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World Health Organization Surgical Safety Checklist with Addition of Infection Control Items: Intervention Study in Egypt

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Abstract

BACKGROUND: Surgical team is in command of the operating room (OR) and takes decisions regarding various patient care procedures. Educational programs directed to them, should be creative, provocative and tailored to their specific needs and the expected outcomes.

AIM: This study aims to design and conduct an educational program of patient safety and infection control for the OR team based on the WHO surgical safety checklist and to assess their post-intervention knowledge and practices.

METHODS: This interventional study was conducted at the ORs of Port-said general hospital. It passed through three stages; baseline assessment of knowledge and practice regarding patient safety and infection control among OR team (surgeons, anaesthetists and nurses), intervention stage in which an educational program based on the WHO surgical safety checklist with modifications and additions of more infection control items was conducted, then re-assessment of their post-intervention knowledge and practices.

RESULTS: All the studied participants showed improvement in both knowledge and practices of patient safety and infection control after the educational program based on the WHO surgical safety checklist with modifications and additions of more infection control items and including not only practices but also knowledge as well, than before.

CONCLUSION: The modification of the WHO surgical safety checklist to fit local knowledge and practices created a comprehensive tool that led to an improvement in both knowledge and practices of patient safety and infection control among the OR team.

Introduction

Operating room (OR) is a critical facility within the hospital where surgical operations are carried out in an aseptic yet stressful environment. This stress coupled with the performance of various surgical patterns is rarely admitted by the surgical community since accentuation of leadership and self- confidence is very exalted that stress is often realised as a stamp of weakness or failure [1].

Surgical team members highly contrive their efforts to attain their patients' full care and safety. Culture of patient safety and infection control needs to be established first of all, especially in OR [2], [3]. World Health Organization (WHO) published the surgical safety checklist which comprises 19 items that must be checked at 3 points all the time of surgery; sign in, time out and time out [4].

A mechanism needs to be developed for capturing data relating to knowledge of patient safety and patient safety practices [2], [3]. Infection prevention and control(IPC) seizes an exquisite place in patient safety framework because it is universally pertinent to health workers and patients at whatsoever health-care station. The conveyance of essential health services and the recovery phase of any health system should include IPC as a vital constituent, not just a response-specific intervention [4].

If health care personnel (HCP) realise the evocation of infection control program, they will presumably carry out any exposure-control plan. Congruity, proficiency, and applicable coordination of IPC activities can be attained through unmistakably written policies, procedures, and guidelines. Infection-control training should be received by HCP minimally three times; on the initial appointment when exposed to new tasks or procedures, and at a minimum, annually. Occupational education and training should take hold of the assigned duties [5], [6].

Providing high-quality care should include organisational atmosphere cohesive to commended patient safety and infection control practices created by hospital administrators. Sufficient resources and visible support in the form of continuous education programs must be provided by hospitals to reach this high-quality care concept [7].

This study aims to design and conduct an educational program of patient safety and infection control for operating rooms OR team at Port-Said general hospital and to assess their post-intervention knowledge and practices changes.

Materials and Methods

Study design

A quasi-experimental study (Pre-post intervention design) was used to assess the effects of a comprehensive educational program about patient safety and infection control in OR on the following main outcome measures: knowledge and practice of OR team (surgeons, anaesthetists, and nurses).

Study Setting

This study was conducted at the ORs of Port-said general hospital, which is 1st Egyptian hospital to implement the new universal health coverage system in Egypt.

Study population

A purposive sampling technique was used. All OR team members composed of 48 surgeons, 8 anaesthetists and 16 nurses, of a total of 72 participants on duty at the time of research were included.

Data collection

The (WHO) recommends: "routine use of a surgical safety checklist before all surgical operations. This checklist, WHO surgical safety checklist is not intended to be concise. Fitting local practice by additions and modifications are encouraged. It is originally branched into three domains (Sign In, Time Out and Sign Out)." [8] It comprises 19 items that need to be checked at three points around the time of surgery as the practice of OR team (Figure 1): 1. During "Sign In" before induction of anaesthesia (7 items for only anaesthetists and nurses); 2. For “Time Out” before skin incision (7 items for all OR team); and 3. For the “Sign Out” before the patient leaves the operating room (5 items for all OR team).

This study added 3 items of knowledge of patient safety as was encouraged by the WHO [9], [10], [11], [12], [13], [14], [15], [16], [17]: 1. Factors inside OR could lead to medical errors including (bad conditions of hospital infrastructure, shortage of staff and work overload and lack of communication between OR team); 2. Types of medical errors inside OR including: (operation at the wrong side/the wrong site, wrong procedure and wrong patient (WSPE); and 3. Reporting medical errors when happening (to both the patient and the administration).

Also, our study added 3 items of infection control inside the OR as knowledge and practice :1. Surgical hand washing technique including (when scrubbing and after scrubbing); 2. Techniques of wearing and removing personal protective equipment (PPE) including (gowning, gloving and maintaining the sterile surgical field); and 3. Techniques for prevention of bloodborne pathogens (BBP) including: (infection prevention and universal precautions).

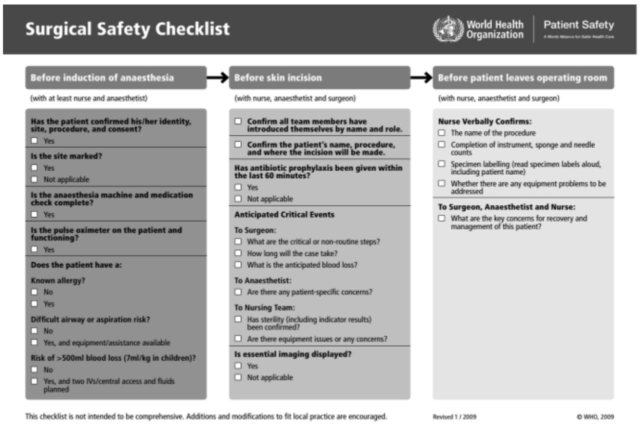
So, this study not only added more infection control items but also assessing and improving the knowledge of OR team through an educational program was added. All of these additions to the original WHO surgical safety checklist was obtained from WHO best practice protocols for clinical procedures safety [18], WHO guidelines on hand hygiene in health care and their consensus recommendations [19] and the Centers for Disease Control (CDC) 2007 guideline for isolation precautions preventing transmission of infectious agents in healthcare settings [20]. These protocols included items of patient safety and infection control specially designed for OR.

Our data collection tools were a questionnaire and an observational checklist. Knowledge of OR team was assessed using the interview questionnaire, while practices were assessed using the observational checklist. One of the researchers was the coordinator to manage and follow up the application of the checklist in OR for practice attending the duties with the OR team and also interviewing them for their knowledge.

The questionnaire also included demographic characteristics OR team including name, age, gender, medical profession (surgeons, anaesthetists and nurses), surgical speciality, Years of working at OR, No of days/week at OR, Average hours at OR/day and No of operations/month.

Each item in both the questionnaire of knowledge and the checklist of practices was assessed through a group of questions and observations respectively. Then the right choices for answers or practices were calculated and divided by total answers and practices for that item, so each item had a percentage from 0% to 100% according to the right choices for each participant, these percentages were then compared for each item before and after the intervention to estimate its effect.

Finally, all the components of knowledge and practice of both patient safety and infection control were collected, so we have four totals, which also compared before and after the intervention for each participant, as follows: 1. Total of knowledge of patient safety; 2. Total of practices of patient safety; 3. Total of knowledge of infection control; and 4. Total of practices of infection control. After all, the change difference percentage of all the components of knowledge and practice of both patient safety and infection control was compared between the 3 studied groups: surgeons, anaesthetists, and nurses.



Surgical Safety Checklist

World Health Organization | Patient Safety

Before induction of anaesthesia (with at least nurse and anaesthetist)

Has the patient confirmed his/her identity, site, procedure, and consent?
- ☐ Yes

Is the site marked?
- ☐ Yes
- ☐ Not applicable

Is the anaesthesia machine and medication check complete?
- ☐ Yes

Is the pulse oximeter on the patient and functioning?
- ☐ Yes

Does the patient have a:

Known allergy?
- ☐ No
- ☐ Yes

Difficult airway or aspiration risk?
- ☐ No
- ☐ Yes, and equipment/assistance available

Risk of >500ml blood loss (7ml/kg in children)?
- ☐ No
- ☐ Yes, and two IVs/central access and fluids planned

Before skin incision (with nurse, anaesthetist and surgeon)

- ☐ Confirm all team members have introduced themselves by name and role.
- ☐ Confirm the patient's name, procedure, and where the incision will be made.

Has antibiotic prophylaxis been given within the last 60 minutes?
- ☐ Yes
- ☐ Not applicable

Anticipated Critical Events

To Surgeon:
- ☐ What are the critical or non-routine steps?
- ☐ How long will the case take?
- ☐ What is the anticipated blood loss?

To Anaesthetist:
- ☐ Are there any patient-specific concerns?

To Nursing Team:
- ☐ Has sterility (including indicator results) been confirmed?
- ☐ Are there equipment issues or any concerns?

Is essential imaging displayed?
- ☐ Yes
- ☐ Not applicable

Before patient leaves operating room (with nurse, anaesthetist and surgeon)

Nurse Verbally Confirms:
- ☐ The name of the procedure
- ☐ Completion of instrument, sponge and needle counts
- ☐ Specimen labelling (read specimen labels aloud, including patient name)
- ☐ Whether there are any equipment problems to be addressed

To Surgeon, Anaesthetist and Nurse:
- ☐ What are the key concerns for recovery and management of this patient?

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged. Revised 1 / 2009 © WHO, 2009

Figure 1: Copy of World Health Organization Surgical Safety Checklist [8]

The Intervention program

Implementation of the program was done by the researcher with the help of hospitals administration as well as the head nurse of each OR. The program was passing through three phases: planning, implementation, and evaluation phases. The Planning Phase was of 6 months duration and included obtaining the official permissions, arrangements with the quality department of the hospital which is responsible for the patient safety, as well as the infection control department and preparation of the educational program for the OR team.

The implementation Phase was of 9 months duration. The educational program was designed according to the baseline assessment data in the following designs: Booklets designed for each speciality (surgeons, anaesthetists and nurses), Powerpoint presentations, Brochures, and Videos. It was tested before actual implantation, then revised, edited and finally conducted. The lectures contained several activities to engage learners such as videos and discussions as well as groups to work to answer some questions that had been answered wrongly in the pre-intervention questionnaire. The practical part was designed to apply patient safety and infection control practices. This part included a simulation of these practices inside the OR.

Finally, the evaluation Phase was of 6 months duration. After the implementation of the educational program by 3 months a post-test questionnaire and observational checklist were used to assess the change in knowledge and practices of participants respectively regarding patient safety and infection control, the results were then analyzed to determine the impact of the intervention program.

Ethical Considerations

The study was approved by the research ethics committee of the Faculty of Medicine, Cairo University in November 2016. Agreements from the responsible authority (Port-Said General Hospital) were obtained. Confidentiality of the collected data was guaranteed. Participants were informed that responding is voluntary and that they can withdraw without stating any reason. Aims of the research were achieved without disturbing the harmony of work rhythm. Feedback about the results was given to the responsible authority at the end.

Data Management and Statistical Analysis

All collected data were assorted into pre- and post-intervention. Statistical analyses were performed using the SPSS program, IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp. Analytic statistics was applied to compare the general characteristics of the 3 studied groups: surgeons, anaesthetists, and nurses. Each item was assessed through a group of questions. Then the right answers were calculated and divided by total answers of the item, so each item had a percentage from 0% to 100% according to the right answers for each participant, before and after the intervention.

Fisher's test was used for comparing categorical variables, Kruskal-Wallis test for unrelated numerical variables and Wilcoxon test for related numerical variables. P values below 0.05 were considered statistically significant. Box and whisker plots were used to compare totals of knowledge and practice scores before and after the intervention. The change difference percentage was calculated as follows: the pre-intervention number was subtracted from the post-intervention number, and then the outcome was divided by the pre-intervention number and multiplied the answer by 100. The change difference percentage was compared between the 3 studied groups: surgeons, anaesthetists, and nurses, using the Kruskal-Wallis test.

Results

The general characteristics of the OR team revealed that the average age was 33±5 years for surgeons, 43±11 years for anaesthetists and 31±9 years for nurses. The anaesthesia team had significantly older age, more hours of working inside ORs as well as the number of operations per month than the rest of OR teams (Table 1).

Table 1: General characteristics of the OR team (n = 72)

General characteristics		Surgeons (n = 48)	Anesthesiatists (n = 8)	Nurses (n = 16)	*P-value*
Age(years)	Mean ± SD	33 ± 5	43 ± 11	31 ± 9	*0.01**
Gender Freq. (%)	Male	39 (81.3)	7 (87.5)	2 (12.5)	*0.001**
	Female	9 (18.8)	1 (12.5)	14 (87.5)	
Surgeon speciality Freq. (%)	General		9 (18.8)		
	Orthopaedic		18 (37.5)		
	Gynaecology		15 (31.3)		
	ENT		2 (4.2)		
	Neurosurgery		4 (8.3)		
OR working experience(years)	Mean ± SD	6 ± 5	17 ± 12	8 ± 9	*0.055*
OR days/week	Mean ± SD	4 ± 1	5 ± 2	4 ± 6	*0.172*
OR hours/day	Mean ± SD	6 ± 2	10 ± 3	5 ± 2	*0.001**
Operations No/month	Mean ± SD	32 ± 24	49 ± 6	15 ± 8	*0.001**

* *P*-value statistically significant at < 0.05.

All the OR team showed a statistically significant increase in knowledge and practices of different items of patient safety after the intervention (P-value < 0.05) except for anaesthetists of item of knowledge: factors inside OR could lead to medical errors, as their knowledge of this item was 100% before as well as after the intervention (Table 2).

Table 2: Comparison of Patient safety Knowledge and practices before and after the intervention

Knowledge of patient safety		Surgeons (n = 48)		Anesthetists (n = 8)		Nurses (n = 16)	
		† Pre-	†† Post-	† Pre-	†† Post-	† Pre-	†† Post-
Factors inside OR could lead to medical errors	Median	100	100	100	100	87.5	100
	(Min-Max)	(25-100)	(100-100)	(100-100)	(100-100)	(25-100)	(100-100)
	P-value	*0.011**		*1*		*0.009**	
Types of medical errors inside OR	Median	57.1	100	93	100	78.5	100
	(Min-Max)	(0-100)	(71.4-100)	(85.7-100)	(100-100)	(28.6-100)	(85.7-100)
	P-value	*0.001**		*0.046**		*0.001**	
Reporting medical errors when happen	Median	0	100	0	100	50	100
	(Min-Max)	(0-100)	(25-100)	(0-100)	(50-100)	(0-100)	(50-100)
	P-value	*0.001**		*0.02**		*0.026**	
Practices of patient safety		† Pre-	†† Post-	† Pre-	†† Post-	† Pre-	†† Post-
Before inducing anaesthesia (sign in)	Median	----	----	92.5	97.5	75	100
	(Min-Max)	----	----	(90-95)	(95-100)	(75-75)	(75-100)
	P-value	----		*0.011**		*0.001**	
Before skin incision (time out)	Median	0	50	50	100	0	57
	(Min-Max)	(0-25)	(12.5-87.5)	(50-50)	(50-100)	(0-57)	(28.6-86)
	P-value	*0.001**		*0.014**		*0.001**	
Before patient leaves OR (sign out)	Median	0	50	33.3	66.7	0	66.7
	(Min-Max)	(0-0)	(50-66.6)	(33.3-33.3)	(66.7-66.7)	(0-50)	(66.7-66.7)
	P-value	*0.001**		*0.005**		*0.001**	

† Pre-: Pre-intervention; †† Post-: Post-intervention; * *P*-value statistically significant at < 0.05.

The total knowledge of patient safety (Figure 2), as well as the total practices of patient safety (Figure 3), showed a statistically significant increase after the intervention (P-value < 0.05).

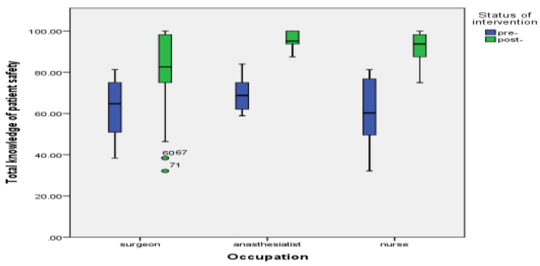


*Figure 2: Total of patient safety knowledge before and after the education program among OR team; * P-value is statistically significant at < 0.05*

All the OR team showed a statistically significant increase in knowledge of different items of infection control after the intervention (P-value < 0.05) except for nurses of item: prevention of transmission of blood-borne pathogens (BBP).

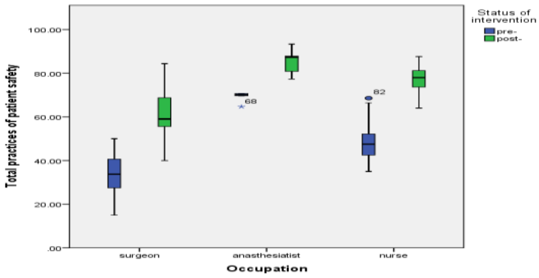


*Figure 3: Total of patient safety practices before and after the education program among OR team; * P-value is statistically significant at < 0.05*

There was no statistically significant increase in their knowledge for this item (P-value > 0.05) (Table 3).

Table 3: Comparison of infection control knowledge and practices before and after the intervention

Knowledge of infection control		Surgeons (n = 48)		Anesthetists (n = 8)		Nurses (n = 16)	
		† Pre-	†† Post-	† Pre-	†† Post-	† Pre-	†† Post-
Surgical hand washing	*Median*	37.5	62.5	56.3	81.3	37.5	62.5
	(Min-Max)	(25-75)	(50-87.5)	(50-75)	(62.5-87.5)	(12.5-62.5)	(37.5-87.5)
	P-value	*0.001**		*0.009**		*0.001**	
Personal protective equipment (PPE)	*Median*	44.4	55.6	61.1	50	44.4	55.5
	(Min-Max)	(22-66.6)	(11-66.6)	(55.5-66.6)	(44.4-66.6)	(0-55.6)	(11-66.6)
	P-value	*0.001**		*0.014**		*0.001**	
Prevention of blood borne pathogens (BBP)	*Median*	83.3	100	0	100	83.3	100
	(Min-Max)	(0-100)	(16.7-100)	(83.3-83.3)	(100-100)	(50-100)	(33.3-100)
	P-value	*0.001**		*0.005**		*0.617*	
Practices of infection control		† Pre-	†† Post-	† Pre-	†† Post-	† Pre-	†† Post-
Surgical Hand Washing Techniques	*Median*	38.5	76.9	30.8	50	33.4	77
	(Min-Max)	(38.5-38.5)	(38.5-92.3)	(0-30.8)	(0-85)	(38.4-38.4)	(38-92)
	P-value	*0.001**		*0.039**		*0.001**	
PPE: Gowning Techniques	*Median*	80	80	80	80	80	80
	(Min-Max)	(80-80)	(80-80)	(80-80)	(80-80)	(80-80)	(80-80)
	P-value	*1*		*1*		*1*	
PPE: Gloving Techniques	*Median*	100	100	100	100	100	100
	(Min-Max)	(100-100)	(100-100)	(100-100)	(100-100)	(100-100)	(100-100)
	P-value	*1*		*1*		*1*	
Techniques of Prevention of BBP	*Median*	0	100	0	100	66.6	83.3
	(Min-Max)	(0-100)	(0-100)	(0-0)	(0-100)	(33.3-100)	(66.6-100)
	P-value	*0.001**		*0.025**		*0.002**	

† Pre-: Pre-intervention; †† Post-: Post-intervention; * *P*-value statistically significant at < 0.05.

The total knowledge of infection control (Figure 4) showed a statistically significant increase after the intervention (P-value < 0.05).

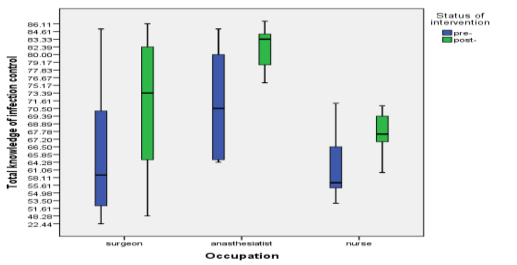


*Figure 4: Total of infection control knowledge before and after the education program among OR team; * P-value is statistically significant at < 0.05*

The total practices of infection control (Figure 5) showed a statistically significant increase after the intervention (P-value < 0.05).

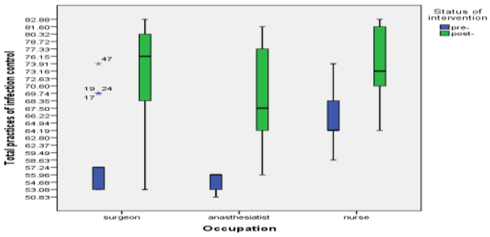


*Figure 5: Total of infection control practices before and after the education program among OR team; * P-value is statistically significant at < 0.05*

The change difference percentage of Factors inside OR could lead to medical errors was statistically significantly higher among nurses than the other OR team as well as before patient leaves OR (sign out) among anaesthesiologists and the total practices of patient safety among surgeons (P-value < 0.05). The knowledge of surgical handwashing and personal protective equipment (PPE) were higher among nurses, while the total knowledge of infection control was higher among surgeons (P-value < 0.05) (Table 4).

Table 4: Comparison of change difference percentage in knowledge and practices of patient safety and infection control among the studied participants

Knowledge of Patient safety *Percent Change difference (%)*		Surgeons (n = 48)	Anesthetists (n = 8)	Nurses (n = 16)	*P-value*
Factors inside OR could lead to medical errors	*Median (min-max)*	0 (0-300)	0 (0-0)	16.7 (0-300)	*0.002**
Types of medical errors inside OR	*Median (min-max)*	50 (16.7-250)	8.3 (0-16.7)	18.3 (0-250)	*0.112*
Reporting medical errors when happen	*Median (min-max)*	0 (0-100)	0 (0-0)	0 (0-100)	*0.668*
Total	*Median (min-max)*	27 (4-160)	45 (8-59)	38 (8-191)	*0.78*
Practices of Patient safety Percent Change difference (%)					
Before inducing anaesthesia (sign in)	*Median (min-max)*	------	5 (0-11)	33.3 (0-33.3)	*0.085*
Before skin incision (time out)	*Median (min-max)*	250 (50-300)	100 (0-100)	50 (0-100)	*0.08*
Before patient leaves OR (sign out)	*Median (min-max)*	0 (0-0)	100 (100-100)	33.3 (33.3-33.3)	*0.003**
Total	*Median (min-max)*	87 (21-270)	25 (11-32)	66 (9-87)	*0.001**
Knowledge of Infection Control Percent Change difference (%)					
Surgical hand washing	*Median (min-max)*	66.7 (33-250)	40 (16.7-50)	66.7 (20-600)	*0.033**
Personal protective equipment (PPE)	*Median (min-max)*	20 (17-25)	20 (20-20)	20 (20-33)	*0.006**
Total	*Median (min-max)*	23 (1.96-115)	12 (4.5-25)	14 (2.89-27)	*0.004**
Practices of Infection Control Percent Change difference (%)					
Surgical Hand Washing Techniques	*Median (min-max)*	100 (0-140)	150 (0-175)	120 (0-140)	*0.156*
Total	*Median (min-max)*	29 (0-48)	31 (2-46)	13 (8-23)	*0.071*

* *P-value* significant at < 0.05.

Discussion

This quasi-experimental study (Pre-post intervention design) was conducted to assess the effects of a comprehensive educational program about patient safety and infection control in OR on the following main outcome measures: knowledge and practice of OR team**.** All the OR team in our study showed improvement in both total knowledge and total practices of patient safety and infection control after the educational program than before. This finding goes in conformity with several previous studies which investigated surgical team performance before and after implementation of educational interventions [4], [5], [21], [22].

The checklist is a framework on which attitudes toward teamwork and communication can be encouraged and improved [4]. Besides, encouraging customisation of the checklist to fit the needs of the team identified from the baseline assessment, may promote a feeling of ownership over the checklist, increasing compliance along the way, that's how our newly modified checklist showed a high compliance and improved adherence among the OR team [23], [24].

Optimal training of OR team requires a program that focuses on the cognitive elements as well as the technical skills, that are essential to providing safer patient care [25]. Our comprehensive educational program about patient safety and infection control that included knowledge rather than only practices, could, therefore, achieve the requisite knowledge and skills, with the resulting improvement.

This improvement after educational programs could be more explained by the following facts: 1) educational visits combined with other complementary interventions including; booklets, brochures, and videos, are more effective than no intervention, 2) a personal visit by a trained person to a health provider in his or her own set is better than inviting them to other settings like educational halls and on times rather than work time with such burden of extra time and effort, 3) using more than one educational outreach visit is more effective than using only one visit and 4) the support obtained from the hospital's administration as well as IC and quality teams, and finally the intense help of OR head nurse in implementing the checklist items into the routine work inside ORs. In addition to the WHO, surgical safety checklist, which is designed in a concise to the point built and facilitated the compliance with most of the items [21], [26].

Our educational program included also training sessions on patient safety and infection control practices in the practical part. This part included a simulation of these practices inside the OR. The usefulness of simulation in OR team training is recognised, with proven validity and noticeable transfer of skills to the clinical setting. Simulation can prepare the OR team for actual practice, so it has the potential to improve both patient safety and the whole OR environment. Generally, the simulation technique of the OR environment can help the development of non-technical skills and aid in preparing OR teams for uncommonly faced situations and emergencies [27], [28].

However, certain individual items of patient safety and infection control showed various degrees of improvement than the total. OR nurses showed an increase in knowledge after the intervention of all the items except for the prevention of BBP. They believe that prevention of BBP is the responsibility of central sterilisation unit (CSU), and they only transmit and properly handling the sterile instruments as much as they can [29]. This conflict in knowledge as regarding the prevention of BBP is the result of that studying the responsibility of central sterilisation unit was beyond the scope of this study, and we only studied all the patient safety and infection control when only the patient is inside OR ready for the planned procedure.

All the OR team showed improvement in infection control practices, mainly of surgical handwashing techniques. However, before the intervention, many of the OR team declared of the complexity of sterile gowning techniques special precaution of not exposing their hands outside the traditional sterile field; outside the cuff of gown allowing just fingertips to touch the proximal boundary of the cuff. Scrubbing cannot completely sterilise the skin but will decrease the bacterial load and risk of wound contamination from the hands. So, during gowning, it must be ensured that no part of the hand protrudes out of the cuff [18], [30].

Our study revealed that surgeons improved more as regarding the component of before patient leaves OR (sign out), the total practices of patient safety and the total knowledge of infection control. Surgeons are the ablest members to give orders to all the team members, and they are tasked with correcting any error that may occur and prevent it during surgery [31]. They are in an exquisite situation to empower distinctive behaviours to ameliorate teamwork in the intraoperative setting and eventually, patient outcomes. Moreover, the fear of surgical site infection is the main motivation for the study of infection control in surgical procedures which makes surgeons of a better knowledge more than others in this matter. Prevention remains of utmost importance [5].

The component of before patient leaves OR (sign out) showed more improvement among anaesthesiologists. This part of the checklist is to be completed before removing the patient from the operating room with the aim is to facilitate the transfer of important information to the care teams responsible for the patient after surgery [8]. Intraoperative transfers of patient care and responsibilities among anaesthesia caregivers, that is, handovers, are relatively frequent. Lost critical information during handovers may result in delays, inefficiencies, suboptimal care, or patient harm [32].

Improvement of factors inside OR could lead to medical errors, knowledge of surgical handwashing and personal protective equipment (PPE) were higher among nurses than the other OR team. Nurses are responsible for the day-to-day smooth running of OR activities and management. Therefore they are better in observing medical errors inside OR and the factors could lead to them [32]. Operating room management including not only patient safety and medical errors, but also operative considerations of infection control [33].

In conclusion, the educational program based on the WHO surgical safety checklist with modifications and additions of more infection control items to fit local practice, being given according to the occupation and role inside OR, together with intervening knowledge too, have led to improvement in both total knowledge and total practices of patient safety and infection control among the OR team; surgeons, anesthesiologists and nurses.

Conducting similar studies but with assessing OR team compliance about the rate of surgical complications in the form of postoperative morbidity and mortality. Also, conducting similar studies to improve special practices of patient safety and infection control in other critical areas like critical care units.

Study Limitations: All the OR team were not gathered except for the time of their scheduled operations, so the educational program was delivered individually not in groups.The enhancement in performance due to participants' knowledge of being observed that modified their behaviour from what it would have been without that knowledge, Hawthorne effect. Data collection was restricted to major surgical operations and didn't include emergency surgical operations. To implement the checklist; it had to be introduced as a formal document and compulsory step to go forward in the surgery which was not available authority for us.

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