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RESEARCH ARTICLE

SURGICAL ASEPSIS PRACTICES AMONG OR STAFF IN KING KHALID HOSPITAL, NAJRAN

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ABSTRACT

Background: Surgical asepsis practices should maintained by the surgical team to prevent contamination of the open surgical wound.
Aim: This study aimed to evaluate the surgical asepsis practices in the operating theatre of King Khalid Hospital, Najran.
Methods: The researchers utilized a three data collection forms to collect the needed data about practices of surgical asepsis. Swabs obtained from surgical site and from OR surfaces for bacteriological examination.
Results: only 55% of patients showered the day of surgery, there was no cleaning of light and scrubbing sinks at 60% and 75% of surgeries respectively. Sterile persons touch only sterile items at 55% of surgeries, 84.9% of them performed surgical scrubbing correctly. There was a contamination of OR floor and conditioning system in 55% of surgeries, there was a surgical site infection(SSI) after suturing among 40% of patients and there was a correlation between contamination of scrubbing taps and SSI post- preparation ($P < 0.05$).
Conclusion: There was an improper surgical asepsis practices performed by OR surgical team, we recommend the importance of continuing education among OR staff to keep them updated with the new trends and developments in surgical asepsis.

INTRODUCTION

Healthcare-associated infections (HCAIs), particularly those involving multi-resistant bacteria, are associated with increased morbidity, mortality, and cost of care and as well as longer length of stay in hospitals (Karki and Cheng, 2012). Based on Centers for Disease Control (CDC) and Prevention National Nosocomial Infections Surveillance system (NNIS) reports, surgical site infection (SSI) are the third most frequently reported nosocomial infection, accounting for 14–16% of all nosocomial infections among hospitalized patients (Rui, *et al.,* 2007). Prevention of infection is the goal for all surgical patients (Bowen, 2011. One of the expected outcomes for surgical intervention is that the patient is free from signs and symptoms of infection, such as pain, foul odor, purulent drainage, and/or fever through 30 days following the procedure. Throughout the patient's perioperative journey, infection prevention requires the application of the principles of microbiology and aseptic practice, as well as effective teamwork (AORN, 2011). Surgical asepsis is a set of specific practices and procedures performed under carefully controlled conditions, with the goal of minimizing contamination by pathogens. It employed to maximize and maintain asepsis (the absence of pathogenic organisms in the clinical setting). Aseptic technique protects the patient from infection and prevents the spread of pathogens (Benson and Powers, 2011).

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Sterile technique is the basis of modern surgery and therefore strict adherence to the recommended practices of sterile technique is mandatory for the safety of the patient as well as for the personnel in the operating room complex (Philips and Berry, 2007). Compliance with infection control and sterile technique principles in practice may prevent nosocomial infections in the operating room complex and will result in the patient's hospital stay being shorter and a reduced cost for the medical aids and hospitals, whereas infections result in an increased institutional cost due to an increased length and complexity of hospital admission (Kilpatrick and Reilly, 2002).

Numerous practices and considerations can contribute to reducing the likelihood of SSI. These include patient preparation (e.g., nutritional assessment, surgical site hair removal, pre-operative showers); following good environmental cleaning techniques, wearing proper surgical attire, and reducing traffic; practicing hand hygiene, the surgical scrub, and antimicrobial prophylaxis; draping, ensuring non-contaminated instrumentation, and, of course, good aseptic technique throughout the surgical procedure (Humphreys, 2009). Sterilization plays an important role in maintaining asepsis in the OR and in preventing contamination of the open surgical wound. Sterilization describes a process that destroys all forms of microbial life (Rutala and Weber, 2008). AORN's "Recommended practices for sterilization in the perioperative practice setting" states that sterilization provides the highest level of assurance that instruments,

sutures, fluids, supplies, and drapes are void of microorganisms (AORN, 2011). The air-conditioning is an important aspect of the operating room complex. To control bio-particulate matter within the operating room environment, ventilating air should delivered to the room from ceiling vents or vents located high on the walls (Phillips, 2007). Studies have also shown that the number of individuals in the operating room and the amount of movement of these individuals within the OR both increase the number of colony-forming units as measured by settle plates within the room. It is also an independent risk factor for SSIs. Therefore, it is important that movement of personnel is kept to a minimum while invasive procedures are in progress (Olsen, *et al.*, 2008). The most common method by which bacteria can gain access into a wound is when the wound is open during the intra-operative period. Surgical hand antisepsis, performed before donning sterile gloves, is another important factor in SSI prevention. The purpose of a surgical hand antisepsis is to reduce transient and resident microorganisms on the hands and maintain the bacterial level below baseline, as this may reduce hospital acquired infections (AORN, 2010). Perioperative nurses should not wear jewelry such as earrings, necklaces, watches, or bracelets that cannot contained within the surgical attire because of the risk of contaminating the surgical attire. Nurses. AORN published the "Recommended practices for surgical attire" to guide perioperative RNs in establishing protocols for selecting, wearing, and laundering surgical attire. Perioperative RNs should model the correct practices for donning and wearing surgical attire, and teach team members about evidence-based practices (The annual AORN Congress, 2012).

The goal of aseptic technique is to protect the patient by preventing or minimizing postoperative infection through creating conditions and following procedures to prevent the introduction of microbial contamination into sterile fields, sterile equipment and the operative site (Rothrock, 2011). The nurse is the member of the healthcare team who leads the rest of the team in practicing prevention strategies to protect the patient from infection. Some of the most basic strategies resulting in positive patient outcomes include; the practice and promotion of hand hygiene, consistent use of aseptic technique, cleaning and disinfection practices (Benson and Powers, 2011). Nurses have a professional and moral obligation to protect the health of their patients and share the responsibility to sustain and protect the natural environment (ICN, 2009). Nurses play an important role in the prevention and control of surgical site infections (SSIs) because they undertake a high proportion of the treatment and care of surgical patients. Sterile technique plays a vital role in the control and prevention of SSIs and surgical site contamination (Labrague, *et al.*, 2012). Nurses understand the importance of maintaining a clean environment and how this contribute to reducing reservoirs of microbes shed from the patient and how this assists in securing the confidence of patients and the public. More specifically, nurses know what really matters in the prevention of cross infection, what can make a difference and how it can achieved practically. Certain practices and procedures, if mastered competently, will reduce the risk of infection for patients. Nurses can influence directly and indirectly on the outcome of patient care in relation to the acquisition of infection (Topley and Privett, 2005).

Aim of the study

The aim of this study was to evaluate surgical asepsis practices in the operating theatre of King Khalid Hospital, Najran.

MATERIAL AND METHODS

Study design

A descriptive design utilized in this study.

Study setting

This study conducted in operating rooms of King Khalid Hospital; a 300-bed general hospital in Najran Region.

Sample

The study conducted on 20 surgeries in the operating theatre to evaluate the surgical asepsis practices performed by surgical team members.

Inclusion Criteria

All types of General Surgery, Neurological Surgery, Urological Surgery and Ophthalmological Surgery were included, surgeries excluded from the study were; general surgery interventions performed as emergency procedures, diagnostic interventions (except for exploratory endoscopy), and general surgery procedures performed on an outpatient basis (ie, ambulatory surgery).

Tools

The researchers utilized a three data collection forms:

Form (I): included information about surgery as name of surgery, numbers of persons entering the operating room, times of OR door opening, number of persons entering and leaving the operating room.

Form (II): composed of an observational checklist (Beldi, *et al.*, 2009) with rating scale of yes (2 marks) and no (1 mark) and included surgical asepsis practices performed for each surgery; divided into three parts:

Part (1): contained eleven items about patient preparation for surgery; shaving, Showering, wearing hospital gown, removal of makeup, removal of hair pins, removal of Jewelry and wearing overhead cap.

Part (2): included ten items about; surgical asepsis practices related to operating room cleanliness between surgeries, after the last surgery, cleaning of furniture, light, walls, floor, vents, air conditioning system, taps, scrubbing sinks and cleaning of equipments.

Part (3): involved 18 items about aseptic technique practices as; draping the surgical table, cleaning the surgical site, draping the patient, creating a sterile field, sterile persons practices, unsterile persons practices, dispose contaminated wastes, washing surgical instruments, handling soiled laundry and discarding of sharp objects.

Form (III): composed of an observational checklist (Castella, *et al.*, 2006) with rating scale of yes (2 marks) and no (1 mark) and contained practices done by all surgical team members founded inside the operating theatre for each surgery which consisted of two parts:

Part (1): involved eight items about practices related to prevention of infection as: wearing over-shoes, wearing

mask, wearing overhead cap, wearing the gown or attire wearing goggles, cutting the nails, removing make up and removing of jewelry.

Part (2): included thirteen items related to performance of surgical hand scrubbing, gowning, gloving, removal of facemask, gown and gloves.

METHOD

Approval to conduct the study obtained from the responsible authorities of King Khalid Hospital after providing an explanation of the study aim, as well as explained the purpose of the study to the surgical team members. Written consent signed from surgical team members as well as from the patients included in this study. The study conducted from February 2013 to Jolly 2013.

Bacteriological technique

The skin cultures obtained by three samples from each surgical site first one obtained pre-preparation of the skin, the second one obtained post-preparation of the skin by the using of avagard 2% solution and the last one obtained after wound suture using sterile bacteriological swabs. The study also included swabs from scrubbing taps, sinks, floor, light source and air conditioning system. After collection, samples were transported immediately (within 2 hours) to the microbiology department of the College of Medicine, Najran University. All samples inoculated into blood agar plates (Difco Laboratories, Detroit, USA). The plates incubated upon collection at 37^{o}C. After 48 hours of incubation, colony counts obtained for all plates. Bacterial count calculated by the use of $\log_{10}$ reduction factor (RF) and represented as (CFU/ml). Species identification not performed because the primary focus is to obtain a quantitative rather than a qualitative analysis (CDC, 2003). Content validity of the study tools (form II and form III) tested by five (professors) experts in the field of medical surgical nursing. Accordingly, all necessary modifications done. Tool tested for its reliability using Cronbach_Alpha Coefficient Statistical test, which revealed that the reliability of the form II was 0.6 and reliability of the form III was 0.97, which indicates high reliability. A pilot study carried out on two surgical procedures in the previous mentioned setting to ensure clarity, applicability, and feasibility of the tools.

Statistical analysis

The collected data were organized, tabulated and statistically analyzed using SPSS software statistical computer package version 15.frequency, percentage calculated.

RESULTS

Table (1) illustrated that there were a 20 surgeries performed for 20 patients which were; (3 Open reduction and internal fixation, 2 Herniorrhaphy, 2 Cholecystectomy,1 Close-reduction andfracture fixation, 1 Nephro-lithotomy, 1 Hemi-colectomy, 2 Resection of bladder tumor, 1 Exploratory laparotomy, 1 Spinal fixation, 1 Appendectomy, 1 Nephrectomy, 1 Maxillo-facial surgery, 1 Craniotomy, 1 Thyroidectomy and 1 Hip prosthesis. Number of persons entered the operating room ranged from six to nine persons, while operating room door opened once or twice in the majority of surgeries and there was one or two persons entered and left the OR during the majority of surgeries.

Concerning surgical asepsis practices related to patient preparation before surgery, Figure (1) presented that, 75% of patients removed hair from surgical site the day before surgery and 25% of them shaved the day of surgery. There was a 75% of patients removed hair by the use of electric clippers and only 75% of them showered the day before surgery, while nearly half of them (55%) showered the day of surgery; 85% of patients showered by antimicrobial soap. On the other hand, nearly all of patients were wearing hospital gown, overhead cap, removed makeup, hairpins and jewelry.

Regarding surgical asepsis practices related to operating room cleaning, Figure (2) showed that, there was no cleaning of vents and air conditioning system at 75% of surgeries, no cleaning of light at 60% of surgeries. There was cleaning of sinks and scrubbing taps properly at 75% of surgeries, also cleaning of walls and flat surfaces and dispensers properly at 80% of surgeries. While there, was a proper cleaning of OR floor between surgeries, after last surgery and weekly cleaning with disinfectant solution performed at 100% of surgeries.

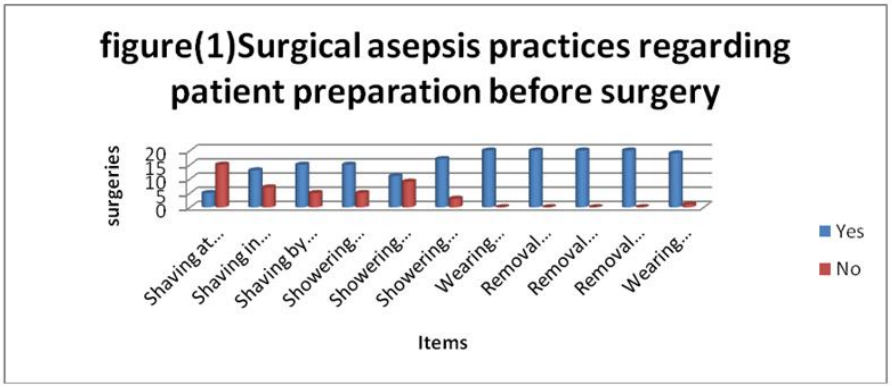
Concerning aseptic technique practices in the operating rooms, Figure (3) presented that, the door of OR continuously opened at 90% of surgeries. Only sterile items e used within the sterile

Table (I) Information related to number of persons entered OR and times of door opening

	Name of surgery	No. of persons Entered the OR	Times of door Opening	persons entering and leaving the OR
1	Open reduction and internal fixation	8	2	2
2	Herniorrhaphy + hernioplasty	7	2	2
3	Cholecystectomy	6	1	1
4	Close-reduction andfracture fixation	7	2	2
5	Nephro-lithotomy	7	1	1
6	Hemi-colectomy	8	1	1
7	Open-reductionand internal fixation	7	0	0
8	Resection of bladder tumor	9	2	2
9	Exploratory laparotomy	8	2	0
10	Spinal fixation	7	0	0
11	Resection of bladder tumor	9	2	1
12	Open reductionand internal fixation	7	1	1
13	Appendectomy	6	1	1
14	Nephrectomy	7	0	0
15	Maxillo-facial surgery	8	2	2
16	Cholecystectomy	6	1	1
17	Herniorrhaphy	7	1	1
18	Craniotomy	7	0	0
19	Thyroidectomy	8	1	1
20	Hip prosthesis	7	1	1

field in 70% of surgeries and sterile persons touch only sterile items or areas at 55% of surgeries. Sterile persons keep well within the sterile areas at 80% of surgeries, unsterile persons avoid reaching over the sterile field at 75% of surgeries and unsterile persons avoid sterile areas at 80% of surgeries. On the other hand, other aseptic technique practices performed correctly by 100% in all surgeries as draping of the patient, cleaning of surgical site, creation of sterile field, sharp disposal, disposal of contaminated items, washing of equipment and surgical instruments and all surgical drapes were disposal.

Concerning practices related to prevention of infection in OR performed by surgical team members, Table (2) revealed that, 100% of the surgical team members did not wear goggles. 93.8% of the operating room staff wore surgical mask correctly, only 5.5% did not cut their nails or removed nail polish. 95.2% of the surgical staff wore overhead cap correctly, but 0.7% wore jewelry while all of them (100%) wore gown and over-shoes. Regarding surgical asepsis practices related to scrubbing, gowning and gloving performed by surgical team members Table (3) showed that 84.9% of the surgical team scrubbed hands and forearms and dried them



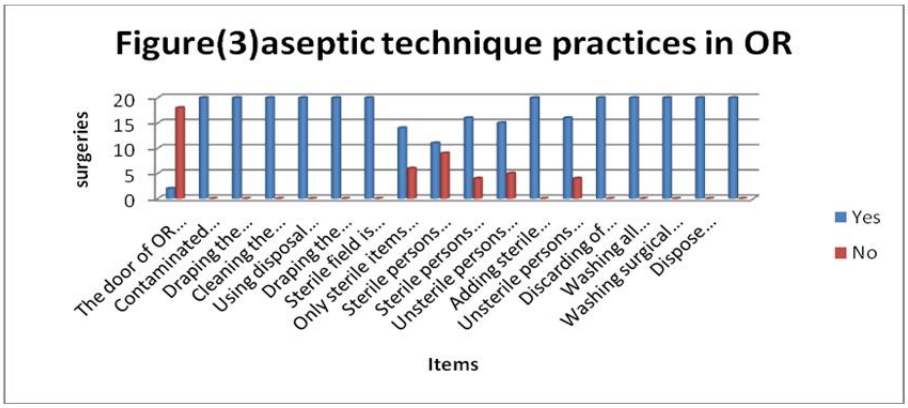


Table (2) Practices related to prevention of infection in OR performed by surgical team members

Items	Infection control practices(146)			
	Yes		No	
	Number	%	Number	%
Wearing over-shoes	146	100%	0	0%
Wearing mask correctly	137	93.8%	9	6.2%
Wearing overhead cap correctly	139	95.2%	7	4.8%
Wearing the gown or attire	146	100%	0	0%
Wearing goggles	0	0%	146	100%
Cutting the nails	138	94.5%	8	5.5%
Removing nail-polish	138	94.5%	8	5.5%
Removing jewelry	145	99.3%	1	0.7%

correctly. 77.4% of them cleaned under nails correctly, 76.7% used aseptic technique in donning surgical gown, while 73.3% removed it correctly. 81.5% used aseptic technique in donning gloves, while, 76% removed it correctly. Regarding number of colony forming units (CFU) related to OR cultures and surgical site cultures, Tables (4) and (5) indicated that, there was a contamination in 40% of scrubbing taps, with the highest count 3.70 CFU/ml and contamination in 20% of scrubbing sinks with the highest count 3 CFU/ml. There was a contamination of the floor in 55% of surgeries with the highest count 3.90. CFU/ml, contamination of the light source in 45% of surgeries with the highest count 3.70 CFU/ml and contamination of the conditioning system in 55% of surgeries with the highest count 3.90 CFU/ml. Regarding surgical site, there was a surgical site infection among all patients pre-preparation of the skin with the highest count 4.18 CFU/ml. There was a SSI post-preparation of the skin among 35% of patients with highest count 3.30 CFU/ml. In addition, there was an infection after wound closure among 40% of patients with the highest count was 3.70 CFU/ml.

Concerning the correlation between surgical site infection and OR infection, Table (6) Illustrated that there was no statistical correlation between surgical site infection pre-preparation of skin, post-preparation of skin and after wound closure and contamination of scrubbing sinks, OR floor, light and air condition. There was a correlation between contamination of scrubbing taps and surgical site infection post-preparation of skin ($P < 0.05$).

DISCUSSION

Number of persons entered and left the OR

We should strive to decrease the frequency of individuals entering and exiting the operating room during surgery, which presents an elevated risk of infection to patients. A negative pressure in the OR forces air to exit whenever the door opened which prevents the potential for airborne pathogens to enter the room and maintains a higher level of sterilization. The risk of infection to the patients is, however, increased by individuals entering the room that have not properly

Table (3) surgical asepsis practices related to scrubbing, gowningand gloving performed by surgical team member

Items	Infection control practices(146)			
	Yes		No	
	Number	%	Number	%
Adjusting the tap	145	99.3%	1	0.7%
Adjusting warm water	146	100%	0	0%
Washing hands and forearms by soap correctly	144	98.6%	2	1.4%
Scrub hands and forearms correctly	124	84.9%	22	15.1%
Cleaning under nails correctly	113	77.4%	33	22.6%
Scrubbing duration from 2-6 minutes	132	90.4%	14	9.6%
Rinsing well	142	97.3%	4	2.7%
Closing tap correctly	141	96.6%	5	3.4%
Drying well	124	84.9%	22	15.1%
Using aseptic(technique in donning surgical gown	112	76.7%	34	23.3%
Using aseptic technique in donning gloves	119	81.5%	27	18.5%
Removal of surgical gown correctly	107	73.3%	39	26.7%
Removal of gloves correctly	111	76%	35	24%

Table (4) Number of colony forming units related to OR cultures and surgical site cultures

N0	Name of surgery	Taps culture	Sink culture	Floor culture	Light culture	Condition culture	Surgical culture		
							Before Prep.	After prep.	After wound closure
1	Open reduction and internal fixation	3.30	3	3.30	1	3.30	1.40	3.30	3
2	Herniorrhaphy + hernioplasty	3	1.30	3	3.30	3	1.70	3	3
3	Cholecystectomy	0	0	0	1	0	3.60	0	3.30
4	Close-reduction and fracture fixation	0	0	3	0	0	4.18	0	0
5	Nephro-lithotomy	3	0	0	1	3.30	1.90	1.70	0
6	Hemi-colectomy	0	0	3	0	0	1.90	3.30	0
7	Open-reductionand internal fixation	3.70	0	0	0	3.90	1	0	3
8	Resection of bladder tumor	0	0	0	1.40	3.90	1.40	0	0
9	Exploratory laparotomy	0	0	3.30	0	3	1.40	0	0
10	Spinal fixation	3	0	3.30	0	3.48	1.70	0	0
11	Resection of bladder tumor	0	3	0	0	3.30	1.30	0	0
12	Open reductionand internal fixation	0	0	3.90	0	0	3.70	0	0
13	Appendectomy	0	0	0	0	3.30	3.90	0	0
14	Nephrectomy	0	3	0	3.70	0	1.40	3	3.70
15	Maxillo-facial Surgery	0	0	3.70	0	0	1.90	0	3
16	Cholecystectomy	0	0	3.30	0	1	1.40	0	0
17	Herniorrhaphy	3	0	3.30	0	0	1	3	3.30
18	Craniotomy	3	0	0	3	0	1.18	0	0
19	Thyroidectomy	3.30	0	3.70	3.48	0	1	3	3.70
20	Hip prosthesis	0	0	0	3.30	3.70	3.70	0	0

Table (5) Number and percentage of SSI and OR surfaces infection

Taps infection		Sink infection		Floor infection		Light infection		Condition infection		SSI infection					
										Pre-prep.		Post-prep.		Post wound Closure	
No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
8	40	4	20	11	55	9	45	11	55	20	100	7	35	8	40

Table (6) Correlation between surgical site infection and OR infection

Surgical site infection	Condition	light	Floor	sink	Taps
After closure	.362	.125	.311	-.340	.385
After cleaning	.371	.145	.411	-.160	.463(*)
Before cleaning	.237	.252	-.048	.140	.130

* Correlation is significant at the 0.05 level (2-tailed).

disinfected and may be carrying microbes on their clothing and skin (Bossart *et al.*, 2005). Results of this study showed that there was one or two persons entered and left the OR during the majority of surgeries. This result was supported by the study done by Bossart *et al*. (2005) for12.67 hrs OR observation; who reported that non-surgical healthcare workers entered within close proximity to the patient 67 times (10 of those occurrences being for a prolonged period of more than 6 minutes) during the operation. These individuals were not appropriately prepared to enter within close proximity to the patient and lacked proper attire and correct sanitization. Regarding number of persons found in OR and door opening during surgeries Pratt, *et al.* (2001); concluded that, minimizing the number of people in the operating room, movement and talking during surgery and keeping the operating room doors closed are very important. Because airborne contamination can expected with increased movement. Mixing of the operating room's air with the corridor air increases the bacterial count in the room and finally yet importantly, shedding increased with activity. Results of the current study illustrated that, number of persons entered the operating room ranged from six to nine persons, because there was a nursing students and internship medical students found in the OR during operations, while operating room door opened once or twice in the majority of surgeries. Another study conducted by Castella *et al.* (2004), observed 799 operations and reported that the mean number of healthcare personnel in the operating room was 6 and doors were opened an average of 12 times during an operation.

Surgical asepsis practices related to patient preparation

Preoperative shaving of the surgical site the night before an operation is associated with a significantly higher surgical site infection (SSI) risk than other methods of hair removal or no hair removal at all. The increased SSI risk associated with shaving attributed to microscopic cuts in the skin that provide a portal of entry for bacteria and a focus for bacterial multiplication. The hair removal methodology should reviewed with the peri-operative staff. The timing of the hair removal and the removal with the use of clippers versus razors are important processes. (AORN, 2012). Normally, the patient's hair should remove from the surgical site. This should done with an electric clipper or depilatory rather than a razor. Hair removal should performed immediately prior to the surgery (Liddle, 2012). Results of this study revealed that 75% of patients removed hair from surgical site the day before surgery while 25% of them shaved the day of surgery and 75% of patients removed hair by the use of electric clippers. Mathias (2000) reported that, 50 % of respondents indicated that they shaved the operative site before the patient comes either to the OR/ or in the OR. While another study done by Castella, *et al.* (2004), found that, from 856 patients observed; 433 patients removed hair the day before surgery; 21% of them removed hair by clippers. There was 71% removed hair by razor and 8% of them removed by depilatory cream. While 293 of patients removed hair, the day of surgery, 17% of them removed hair by clippers and 83% of them removed hair by razor. On the other hand, Beldi, *et al*. (2009), noted that, all patient's hair was removed using clippers immediately before the operation.

Whole-body bathing or showering with antimicrobial soap is one of the approaches aimed to reduce the bacterial density on skin of patients (Safdar and Bradley 2008). However, to gain maximum antiseptic effect, it must allowed drying completely and not be washed off. This may lower the risk of horizontal transmission of bacteria to other patients, and the incidence of healthcare-associated infections (Anderson, *et al.*, 2008). Results of the current study indicated that, 75% of patients showered the day before surgery while nearly half of them (55%) showered the day of surgery in addition 85% of patients showered by antimicrobial soap. This result was consistent with the results of Castella *et al.* (2004), who revealed that, 78% of patients had a shower (either on the day before or on the day of the operation), 80% showered with soap, and 20% with an antiseptic product. Regarding other pre-surgical practices performed for patient preparation, results of the current study illustrated that nearly all of patients were wearing hospital gown, overhead cap, removed makeup, hairpins and jewelry. This positive result may be related to the presence of preoperative checklist that must be completed before surgery which containing all pre-surgical practices that should be performed to the patient, and these practices usually performed routinely for all surgical patients. These results were compatible was Liddle (2012) who stated that, Before surgery, patient changes into a hospital gown that is left untied and open in the back. The patient with long hair may braid it, remove hairpins, and cover the head completely with a disposable paper cap. The mouth inspected, and dentures or plates removed. If left in the mouth, these items could easily fall to the back of the throat during induction of anesthesia and cause respiratory obstruction. Jewelry not worn to the operating room, wedding rings and jewelry of body piercings should remove to prevent injury.

Surgical asepsis practices related to OR cleaning

Regarding surgical asepsis practices related to cleaning of vents and air conditioning system, results of this study showed

that, there was no cleaning of vents and air conditioning system at 75% of surgeries. This result was not congruent with Fortunato (2000), who stated that, Air-conditioning systems effectively reduce the number of airborne organisms by removing aerosol and dust particles. The air that contaminated by dust and lint is removed as fresh, clean outside air is supplied. The recirculation of the filtered air at a minimum rate of fifteen volume exchanges per hour, at least four of which are fresh air, considered safe and economical. Cleaning of vents and air conditioning system is important in maintaining proper functioning of the system. Regarding operating room light cleaning, AORN (2010), reported that, dirt from overhead lights falling into the incision might be inevitable, unless sterile lighting invented. Therefore, lights always should be meticulously damp dusted before the first scheduled surgical procedure of the day and after each procedure with a facility-approved hospital detergent/disinfectant and water. Results of the current study reported that, there was no cleaning of light at 60% of surgeries. This result was incompatible with the finding of Phillips (2007), who stated that environmental services are relevant to infection control and the prevention of cross-infection and therefore operating room light contamination can cause surgical site infection. The operating lights should cleaned after each surgical procedure.

Concerning cleaning of operating room sinks, according to Fortunato (2000), surgical procedure rooms and scrub/utility areas should terminally cleaned daily. This done to reduce the number of microorganisms, dust, and organic debris present in the environment. This routine should use at the end of the day's schedule. Results of this study indicated that, there was a proper cleaning of sinks and scrubbing taps at 75% of surgeries, also cleaning of scrubbing dispensers done at 80% of surgeries. This result was consistent with Phillips (2007), who showed that, the water tap's head should be of a type that can removed for terminal sterilization and the containers for antimicrobial hand washing agents should be cleaned and terminally sterilized before refilling.

Regarding cleaning of OR surfaces, Fortunato (2000), said that, for furniture, wash horizontal surfaces of all tables and equipment with a disinfectant solution (avoid using spray bottles as this will aerosolize particles). Operating table mattress pads must washed also. Clean the casters of mobile furniture by pushing through the disinfectant solution. Results of this study revealed that, cleaning of walls and flat surfaces performed properly at 80% of surgeries. This result was against the finding of Jefferson, *et al.* (2011) who reported that, proper environmental cleaning is essential for effective patient care in the operating room because high-touch surfaces can harbor infection-causing pathogens if not disinfected thoroughly. "In fact, a recent study to determine if high-touch surfaces in the operating room were effectively disinfected found that only 25 % (237 of 946 targeted surfaces) were cleaned properly. The study also found that enhanced staff training and education yielded significant improvements. Proper cleansing reduces the amount of exogenous microorganisms in the surgical environment and helps to reduce air born contaminants that may travel in dust and settle on surfaces. In addition, well-developed cleansing protocol should implemented for all surgical procedures for protection of both patient and staff (Mangum and Gruendemann, 2001). Concerning cleaning of operating room floor, results of the current study indicated that there was a proper cleaning of OR floor between surgeries, after last surgery and weekly cleaning with disinfectant solution performed at 100% of surgeries. This result was against the result of Alaaa-Eldeenm, *et al.* (2012), who reported that, concerning practices related to post operative environmental hygiene, the study findings showed that these practices were done correctly for more than one half of patients.

Aseptic technique practices in OR

Infection delays the healing / repair of tissues; therefore, the implementation of infection control and sterile technique principles strictly enforced to prevent the transmission of organisms causing infection. The primary goal of the sterile surgical team members in the operating room complex is to prevent infection. This may be achieved by certain activities, such as environmental cleaning, disinfecting and sterilization of instrumentation and equipment, all of which form part of the infection control principles, and last but not least, the application of the sterile technique principles (Mogotlane, *et al.*, 2005). Results of the current study showed that, the door of OR continuously opened at 90% of surgeries. This result was incongruent with the finding of AORN (2010), who noted that, open OR doors are conduits for potentially contaminated air. Each surgical suite should have strict rules about which doors should remain shut unless entrance or exit is required. Traffic in and out of the OR should kept to a minimum. The doors to the OR should remain closed except when personnel are entering or leaving or patients, supplies, or equipment are being moved in or out of the OR.

Breaks in sterile technique can and do occur, even for the most conscientious perioperative practitioners. Prevention of surgical site infections, therefore, takes on great significance in today's dynamic health care environment. Key responsibilities of perioperative nurses are to recognize and correct common breaks in sterile technique that are made in preparation for and during a surgical procedure and to implement methods to prevent future occurrences (Hopper and Moss, 2010). Concerning aseptic technique practices related to sterile field, results of this study pointed out that, sterile items used only within the sterile field in 70% of surgeries. Sterile persons touch only sterile items or areas at 55% of surgeries, sterile persons keep well within the sterile areas at 80% of surgeries, unsterile persons avoid reaching over the sterile field at 75% of surgeries and unsterile persons avoid sterile areas at 80% of surgeries. These results were compatible with the result of Taneja *et al.* (2009) who concluded that, not all nurses in the sample applied a simple aseptic technique. In addition, Ozdemir (2010) pointed out that, there was a lack of operating room personnel practices regarding basic infection control protocols. Moreover Manisha *et al.* (2012) reported that, the mean reported infection control practice was 57.5%. On the other hand, these results were incompatible with Labrague, *et al.* (2012), findings who revealed that, largely operating room nurses applied the principles of sterile technique. He explained that this might attributed to the rigid training these nurses underwent during the in-house training conducted regularly by their institutions to keep them updated with the different nursing skills including performance of sterile technique. Regarding aseptic technique practices related to draping of patients, creating of a sterile field, results of the current study indicated that all surgical personnel performed

these techniques correctly and all surgical drapes were disposal. These results were going in line with the findings of Beldi, *et al.* (2009) who concluded that, single-use sterile drapes used in all patients. While these findings were incompatible with Alaaa-Eldeen, *et al.* (2012) who showed that, nurses compliance with the principles of aseptic technique in draping for approximately one half of patients. Regarding cleaning of surgical site, results of this study showed that, surgical site cleaning performed properly by avagard 2% for all patients. This result was consistent with the finding of Beldi *et al*. (2009) who concluded that, skin disinfection was applied 3 times using povidone-iodine– based disinfectant.

The prevention of sharps injuries has always been an essential element of Universal and now Standard Precautions.1-3 Injuries to healthcare personnel from needles and other sharp objects have been associated with transmission of human immunodeficiency virus (HIV), hepatitis B virus (HBV), and hepatitis C virus (HCV)(Do, *et al.*, 2003). The National Audit Report (2003) on safety in the National Health Settings (NHS) found that 17 per cent of reported accidents in the NHS were due to sharps injuries. Some estimates put the number of injuries as high as 100,000 per year. Waste reduction, segregation and disposal are all crucial to sustaining a healthy environment and reducing subsequent public health implications and financial costs. Nursing staff are proportion of the health care worker workforce that purchase (ICN, 2009). Respecting aseptic technique practices related to disposal of sharp and contaminated items, results of this study showed that, these practices done correctly by all surgical personnel. Searle (2000) agreed these results and noted that, scrupulous control of the environment and of the equipment is imperative. Environmental services include procedures such as cleaning and disinfecting the operating room complex environment, handling soiled laundry and disposing of solid waste. On the other hand, these results were against the results of Ozdemir (2010) who pointed out a lack of surgical staff practices related to sharp and waste disposal.

Nursing staff are responsible about cleaning of equipment and manage subsequent waste generated. Ineffective management of health care waste can also result in additional costs related to the disposal of waste if not segregated appropriately (RCN, 2011). According to Ohlsson (2006), the cleaning process of the instruments is essential. Instruments that disassembled must take apart for effective cleaning. Dirt that easily seen must be removed; the instruments must then be rinsed and left to dry. In this regard, Spry (2005) stated that proper cleansing, disinfection and sterilization of contaminated objects significantly and often reduce microorganisms. Results of the current study revealed that washing of equipment and surgical instruments done by all surgical staff at all surgeries correctly. Labrague *et al.* (2012), who reported that, all surgical nurses were follow principles of surgical asepsis in cleaning and preparing of equipment and instruments, agreed this result. Moreover, Alaaa-Eldeen, *et al.* (2012) clarified that the practices related to care of surgical instruments such as cleaning, preparing for sterilization, and autoclaving done correctly for the majority of patients. On the other hand results of the present study was incongruent with the results of Pudner (2000), which indicated that the minority of nurses use infection control measures during cleaning, disinfection and sterilization of instruments. In addition, Abo-shadi and Ibrahim (2001), stated that nurses did not clean or sterilize instruments effectively and the performance of nurses was poor regarding cleaning and disinfection of instruments. Moreover, the World Health Organization (2004) revealed that these practices not correctly done for the majority of patients involved in the study.

Practices related to prevention of infection

Wearing surgical attire and appropriate personal protective equipment in the semi-restricted and restricted areas of health care facilities promotes personnel safety and helps ensure cleanliness in the peri-operative environment. It understood that the human body and the various surfaces in the peri-operative setting are sources of microbial contamination and microbe transmission (Braswell and Sprucem, 2012). Protective eyewear, masks, or face shields must worn when splashing or spraying is likely. Masks should be worn, along with protective eyewear (eg, goggles, glasses with solid side shields, chin-length face shields) whenever eye, nose, or mouth contamination reasonably can be anticipated as a result of splashes, spray, or splatter of blood droplets or other potentially infectious materials. Goggles worn to protect the scrubbing persons from any body fluids splashing into their eyes (Fogg, 2003). Results of this study revealed that 100% of the surgical team members did not wear goggles. Angelillo, *et al.* (2002), who found that, only 38% of the operating room staff used protective eyewear, agreed this result. In addition, another study performed by Ganczak and Szych (2007) noted that, compliance of surgical personnel was much lower for protective eyewear (9%). However, this result was incompatible with the finding of Castella *et al*. (2004) who reported that, Safety shields for protecting eyes and mucosa worn by the surgical team.

Surgical masks decrease sterile field contamination with nasal and oropharyngeal commensal bacteria. Efficacy reduced beyond 15 min of use, which advocates for the donning of a fresh mask for each procedure (Siegel, *et al.*, 2007). Individuals entering the restricted areas should wear a surgical mask when open sterile supplies and equipment are present. The mask protects both the patient and the perioperative team members from exposure to microorganisms. All members of the perioperative team are at risk for exposure from droplets. Wearing a surgical mask protects health care providers from droplets greater than 5 micrometers in size. Wearing a surgical mask protects the patient from exposure to infectious material carried in the health care provider's nose or mouth. Wearing a surgical mask also protects the health care provider from exposure to other infectious material from patients, such as respiratory secretions or sprays of blood or body fluids. Wearing a surgical mask decreases the risk of inadvertent splashes or splatters of blood or body fluid into the health care provider's mouth or nose (Braswell and Sprucem, 2012). Results of this study showed that 93.8% of the operating room staff wore surgical mask correctly. This result was in the same line with a study done by Castella *et al.* (2004) who concluded that, 88% of the surgical team members wore mask correctly. In addition, Beldi *et al.* (2009) concluded that, all members of the surgical team wore surgical masks. Moreover, Labrague, *et al.* (2012), reported that, all OR staff wore surgical mask well. However, this result was inconsistent with results of Angelillo, *et al*, (2002) who presented that, only 38% of the surgical team were routinely used surgical mask.

Recent studies found no increase in microbial growth related to wearing freshly applied nail polish; however, nail polish that is obviously chipped or worn longer than four days is associated with the presence of greater numbers of bacteria and has been associated with infections. Surgical conscience, therefore, must be a foremost behavior in individuals who choose to wear nail polish in the surgical setting (Arrowsmith *et al*., 2004). Results of the current study indicated that only 5.5% of the surgical team members did not cut their nails or removed nail polish. This result was compatible with results of the study done by Castella *et al*. (2004), who stated that, 95% of persons present in the operating room had short fingernails and free from nail polish. Wearing of surgical caps reduces ambient bacterial contamination. Hair covers eliminate the possibility of hair or dandruff that shed onto scrub suits and into the environment. (Siegel, *et al.*, 2007). All personnel should cover their head and facial hair when in the semi-restricted and restricted areas. Hair coverings should cover facial hair, sideburns, and the nape of the neck. Perioperative nurses can help minimize the risk of surgical site infections by covering head and facial hair, which prevents skin squamous and hair shed from the scalp from falling onto the sterile field (Braswell and Sprucem, 2012).Results of this study indicated that, only 4.8% of the surgical staff did not wear overhead cap correctly. This result is consistent with the result of Castella *et al*. (2004), who said that, 87.5% of operating room members wore a cap/hood correctly so that it fully covered head hair. In addition, Beldi *et al*. (2009) noted that, all members of the surgical team wore surgical caps and masks. Moreover, Labrague *et al*. (2012), reported that, all OR staff wore head cover at all times.

Remove jewelry where possible, although local policy may allow tape to apply around jewelry that is difficult to remove (Liddle, 2012). Jewelry carries increased bacterial counts despite hand hygiene (Siegel, *et al.*, 2007). Peri-operative nurses should not wear jewelry such as earrings, necklaces, watches, or bracelets that contained within the surgical attire because of the risk of contaminating the surgical attire. Research now shows that bacteria are nine times higher on the skin beneath fingers and nose rings than on the rings themselves. Wearing rings may in fact, cause injury to the wearer or to patients. For example, a ring may become caught while the nurse is preparing surgical equipment and results in an injury, laceration, or avulsion. The ring contaminated with unknown microorganisms during a surgical procedure, causing the skin beneath the ring to become colonized (Bartlett, *et al*, 2002). Results of the current study showed that only 0.7% of the surgical room members wore jewelry. This result was incompatible with the study of Castella *et al*. (2004), who reported that, Jewelry (ie, neck jewelry, earrings, rings, bracelets, and/or wristwatches) worn by 34% of the surgical personnel.

Footwear worn in the operating theatre shall be clean, comply with occupational health and Safety standards and be of a design and material to permit proper cleaning. Footwear should be waterproof, have an easily cleanable sole and upper surface, and have enclosed toes to minimize injuries. Permanent theatre staff should wear dedicated theatre/boots, these should be named and cleaned when stained or at least weekly with soap and water. Visitors or other hospital staff who wear overshoes must only wear them within the theatre department (ACORN, 2010). Results of this study reported that 100% of the surgical team members wore over-shoes. This result was congruent with Castella *et al*. (2004), who concluded that shoe covers worn by 96% of persons in the operating room.

Surgical gown plays a crucial role in asepsis by reducing the transfer of bacteria from the skin of the surgical staff to the air in the operating room. Wearing surgical gowns is vital because there will always be microorganisms on or in the human skin, even after conducting strict hygienic and sterilization procedures. It understood that the human body and the various surfaces in the perioperative setting are sources of microbial contamination and microbe transmission. Clean surgical gown helps to minimize the introduction of microorganisms and lint from health care personnel to clean items and the environment. The purpose of surgical gowns and other protective clothing is not only to keep bacteria from entering surgical wounds, but also to protect the surgical staff from blood, urine, saline, or other chemicals and bodily fluids during surgical procedures (Braswell *et al*., 2012). Results of the current study noted that, 100% of the surgical team members wore surgical gowns. This result was going in line with the findings of Castella *et al*. (2004), who concluded that, 96% of surgery team members adhered to the principles of asepsis for donning sterile gowns. In addition, this result was compatible with the finding of Labrague *et al*. (2012) who pointed out that, all OR staff wore proper surgical suit/ attire at all times.

Surgical asepsis practices related to scrubbing, gowning and gloving

The hands of surgeons and scrub nurses carry microorganisms identified as sources of microbial contamination, so the surgical hand scrub plays a significant role in preventing nosocomial and surgical site infections (AORN, 2010). Hand hygiene is one of the most effective infection control practices to protect both the patient and healthcare worker (HCW) from colonization and/or infection with microorganisms (Siegel *et al*., 2007).The majority of microorganisms found on the hand. Removing debris from fingernails requires the use of a nail cleaner under running water; additional effort is necessary for longer nails. The risk of tearing gloves increases if fingernails extend past the fingertips. Long fingernails may cause injury when moving or positioning patients (Fogg, 2003). Gowning and gloving considered a part of the daily routine of OR staff. As required by Standard Precautions, sterile gowns and gloves worn to prevent the migration of microbes from the skin and scrub attire of the sterile team member to the sterile field. Additionally, sterile attire prevents blood and body fluids from contaminating the team member. Lastly, sterile attire aids in preventing surgical site infections (SSI) by allowing team members to work within the sterile field (Frey and Ross, 2008). Regarding surgical asepsis practices related to scrubbing, gowning and gloving that, performed by surgical team members, results of this study showed that, 84.9% of the surgical team scrubbed hands and forearms and dried them correctly. 77.4% of the surgical team cleaned under nails correctly, 76.7% used aseptic technique in donning surgical gown, while 73.3% removed surgical gown correctly, 81.5% used aseptic technique in donning gloves, while, 76% removed it correctly. These findings were consistent with Phillips and Berry (2004), who found that the

majority of nurses had complied well with scrubbing, gowning and gloving. Also Castella *et al*. (2004) showed that, 78.2% of surgical team members performed preoperative hand scrubbing in the correct sequence and for the correct amount of time. Moreover Labrague *et al*. (2012) revealed that, largely all operating room nurses applied scrubbing, gowning and gloving. While another study done by Alaaa-Eldeen, *et al*. (2012) reported that, scrubbing, gowning and gloving done correctly for approximately one-half of patients.

Contamination of OR and surgical site

The wound considered clean when the operative procedure does not enter into a normally colonized viscous or lumen of the body. SSI rates in this class of procedures are less than 2%, depending upon clinical variables, and often originate from contaminants in the OR environment, from the surgical team or most commonly from skin. Intraoperative skin preparation is of critical importance, not only that the antibacterial solution used has broad spectrum properties, but also that the product be properly applied (Pear, 2007). Despite improvements in prevention, SSIs remain a significant clinical problem as they are associated with substantial morbidity and mortality and impose severe demands on healthcare resources. The incidence of SSIs may be as high as 20%, depending on the surgical procedure, the surveillance criteria used, and the quality of data collection. Numerous patient-related and procedure-related factors influence the risk of SSI, and hence prevention requires a 'bundle' approach, with systematic attention to multiple risk factors, in order to reduce the risk of bacterial contamination and improve the patient's defenses. The Centers for Disease Control and Prevention guidelines for the prevention of SSIs emphasis the importance of good patient preparation, aseptic practice, and attention to surgical technique; antimicrobial prophylaxis is also indicated in specific circumstances (Owens and Stoessel, 2008). Respecting operating room contamination, samples that taken from 20 OR rooms, indicated that, there was a contamination in 40% of scrubbing taps, with the highest count 3.70 CFU/ml and contamination in 20% of scrubbing sinks with the highest count 3 CFU/ml. In addition, there was a contamination of the floor in 55% of surgeries with the highest count 3.90 CFU/ml; contamination of the light source in 45% of surgeries with the highest count 3.70 CFU/ml and contamination of the conditioning system in 55% of surgeries with the highest count 3.90 CFU/ml. In this regard (Singh *et al*., 2013) noted that, The bacterial pathogens were isolated comprising of Staphylococcus aureus and coagulase negative Staphylococci spp., had the highest percentage of occurrence in air samples while in surface samples Bacillus spp. showed highest percentage of occurrence. In addition, Edmiston, *et al*. (2005) found that, Coagulase-negative staphylococci recovered from 86% of air samples, whereas Staphylococcus aureus recovered from 64% of air samples. Moreover, Munoz-Price, *et al*. (2012), concluded that, Thirty-four floor areas were cultured, including 22 at baseline and 12 at follow-up; pathogens were isolated from 63% and 66% of floor areas, respectively (P = .917). Gram-negative bacilli were identified in 63% of floor samples at baseline and in 41.6% of floor samples at follow-up (P = .108).

Surgical site infection (SSI) is the second most common health care associated infection and one of the most important causes of healthcare associated infections (HCAIs), accounting for up to 20% of all HCAIs, and affecting at least 5% of patients undergoing a surgical procedure moreover. Treatment for SSIs is both time consuming and a significant burden on the healthcare system (NICE, 2008). Surgical site infection accounts for 14% to 16% of hospital-acquired infections. Reported surgical site infection rates ranged from 0.5% to 13%, depending on the type of surgery and patient characteristics (Smyth *et al*., 2008). Applying strategies for the prevention of surgical site infection help to reduce surgical patients' morbidity, mortality and length of stay, and save cost for the healthcare institutions (Bratzler *et al*., 2005). Surgical site infections are associated with considerable morbidity and over one-third of postoperative deaths related, at least in part, to SSIs. The consequences of such infections can be catastrophic: extended recovery times, more time in hospital, patient discomfort and disability (Plowman *et al*., 2001). Regarding surgical site contamination, results of the current study showed that, there was a surgical site infection among all patients pre-preparation of the skin with the highest count 4.18 CFU/ml and there was a SSI post-preparation of the skin among 35% of patients with highest count 3.30 CFU/ml. In addition, there was an infection after wound closure in 40% of patients with the highest count 3.70 CFU/ml. Cronquist *et al*. (2001), reported that, pre-post preparation cfu counts varied significantly by the site of surgery: the mean log cfu count for pre-preparation samples taken from the head (craniotomies and VP shunt insertions) was 4.13 log, (range, 0–7 log), and from backs, (spinal surgery) was 2.39 log (range, 0–7 log; $P <$ .0001). Eighteen percent of pre-preparation samples from backs showed no bacterial growth, and 1.4% of head pre-preparation samples had no growth ($P <$ .0001). Mean post-preparation log counts from the head (0.62) and back (0.54) were not significantly different, and the proportion of samples with no growth did not differ by site. There was microbial growth in approximately one quarter of post-preparation samples. In addition, Edmiston, *et al*. (2005) found that Coagulase-negative staphylococci were recovered 51% from within 0.5 m of the surgical wound, whereas Staphylococcus aureus was recovered 39% within 0.5 m from the wound.

Correlation between surgical site infection and OR infection

Sources of environmental contamination can be a source of infection to both caregivers and patients and may include people, supplies, equipment, insects, packaging materials, and anything that is not specifically intrinsic to the actual patient receiving care. Any surface, living or inanimate, can serve as a vector, or carrier, of a harmful substance. Contaminants include microorganisms, chemicals, foreign particulate matter, and other materials, which can interfere with the health and safety of patient and surgical team (Fortunato, 2000). Infection at or near surgical incisions within 30 days of an operative, procedure contributes substantially to surgical morbidity and mortality each year. The prevention of surgical site infections encompasses meticulous operative technique, timely administration of appropriate preoperative antibiotics, and a variety of preventive measures aimed at neutralizing the threat of bacterial, viral, and fungal contamination posed by operative staff, the operating room environment, and the patient's endogenous skin flora. It is the latter aspect of contamination, and specifically mechanical methods of prevention, on which this review focuses (Reichman and Greenberg, 2009). Surgical site infections arise when

microorganisms enter a surgical site and multiply. Potential sources of microorganisms in the operating theatre are surgical team members, circulating air, surgical instruments and the patient themselves. Staphylococcus aureus is the organism most commonly cultured from SSI (HPA, 2009). Regarding the correlation between surgical site infection and operating room infection, results of this study illustrated that there was a statistical correlation between contamination of scrubbing taps and surgical site infection after skin preparation only ($P < 0.05$). In this regard, Gurkan and Wenz (2006) reported that, here is a direct correlation between surgical site infection and environmental operating room contamination. In addition, most bacterial contamination usually transferred to the wound secondarily after first landing on other supposedly sterile surfaces. The source of environmental bacteria in OR shown to be the operating room personnel, and the quantity of environmental bacteria that the personnel shed and the number of people present. 30% of people are colonized by Staphylococcus aureus, and people shed about 106 skin scales loaded with bacteria per day. Moreover, Napoli *et al*. (2012) revealed that, bacterial contamination of operating theatre had contributed significantly to high prevalence of nosocomial infections. The resultant effect of bacterial contamination is much more pronounced in post-operative /or open wound that could occurs during dressing or contaminated air atmosphere in the operating theatre. Microbiological contamination of air in the operating room generally considered a risk factor for surgical site infections in clean surgery.

Conclusion and Recommendations:

This study concluded that there was improper patient preparation for surgery, there was improper cleaning of OR surfaces except cleaning of floors, there was improper aseptic technique practices in OR, all surgical team did not wore eye goggles and practices related to prevention of infection were performed improperly. There was a contamination in OR floors and scrubbing sinks and taps in more than half of surgeries, as well as contamination of OR surfaces in more than one third of surgeries. In addition, there was a contamination in surgical site among all patients pre preparation of skin and among more than one third of patients post preparation of skin by avagard 2% and after skin closure. There was a correlation between contamination of scrubbing taps and surgical site infection after skin preparation. This study reinforce the importance of continuing education among operating room staff to keep them updated with the new trends and developments in surgical asepsis in order to become increasingly efficient and effective at preventing nosocomial infections. The results generated from this study will provide insight to Nursing Administrators who are aiming to improve safe, complication free, and positive surgical outcome. Hospital programs for new nurses may likewise benefit from this study by providing information to newly hired nurses that will improve and enhance performance and provide quality nursing care to their surgical patients. This study focuses on a small number of patients involved in the surgeries, thus further study utilizing a bigger population maybe done. Furthermore, studies identifying other factors that related to knowledge and practice of sterile technique could investigated; also, other factors that may affect surgical site infection may be included.

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