove removal is a must	51(87.9%)	0.016

Types of gloves		
Waste handling(heavy utility gloves)	6(10.3%)	<0.001
IV catheter insertion(non sterile gloves)	14(24.1%)	<0.001
Urinary catheter insertion(sterile gloves)	34(58.6%)	<0.001
Bathroom cleaning assessment(potential risk)	21(36.2%)	<0.001
Bathroom cleaning management (Hand hygiene &PPE)	31(53.4%)	<0.001
Blood pressure measurement assessment(no risk)	44(75.9%)	<0.001
Blood pressure measurement management(PPEs are not required)	24(41.4%)	<0.001
Multi dose vial injection assessment (high risk)	30(51.7%)	<0.001
Multi dose vial injection management (apply aseptic technique)	30(51.7%)	<0.001
6-Aseptic technique (urinary catheterization)		
One of the most common causes of HCAIs.	42(72.4%)	<0.001
Should not be changed routinely	7(12.1%)	<0.001
Antiseptic hand hygiene should not be done before insertion	14(24.1%)	<0.001

Regarding PPE (gloves), significant improvement was found in all items except gloves must be changed when moving from a contaminated site to a clean site on the same patient. Regarding risk assessment &management and aseptic technique significant improvement was found in all items.

Table (5): isolation precautions, environmental cleaning,disinfection&sterilization and classification of equipments

	N=58 (100%)	P value
7-Isolation precautions (TB)		
Location of the patient (isolation room with negative pressure)	49(84.5%)	0.049
PPEs (N95 mask, gloves are required)	32(55.2%)	<0.001
Type of hand hygiene after patient contact (antiseptic hand hygiene or alcohol- based hand rub)	19(32.8%)	1.000
8-Environmental cleaning		
Cleaning should be from higher to lower surfaces	57(98.2%)	0.001
Chlorine-based solution is recommended for environmental decontamination of blood	39(67.2%)	<0.001
Scrubbing is the most effective way to remove dirt and microorganisms.	54(93.1%)	0.004
9- Cleaning, disinfection &sterilization		
Destroys all microbial forms(sterilization)	52(89.7%)	<0.001
Destroys all vegetative bacteria, viruses, fungi but not bacterial spores(ILD)	54(93.1%)	<0.001
Kills some bacterial spores if in sufficient Concentration, but doesn't kill high numbers of spores(HLD)	53(91.3%)	<0.001
Involves detergent or enzymatic presoak that removes dirt(cleaning)	57(98.3%)	0.001
10- Classification of equipments& the proper decontamination method:		
Classification		
Endoscope (semi-critical)	29(50.0%)	0.248
Vascular catheter (critical)	55(94.8%)	0.065
Stethoscope (non-critical)	50(86.2%)	0.096
Tongue depressor (semi-critical)	27(46.6%)	0.701
Decontamination		
Endoscope (HLD)	18(31.0%)	0.003
Vascular catheter (sterilization or disposal)	51(87.9%)	0.004

Stethoscope (cleaning)	53(91.4%)	<0.001
Tongue depressor (disposal)	42(72.4%)	<0.001

Regarding the isolation precautions significant improvement was found in all items except type of hand hygiene indicated after patient contact. Significant improvement was found in all items of environmental cleaning and cleaning, disinfection &sterilization. Regarding medical equipments classification & decontamination, significant improvement was found in equipment decontamination however no significant improvement was found in equipment classification.

Table (6): waste disposal and needle stick injury

	N=58 (100%)	P value
11-Waste disposal(type& sorting)		
Used catheters (infectious wastes)	58(100.0%)	<0.001
Used catheters (red bin)	58(100.0%)	<0.001
Needles, syringes (sharps)	57(98.3%)	<0.001
Needles, syringes (safety box)	58(100.0%)	<0.001
Papers, trash (general non medical wastes)	58(100.0%)	0.500
Papers, trash (black bin)	58(100.0%)	<0.001
Body tissue (pathological wastes)	57(98.3%)	0.006
Body tissue (red bin)	46(79.3%)	<0.001
Broken tubes (sharps)	56(96.6%)	0.003
Broken tubes (safety box)	51(87.9%)	<0.001
Gloves, dressings (infectious wastes)	57(98.3%)	<0.001
Gloves, dressings (red bin)	55(94.8%)	<0.001
12-Needle stick injury		
The most common cause of needle stick injury among HCWs is not sudden movement of patient during injection	50(86.2%)	<0.001
Should be washed immediately with soap and water	53(91.4%)	<0.001
Is the main cause of occupational exposures to blood-borne pathogens.	57(98.3%)	0.625

Regarding waste disposal, significant improvement was found in all items except papers& trash type. Regarding needle stick injury, significant improvement was found in all items except in being the main cause of occupational exposures to blood-borne pathogens.

Table (7): correct steps in routine hand hygiene

Steps in the proper order	Pretest N=58(100%)	Immediate posttest N=58(100%)	P value
1-Routine hand hygiene			
Remove accessories	17(29.3%)	29(50.0%)	0.017

Wet hands	39(67.2%)	51(87.9%)	0.023
Apply soap	56(96.6%)	53(91.4%)	0.453
Rub palm to palm	49(84.5%)	56(96.6%)	0.065
Right palm on left dorsum	42(72.4%)	56(96.6%)	0.001
left palm on right dorsum	42(72.4%)	54(93.1%)	0.004
Interlace fingers	47(81.0%)	46(79.3%)	1.000
Back of right fingers in left palm	22(37.9%)	39(67.2%)	0.002
Back of left fingers in right palm	22(37.9%)	38(65.5%)	0.002
Rotational rub of right thumb	35(60.3%)	49(84.5%)	0.007
Rotational rub of left thumb	35(60.3%)	49(84.5%)	0.007
Rub tips of right fingers	47(81.0%)	52(89.7%)	0.267
Rub tips of left fingers	46(79.3%)	52(89.7%)	0.146
Rub right wrist	27(46.6%)	48(82.8%)	<0.001
Rub left wrist	28(48.3%)	48(82.8%)	<0.001
Rinse under running water	53(91.4%)	51(87.9%)	0.754
Dry with single use paper towel	12(20.7%)	52(89.7%)	<0.001
Close tap with paper towel	31(53.4%)	54(93.1%)	<0.001
Discard paper towel in black bin	15(25.9%)	47(81.0%)	<0.001
Duration 40-60 seconds	15(25.9%)	51(87.9%)	<0.001

Among the 20 steps of proper hand hygiene, pretest showed varied proportions ranging from20.7% (drying hands with single use paper towel) to 96.6% (applying soap). Significant improvement was found in steps except in applying soap, rubbing palm to palm, interlacing fingers, rubbing tips of right and left fingers and rinsing under running water.

Table (8): Percent of correct steps in cannula insertion in pretest and immediate posttest

Steps in the proper order	Pretest N=58(100%)	Immediate posttest N=58(100%)	P value
2-Cannula insertion			
Routine hand hygiene	34(58.6%)	50(86.2%)	<0.001
Wear non sterile gloves	21(36.2%)	51(87.9%)	<0.001
Patient arm in right position	9(15.5%)	13(22.4%)	0.424
Tourniquet application	36(62.1%)	45(77.6%)	0.108
70% alcohol in one direction	37(63.8%)	54(93.1%)	<0.001
leave to dry for 30 seconds	1(1.7%)	26(44.8%)	<0.001
Insert with no touch technique	56(96.6%)	44(75.9%)	0.002
look for flash back	25(43.1%)	20(34.5%)	0.332
Release tourniquet	32(55.2%)	36(62.1%)	0.557
Anchor with clean tape	54(93.1%)	54(93.1%)	1.000
label tape with insertion date	32(55.2%)	45(77.6%)	0.024
leave site dry	25(43.1%)	41(70.7%)	0.009
Discard sharp in safety box	45(77.6%)	51(87.9%)	0.238
Remove gloves	35(60.3%)	51(87.9%)	0.002
Gloves in red bin	26(44.8%)	45(77.6%)	<0.001

Routine hand hygiene	18(31.0%)	47(81.0%)	<0.001
Dry hands	10(17.2%)	41(70.7%)	<0.001

Among the 17 steps covering the proper cannula insertion, pretest showed varied proportions ranging from 1.7% (leaving alcohol to dry) to 96.6% (insertion with no touch technique). No significant improvement was found in placing patient arm in right position, tourniquet application, looking for flash back, releasing tourniquet, anchoring cannula with clean tape and discarding sharps in safety box. Significant decline was found in inserting the cannula with no touch technique. Significant improvement was found in all other steps.

Table (9): Percent of correct steps in scoop technique and thermometer cleaning in pretest and immediate posttest

Steps in the proper order	Immediate posttest N=58(100%)	P value
3-Scoop technique		
Place cap on a flat surface	58(100.0%)	0.500
Hold syringe with one hand	58(100.0%)	0.016
Use needle to scoop up cap	57(98.3%)	0.063
Use other hand to secure cap on needle hub	57(98.3%)	0.07
Handle cap on bottom only	47(81.0%)	<0.001
Discard in safety box	46(79.3%)	1.000
4- Thermometer cleaning		
Wear non sterile gloves	49(84.5%)	<0.001
Wash with warm water &detergent	55(94.8%)	<0.001
Dry with single use paper towel	43(74.1%)	<0.001
Clean with alcohol cotton from less to more contaminated part	53(91.4%)	0.375
leave to dry	37(63.8%)	<0.001
Put in container	54(93.1%)	0.001
Remove gloves	48(82.8%)	<0.001
Discard gloves in red bin	43(74.1%)	<0.001
Routine hand hygiene	42(72.4%)	<0.001

Among the 6 steps of scoop technique, pretest showed varied proportions ranging from 46.6% (handling cap on bottom only) to 96.6% (placing cap on a flat surface). Significant improvement was found in holding syringe with one hand and handling cap on bottom only but no significant improvement was found in other steps.

Among the 9 steps of thermometer cleaning, pretest showed varied proportions ranging from1.7 % (washing thermometer with water and detergent and discarding gloves in red bin) to 96.6% (cleaning with alcohol cotton). Significant improvement was found in all steps except in cleaning the thermometer with alcohol cotton from less to more contaminated part.

Regarding the importance of IC, improvement was lost in reducing the transmission of resistant strains. Improvement was sustained incompletely in being cost effective No improvement was found in the other items. Regarding ways of infection transmission, improvement was sustained completely in patient-patient and patient-HCW transmission however only immediate improvement was achieved in the other 2 items. Regarding the hand hygiene, improvement was lost in the method which causes less dryness and antiseptic hand hygiene is indicated before caring for newborns. No improvement was found in indication of routine hand hygiene after gloves removal. Improvement was sustained completely in all other items.

6.DISCUSSION

Capacity building of nursing students is crucial being in contact with the patients for longer duration than the physicians, so if they 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 and as a result reduction in the health care quality. Thus IC programs should be innovative, educational and motivational and tailored to specific HCWs as nurses

IC knowledge assessment:

In the pre-test assessment IC knowledge of the nursing students was generally low with a mean percent score 53.21±9.29 and that was expected due to the informal and unclear method of IC teaching in the institute, the insufficient IC curriculum given to the nursing students which led to the dissatisfaction by the majority of them, the passive way of learning IC, absence of teamwork and absence of appropriate feedback from the institute staff on their performance**.**highlighted some principles for good practice in undergraduate education among which; the active way of learning as students do not learn much just sitting in classes listening to teachers, 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 race as good learning, is collaborative and social, not competitive and isolated. Prompt feedback is essential as students need appropriate feedback on performance to benefit from courses. At various points during college, and at the end, students need chances to reflect on what they have learned, what they still need to know.

In the pretest, the students achieved the highest scores in the 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. This is logical as the isolation precautions chapter as well as most of the theoretical points covering the aseptic technique are completely absent from their curriculum.

After conducting the IC training, the total mean percent score of the students in the immediate post-test was significantly higher than pre-test 89.72±7.39 (p value<0.001), this reflects the effectiveness of IC training in raising level of knowledge of the nursing students as the training power point presentation consisted mainly of pictures rather than text, open ended questions and group discussions which might have attracted the students' attention and facilitated their recall of the information also hand outs were provided to all students thus helped them to revise and recall what they received in the training and it was a simple and organized source for basic IC knowledge.

All knowledge items showed significant improvement (p value<0.001), the median percent score in each and every knowledge item reached 100% except the isolation precautions and medical equipments classification which though they showed significant improvement yet their median percent scores were lower than other items (isolation precautions 66.6% and medical equipment classification75%).

IC skills assessment:

After conducting the IC training, the total mean percent score of the students in the immediate post-test was 81.78±13.71which is significantly higher than pretest (p value<0.001), all skills showed significant improvement(p value<0.001) except thermometer cleaning didn't show significant change(p value 0.080).

The causes of skills fading in this 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.

Comment [FN5]: Discuss with the theory

7. RECOMMENDATIONS

Based upon the conclusions of the study, the following recommendations are suggested to improve the TIN-CU students' IC knowledge and skills:

- Emphasis should be made on IC as an important knowledge and skill in nurses' career across the nursing educational program.

- Upgrading IC curriculum of the nursing students.
- Avoid redundancy of the curriculum
- Reforming IC education and training courses: Preparinginstructional units for training course that include topics for both theoretical and practical aspects
- Introducing live demonstrations and volunteer patients into the practical training course
- Theoretical training can be introduced through interactive lectures
- Introducing IC refreshing courses to allow retaining information and skills especially the less practiced and multi-step such as the invasive interventions.

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