Operating Rooms Environmental Cleaning: Knowledge and Performance of Nurses and Cleaners

Ms. Samar Ibrahim Ahmed 1, Dr. Sahar Mohamed Soliman 2, Dr. Madiha Hassan Nabih Mohamed3

1B.S.c-Nursing, Clinical Instructor

2Professor of Community Health Nursing, Faculty of Nursing Mansoura University, Egypt

3Assist Professor of Medical-Surgical Nursing, Faculty of Nursing Mansoura University, Egypt

1.ABSTRACT

Background: Environmental cleaning of the operating rooms through housekeeping services such as maintenance of safe, clean and well-groomed environment keeps the environment in a good sanitation and free from potential infection. **Aim:** Assess the knowledge and performance of nurses and cleaners regarding environmental cleaning in operating rooms. **Sample:** A ample of 154 nurses and 48 cleaners participated in the study. **Design:** A mix between quantitative (cross-sectional design) and qualitative design. **Setting:** This study carried out at operating rooms departments in which major surgical procedures are being implemented at Mansoura University Hospital **Tool:** Three tools were used in this study, self-administrated demographic and occupational, characteristics questionnaire, knowledge assessment questionnaire, observational checklist. **Results:** regarding operating room cleaning process, 53.2 % of the studied nurses showed fair level of knowledge, whereas 85.4% of the studied cleaners showed good level of knowledge. Vast majority of both nurses and cleaners showed improper performance regarding operating room cleaning process. There was a significant association between studied nurses' total knowledge with age, education, and years of experience. There was not any association between studied nurses' total performance with their demographic characteristics. **Conclusion:** Majority of the studied nurses showed poor knowledge and improper practice regarding operating room cleaning process whereas cleaners showed good knowledge but have improper practice. Significant association documented between studied nurses' total knowledge with age, education, and years of experience. **Recommendation:** Provide a protocol for healthcare workers about operating rooms environmental cleaning, continuous training and periodic assessment of healthcare workers' performance related to environmental cleaning.

Keywords: Healthcare workers, Environmental Cleaning, Operating Rooms, Knowledge, Performance.

2.Introduction:

Environmental surfaces in health care settings are carrying a risk of transmitting microorganisms within health care facilities to patients, staff, visitors and subsequently to the entire external society because of the provision of care to large number of patients that results in the contamination of surfaces and objects with harmful microorganisms. Transmission of microorganisms within health care facilities is complex and very different from transmission outside health care facilities and the following consequences of transmission may be more severe leading to what we are calling the burden of health care-associated infection **(Provincial Infectious Diseases Advisory Committee (PIDAC), 2018 and World Health Organization (WHO), 2020).**

Therefore, the environment of the health care organizations is more risky for transmitting infection than in public areas of non-health care organizations, because of the nature of activity carried out in the health care facilities and the transient behavior of patients, staff and visitors inside the health care settings, which increases the probability of direct and indirect contact with that risky contaminated surfaces and objects that leading to infection transmission **(Doll, Stevens & Bearman, 2018).**

Operating rooms have a high risk for harboring potential pathogens because of the vulnerability of patients who are exposed to invasive procedures that elevate the incidence and the possibility of occurring infections e.g., surgical wound infection. Traditionally, SSI risk stratification starts from the patient's own bio-load, followed by peri-operative practice variables including surgical technique, attire and instrument reprocessing, and operating room (OR) environment. The latter, is well

known and recognized as a potentially significant reservoir for pathogens and microbes Moreover, contamination of highly reached and frequently touched hospital surfaces with drug resistant bacteria such as MRSA and VRE has been well recognized and documented **(Dancer, 2014; Aziz, 2014; Allegranzi, 2014, CDC, 2019 and Doll et al., 2018).**

Because cleaning and disinfecting of operating room environment are important parts of a comprehensive infection prevention strategy healthcare workers must optimize the cleaning management in the operating room, induce, enhance the effective and optimal usage of the operating room **(Murrell et al., 2019 and Li et al., 2020).** So, its mandatory to improve nurses and cleaners' knowledge and performance related to operating rooms environmental cleaning.

Study aim

Assess the knowledge and performance of nurses and cleaners regarding environmental cleaning in operating rooms.

Research questions:

1. What is the level of health care workers'(nurses and cleaners) knowledge regarding cleaning of operating rooms at healthcare facilities?
2. What is the level of health care workers'(nurses and cleaners) performance during cleaning procedure of the operating rooms at healthcare facilities?

Subjects and method

Research Design: cross-sectional design.

Setting: This study carried out at operating rooms departments in Mansoura University Hospital.

Participants:

The study subjects included health care workers (nurses and cleaners) who are working at major surgical procedures units and involved in the process of cleaning.

Sample Size and Sampling Technique

1.Sample size for nurses:

When the population size= 220 nurses, desired precision= 5%, expected frequency of

adherence to environmental cleaning process = 50% and design effect= 1, and the confidence level 95%, the minimal required sample size is 140 nurses by adding 10% for non-respondents, the total required sample will be 154 nurses.

2.Sample size for cleaners:

When the population size= 50 cleaner, desired precisions= 5%, expected frequency of adherence to environmental cleaning process = 50% and design effect= 1, and the confidence level 95%, the minimal required sample size is 44 cleaners by adding 10% for non-respondents, the total required sample will be 48 cleaners **(Schaeffer, Mendenhall, Ott, 1990).**

Sampling Technique:

Convenient sampling technique was used with study participants (nurses and cleaners).

Tools: the researchers used three tools in this study for data collection after reviewing the national and international review.

Tool (I): Self-administrated demographic and occupational characteristics questionnaire:

This tool composed of two segments:

- The first segment was used to assess demographic such as age and sex.
- The second segment was used to assess occupational characteristics such as qualifications, experience years and previous attendance of training program about environmental cleaning at operating rooms.

Tool (II): Knowledge assessment questionnaire:

Part (1) to assess nurses' knowledge:

A self-administered questionnaire was used to assess nurses' knowledge about operating room cleaning process as (definitions related to cleaning, highly touched surfaces, assessment of cleaning, care of environmental cleaning equipment, characteristics of environmental cleaning carts and equipment's storage…).

The questionnaire was composed of 30 questions (20 open-ended questions and 10 were Yes or No questions) one mark awarded for each correct response.

Scoring system: -

The total scores of the knowledge ranged from 0 to 30. The knowledge level was categorized into three levels: -

- Poor = scores less than 50% of total scores
- Fair = scores 50% to less than 65% of total scores
- Good = scores 65% of total scores or more.

Part (2) to assess cleaners' knowledge:

Semi structured interviews was used to assess cleaners 'knowledge about operating room housekeeping process as (definitions related to cleaning, care of environmental cleaning equipment, characteristics of environmental cleaning carts and equipment's storage, ….).

The questionnaire was composed of 21 questions (15 open-ended questions and 6 were Yes or No questions) one mark awarded for each correct response.

Scoring system: -

The total scores of the knowledge ranged from 0 to 21. The knowledge level was categorized into three levels: -

- Poor = scores less than 50% of total scores
- Fair = scores 50% to less than 65% of total scores
- Good = scores 65% of total scores or more.

Tool (III):   Observational checklist:

Part (1) to assess nurses' performance:

This tool composed of (68 points); one mark awarded for each proper action.

This checklist was divided into 5 parts. First part concerned to initial cleaning practices before the first case surgery (11 points). The second part related to cleaning practices between cases (15 points). The third part about terminal cleaning of the day (18 points), followed by the fourth part which had pre- and postoperative areas cleaning on

patient discharge (10 points), and ended by the fifth part concerned to terminal cleaning at pre- and postoperative areas (14 points).

Scoring system: -

The score levels for nurses' practice have been categorized as: -

- Improper = score less than 75% of total score and
- Proper = score 75% of total score or more.

Part (2) to assess cleaners' performance:

This tool composed of (86 points) one mark awarded for each proper action.

This checklist was divided into 5 parts. First part concerned to initial cleaning practices before the first case surgery (10 points). The second part related to cleaning practices between cases (21 points). The third part about terminal cleaning of the day (33 points), followed by the fourth part had pre- and postoperative areas cleaning on patient discharge (10 points), and ended by the fifth part concerned to terminal cleaning at pre- and postoperative areas (12 points).

Scoring system: -

The score levels for cleaners' practice have been categorized as: -

- Improper = score less than 75% of total score and
- Proper = score 75% of total score or more.

Phases of the Study

This study was accomplished through two main phases:

Phase I- Preparation phase:

1- **Administrative process**

The researchers get ethical approval from the Research Ethics Committee of Faculty of Nursing, Mansoura University before implementing this study. Then get an official letter from the Faculty of Nursing that issued to the appropriate authorities in the selected settings (Mansoura University Hospital) and obtained permission to conduct this study after explaining the aim of study.

Ethical considerations:

- The researchers informed the participants with the purpose of the study and assured

that participation in the study is voluntary. Then obtained the oral consent from nurses and cleaners who accepted to participate in the study and informed them that results have been used as component of the necessary research, as well as for further publications and education.

2- Literature review:

The researchers reviewed of related local and international literature on the different aspects of environmental cleaning of operating rooms of healthcare facilities using scientific published articles, internet search and textbooks. This review was used as a guide for developing the study tools.

3- Developing of the study tools:

- The researchers developed tools (I to III) after reviewing the related literature.

- Content validity of the developed tools: experts(jury) in community health nursing and medical surgical nursing tested the content validity of the developed tools, and the required modification has been carried out.

- Face validity of the developed tools had been tested. Conducted pilot study on 10% of study subjects (16 nurses and 5 cleaners).

Phase II- Operational phase:

Stage 1: Data Collection stage

This stage implemented through:

- The researchers collected data at separate visits on a schedule from 2-3 visits per week.

- Tool 1 used to collect socio-demographic data.

- Tool II used to collect data regarding nurses' and cleaners' knowledge of environmental cleaning process in the operating rooms.

- Tool III used to collect data regarding nurses' and cleaners' performance of environmental cleaning process in the operating rooms.

Stage 2: - Statistical analysis

- Statistical analysis has been done according to the most currently reliable and valid statistical methods.

- The collected data have been coded, entered, and analyzed by personal computer using stand for Statistical Product and Service Solutions (SPSS) program version 20.

- After complete data entry, the analysis has been conducted by applying frequency tables with percentages.

- Qualitative data have been presented as number and percent.

- The Chi-Square test and fisher's exact test have been used for comparison between groups as appropriate.

- All tests have been performed at a level of significance (P-value) equal or less than 0.05 have been considered statistically significant.

- Quantitative data have been described as mean ± SD (Standard Deviation). They have been tested for normality by Kolmogorov-Smirnov test.

Results

Table (1) reveals nurses' demographic and occupational characteristics. Regarding age, it was noticed that the studied nurses mean age 37.35 ± 2.8. Female represented 83.8% of studied nurses, 45.5% of the studied nurses had bachelor's degree and 43.5% had technical degree. It was noticed that 52.6% of studied nurses had < 10 years of experience, 28.6% attended one training course and only 2.6% attended twice, out of attendance 15.6% attended workshops regarding standard operating rooms and 13.0% attended workshops regarding infection control precautions. The main areas provided training were governorate training department 15.6 % and hospital training department. 16.2% of nurses attended training programs for 6 days and 12.3% attended for three days. 16.2% of nurses attended training programs between years 2015 to 2019. Regarding training method 21.4% of nurses received training course through face-to-face lecture without

media. In relation to trainer qualifications 23.4% of trainers get bachelor's degree.

Table (2) shows cleaners' demographic and occupational characteristics. Regarding age, it was noticed that the studied cleaners' mean age 30.55 ± 5.1. Female represented 54.2% of studied cleaners, 54.2% of studied cleaners graduated from secondary school, 37.5% of studied cleaners had < 10 years of experience, and 29.1% attended one training program, out of attendance 16.7% received training courses about hand washing and personal protective equipment. The area provided training was hospital training department for 31.2% of cleaners. Regarding duration of training 22.8% attended training courses for 6 days and 16.7% of cleaners attended training programs between years 2015 to 2019. Regarding training method 22.9% of cleaners received training course through Face-to-face lecture without media. In relation to trainer qualifications 20.8% of trainers were get bachelor's degree and specialized in infection control.

Table (3) Documents that knowledge of the studied nurses was fair regarding operating room cleaning process 53.2 % and was good among 41.6% of nurses with total mean score 51.34(8.45).

Table (4) reveals that knowledge of the studied cleaners was good regarding operating room cleaning process 85.4% and was fair among 14.6% of cleaners with total mean 48.22(6.13)

Table (5) shows that performance of the studied nurses was improper regarding preparation of environment before starting operation of the day (94.2%), cleaning operating rooms between cases (99.4%), terminal cleaning of operating rooms (77.9%), pre- and postoperative areas cleaning—patient discharge (95.5%), and pre- and postoperative areas cleaning—terminal cleaning (93.5%)

Table (6) illustrates that performance of the studied cleaners was improper regarding cleaning operating rooms between cases (97.9%), pre- and postoperative areas cleaning—patient discharge (72.9%), and pre- and postoperative areas cleaning—terminal cleaning (97.9%).While improper performance was observed among all cleaners (100.0%) regarding preparation of environment before starting operation of the day and terminal cleaning of operating rooms.

Table (7) elicits that there was a significant association between studied nurses' total knowledge with age (0.027), education (0.053) and years of experience (0.050). There was not any association between studied nurses' total performance with their demographic characteristics.

Table 1: *Nurses' demographic and occupational characteristics (N=154)*

Items	N = (154)	(%)
Age		
20-29years	44	28.6
30-39 years	57	37.0
40-49	41	26.6
50-59	12	7.8
Mean ± SD	37.35 ± 2.8	
Gender		
Males	25	16.2
Females	129	83.8
Educational level		
Secondary	17	11.0
Technical	67	43.5
Bachelor	70	45.5
Years of experience in operating rooms		
< 10	81	52.6

	73	47.4
≥ 10	73	47.4
Attended training programs / workshops related to house keeping		
Once	44	28.6
Twice	4	2.6

Table 1: *Nurses' demographic and occupational characteristics (N=154)* (cont)

Items	N = (154)	(%)
Place of training		
Governorate training department	24	15.6
Hospital training department	19	12.3
Training in the governorate and hospital	5	3.2
Duration of training		
3 days	23	14.9
6 days	29	18.8
Year of training		
≤2009	11	7.1
≤2014	12	7.8
≤2019	25	16.2
Training content		
General standard precautions	20	13
Nursing performance and procedures in operating rooms	24	15.6
Infection control precautions in operating rooms	4	2.6
Teaching method		
Face to face lecture without media	33	21.4
Face to face lecture with media	28	18.2
Trainer qualification		
Bachelor's degree of nursing	36	23.4
Bachelor's degree of nursing and specialized in infection control	34	22.1

Table 2: *cleaners' demographic and occupational characteristics (N=48)*

Items	N = (48)	(%)
Age		
20-<29years	6	12.5
30-<39 years	16	33.3
40-49	16	33.3
50-59	10	20.9
Mean ± SD	**30.55 ± 5.1**	
Gender		
Males	22	45.8
Females	26	54.2
Educational level		
Illiterate	12	25.0
Secondary	26	54.2
Bachelor	5	10.4
Others	5	10.4
Years of experience in operating rooms		
< 10	28	58.3
≥ 10	20	41.7

Attended training programs / workshops related to house keeping		
One	14	29.1
Two	1	2.1

Table 2: cleaners' demographic and occupational characteristics (N=48)(cont)

Items	N = (48)	(%)
Place of training		
Hospital training department	15	31.2
Duration of training		
3 days	4	8.4
6 days	11	22.9
Year of training		
≤2014	7	14.5
≤2019	8	16.7
Training content		
Cleaning, waste management and linens management	3	6.3
Hand washing and personal protective equipment	8	16.6
Cleaning, waste management, furnishings, hand washing and personal protective equipment	4	8.3
Teaching method		
Face to face lecture without media	11	22.9
Face to face lecture with media	4	8.3
Trainer qualification		
Bachelor's degree of nursing	9	18.75
Bachelor's degree of nursing and specialized in infection control	10	20.8

Table 3: *Nurses' total knowledge score regarding operating room cleaning process* **(N=154).**

Knowledge Levels	N = (154)	(%)
Poor	8	5.2
Fair	82	53.2
Good	64	41.6
B ± SD	51.34(8.45)	

Table 4: *cleaners' total knowledge score regarding operating room cleaning process (N=48)*

Knowledge Levels	N = (48)	(%)
Fair	7	14.6
Good	41	85.4
B ± SD	48.22(6.13)	

Table 5: *Nurses' total Performance score regarding* operating room cleaning process *(N=154)*

Performance	Proper		Improper	
	N	(%)	N	(%)
Environmental preparation before starting operation of the day	9	5.8	145	94.2
Cleaning operating rooms between cases	1	0.6	153	99.4
Terminal cleaning of operating rooms	34	22.1	120	77.9
Pre- and Postoperative areas cleaning—Patient Discharge	7	4.5	147	95.5
Pre- and Postoperative areas cleaning—terminal cleaning	10	6.5	144	93.5
B ± SD	38.3±12.8			

Table 6: *cleaners' total performance score regarding* operating room cleaning process *(N=48).*

Competencies	Proper		Improper	
	N	(%)	N	(%)
Environmental preparation before starting operation of the day	0	0.0	48	100.0
Cleaning operating rooms between cases	1	2.1	47	97.9
Terminal cleaning of operating rooms	0	0.0	48	100.0
Pre- and Postoperative areas cleaning—Patient Discharge	13	27.1	35	72.9
Pre- and Postoperative areas cleaning—terminal cleaning	1	2.1	47	97.9
$X^2 \pm$ SD	17.6±13.5			

Table 7: *Association between demographic and occupational characteristics of the studied nurses and their total knowledge and performance scores*

Personal data	Total Knowledge	Total performance
Age		
20-29years	40.22±4.21	33.31±60.45
30-39 years	60.24±6.1	45.42±2.03
40-49	63.58±4.25	46.92±4.53
50-59	62.24±4.1	45.92±7.63
[F]P	0.027*	0.568
Educational level		
Nurse secondary	55.81±3.26	28.31±1.45
Institute	51.20±8.24	30.42±2.03
Bachelor	68.75±6.66	51.92±6.53
Other	67.86±4.28	41.92±3.63
[F]P	0.053*	0.624
Years of experience		
1-9	45.11±10.54	38.11±3.45
10-19	59.21±5.44	30.78±5.21
20-29	61.54±5.96	35.88±4.25
30-40	56.26±9.44	37.33±12.4
[F]P	0.050*	0.421
Attending training programs / workshops		
No	45.99±14.65	31.31±1.45
one	59.11±9.23	35.42±22.03
two	59.11±9.23	31.92±6.53
[t]P	0.421	0.134

Discussion

The impact of the environment on infection rates has been demonstrated when; adequate environmental cleaning is lacking, the risk of infection increases if a patient is admitted immediately into an environment previously occupied by another patient infected by the same pathogen. Thus, highlighting the environment as a route of transmission of health care associated infection (HAI). Also, increasing the attention to environmental cleaning and cleanliness by healthcare systems **(Kramer & Assadian, 2014 and Suleyman, Alangaden, & Bardossy, 2018).**

The ability of potential pathogens to persist for long periods of time on inanimate surfaces has been reviewed previously, some organisms are able to survive weeks to months in the hospital environment. It indicates that patients are at risk of acquiring a multidrug-resistant organism (MDRO) if the previous room occupant was infected, suggesting transmission via the contaminated environment despite routine cleaning efforts **(Lin, Ou, Lin, Peng & Yao, 2016)**. While

many approaches to environmental cleaning exist, manual cleaning supplemented with ongoing assessment and feedback may be the most feasible for healthcare facilities with limited resources **(Doll, Stevens & Bearman, 2018)**.

The current study revealed that nurses' demographic and occupational characteristics mean age was 37.35 ± 2.8, mostly female, had bachelor's degree, with < 10 years of experience. Low percentage had training programs / workshops once, out of attendance standard operating rooms and infection control precautions, the main areas provided training were governorate training department and hospital training department for 6 days, between years 2015 to 2019 using face to face lecture without media.

In relation to cleaners' demographic and occupational characteristics the mean age was 30.55 ± 5.1, mostly female, secondary school, with < 10 years of experience. Low percentage had training programs / workshops once about hand washing and personal protective equipment. The area provided training was hospital training department for 6 days between years 2015 to 2019.

Nurses and cleaners score level of knowledge, performance and regarding operating room cleaning process.

Cleaning perioperative environment is a basic principle for all perioperative team members. Frequently cleaning high-touch surfaces helps prevent the spread of infections, and routinely cleaning and disinfecting the patient's environment can reduce the level and frequency of contamination and the risk of HAIs. Perioperative team members should use a bundled approach to perform a standardized cleaning routine and implement a successful monitoring program **(Spruce & Wood, 2014 and Centers for Disease Control and Prevention (CDC), 2019)**.

The current study revealed that the knowledge was good among minority of the studied nurses regarding operating room cleaning process. This may be attributed to limited workshops and training course regarding environmental cleaning. Whereas

the knowledge was good among majority of the studied cleaners regarding operating room cleaning process and this from the researcher's point of view that cleaning process is the main function of cleaners.

In this respect **Carling & Huang, (2013)** who conducted study in United Kingdom reported that the need for cleanliness of the perioperative environment is a basic principle for all perioperative team members. At times, personnel can overlook this basic principle and fail to clean the OR environment effectively because of decreased knowledge level regarding standardized cleaning process to perform it in an effective manner. Also, they should be knowledgeable about areas that are frequently touched by health care providers or patients called "high-touch" surfaces, and to understand that frequent cleaning of these surfaces is essential to prevent spread of potentially infectious organisms.

Also, **Jemal, Gashaw, Kinati, Bedada & Getahun, (2020)** who conducted a study in Ethiopia reported that many health care workers had low knowledge, negative attitudes, and poor infection prevention practices. Effective performance is required to deliver safe and clean healthcare facilities for optimal outcomes, for both patients and healthcare providers. **Aluko et al, (2016)** who conducted study in Nigeria emphasized that most of studies have reported a low level of knowledge about infection control precautions to reduce the occupational risks for healthcare workers (HCWs). So, it is essential to educate health care workers regarding infection prevention practices including environmental cleaning that apply to all patients, regardless of infection status. It is based on the principle that all blood, body fluids, secretions, excretions except sweat, non-intact skin, and mucous membranes may contain transmissible infectious agents".

Doll et al., (2018) and Geberemariyam, Donka & Wordofa, (2018), who conducted studies in Virginia of USA and Southeast Ethiopia declares lack of knowledge about the appropriateness, efficacy and use of IPC measures determined poor compliance. To overcome these barriers, continuous health

education and training are the cornerstones for improving practices. HCWs should be aware of this fact.

Darawad & Mahmoud, (2013) and Giard et al., (2016), they conducted studies in Jordan and France highlighted that the following factors such as having an infection-control policy, continuous training programs as well as establishing a well-developed infection reporting system in the healthcare settings significantly affect the level of knowledge and compliance of health care workers with the preventive strategies. Also, **Abuduxike, AcarVaizoglu, Asut & Cali, (2021) and Carling, (2016),** revealed that the majority of HCWs in Northern Cyprus and Boston, USA have an unsatisfactory level of knowledge, and inadequate practice, toward standard precautions at the workplace, and confirmed the value of an objective structured programmatic process to broadly improve cleaning practice and documented the challenges of implementing such activities.

Moreover, **Curryer et al, (2021),** emphasized that Australian hospitals having staff who are knowledgeable about environmental cleanliness and who are committed towards preventing infection that is critical for the optimal delivery of care, patient safety and a complication free patient recovery. Team effectiveness is important in terms of mentoring, knowledge sharing and training, making sure that staff are working towards similar goals, for ensuring hygiene compliance, and the smooth flow of workplace information. In the same line **Birlie et al, (2021)**, reported that, nurses in north-central Ethiopia described much learning and knowledge uptake, experiential learning and knowledge sharing being lost. Nurses stressed the importance of embedding cleaning knowledge and hygiene into practice through early education, post-graduation training and mandatory accreditation. Other factors influencing cleaning compliance included lack of detailed organizational guidelines regarding recommended cleaning methods and how often cleaning should be performed, lack of management support and role conflicts.

These results agree with **Henderson, Willis, Roderick, Bail & Brideson, (2020)** who highlighted that environmental cleaning is a key of preventing infections in healthcare settings and is cost-effective in Australia. Workplace factors such as time pressures, staff knowledge, work processes, organizational structures, and the everyday complexity of health care systems can play a key role in how well environmental cleanliness is maintained and healthcare associated infections prevented. There is a need for clean and safe healthcare facilities, standard precautions, and biohazard-free facilities.

Henderson et al., (2020) found that while nurses broadly understood the importance of cleaning, they are not all displayed correct knowledge of how to clean correctly nor which disinfectants to use situations. Likewise, evidence-based knowledge and professional development are important for nurses, as knowledge informed everyday working practices. Hygiene and cleanliness were perceived as both shared activity and mutual, interdependent relationship, existing on multiple (public, private, organizational, clinical) levels.

Henderson et al., (2020). As well, **Curryer et al., (2021)**, found in Australia that environmental cleanliness and hygiene within clinical and community settings are critical issues. experiential learning for nurses at all stages of their careers, and the need for better translation of nurses' knowledge and experience. Moreover, hygiene and cleanliness should be a shared activity and responsibility, with nurses, healthcare workers, senior management, patients, and the broader community working together to reduce infection.

In the same line **Forrester, Powell, Forrester, Fast, Weiser., (2018)** mentioned that raising awareness of administrators in Stanford, California about the dangers of unclean environments, training of all stakeholders involved in the cleaning process and governance including end users, and increased awareness of the importance of environmental hygiene by the facility administration may lead to improved

organization of environmental cleaning and support staff.

Olans, Olans & DeMaria, (2016) and Ogunsola & Mehtar, (2020) they conducted studies in Boston, USA and South Africa respectively are reported that policies will provide a framework for configuration, utilization, and quality management strategies to address the various challenges resulting from environmental contamination. Leadership is crucial and an increase in political awareness can lead to the much-needed changes to improve outcomes. The improvement occurs by training IPC professionals including cleaning staff to develop policies, set standards and ensure effective implementation of processes to reduce environmental contamination.

Contrary to the current–results Lien et al., (2018) who reported that in Vietnam an individual in healthcare facility, staff practice, which is driven by their knowledge and attitudes, plays a decisive role in the success of infection control programs. The core problem is not the lack of effective precautions and evidence-informed guidelines, but that healthcare workers (HCWs) applied these measures inadequately and inconsistently. Staff and cleaners had lower knowledge scores.

Operating room cleaning practices were carried out by competent and trained personnel between each operation and at the end of the daily operating session. Between one operation and the next, in accordance with the generally accepted principles, surface cleaning starts from the cleanest area to the dirtiest and from the highest level to the lowest (Dallolio et al., (2018).

As regards to performance; nurses' and cleaners' total score level of performance was improper regarding operating room cleaning process. It is possible due to lack of training programs.

The current results agree with the (Doll et al., 2018, and Geberemariyam, Donka, Wordofa., 2018) results in Virginia in USA and Southeast Ethiopia respectively, are documented that recent attention to the quality of environmental cleaning in hospitals has revealed that cleaning efforts are often insufficient, leaving microbial contamination present on surfaces.

In USA Rutala & Weber, (2019) and Munoz-Price et al., (2019) found that, perioperative personnel did not perform adequate environmental surface cleaning, or disinfection after each surgical procedure to remove the contamination from OR and anesthesia work area surfaces. When creating or updating environmental surface hygiene policies and procedures, leaders should focus on the following elements: surface cleaning and disinfection of noncritical equipment and high-touch areas, room turnover cleaning between procedures, departmental policy and interdisciplinary collaboration, objective monitoring of cleaning performance, and staff member education and training.

The following studies Agency for Healthcare Research and Quality, (2020) and Watson, Watson & Torress-Cook, (2016), in USA and California respectively reported that environmental cleaning practice are inadequate, objectively monitoring staff members' cleaning performance and providing appropriate feedback is an integral part of health care facility infection prevention. Monitoring of cleaning practices and staff member adherence to cleaning protocols can help in decreasing contamination of surfaces in the environment of hospital, improving cleaning quality and reducing patient HAI transmission.

Also, Pyrek, (2020) and McGarity & Salgado, (2019). Pointed that crucial aspect of infection prevention in health care facilities in USA, is ensuring that staff members received the proper education and training in environmental surface hygiene practices to improve environmental cleaning quality and result in reducing transmission rates of HAIs. Education and training in environmental hygiene should be conducted for all OR staff members during both orientation for all newly hired personnel and at regular intervals throughout the year with competency validation. that in high- and low-income countries.

Furthermore, **Branch & Amiri, (2020) and Spruce & Wood, (2014)** who conducted studies in USA and California respectively is emphasized that environmental surface hygiene plays a key role in a multimodal approach to infection prevention in health care settings. time pressure on personnel result in inadequate cleaning and disinfection of contaminated equipment and noncritical items in the OR, including anesthesia work areas. Contaminated OR equipment, particularly high-touch items, can accumulate pathogens that may be transmitted to patients and may cause HAIs. A bundled approach (using an interdisciplinary team, using appropriate disinfecting, and cleaning agents, creating checklists and educational presentations, using innovative and emerging technology) is essential to performing a standardized cleaning routine and implementing a successful monitoring program

Center of Disease Control and Prevention **(CDC 2019)** recommended periodic conduction of competency assessments and refresher trainings in South Africa as needed focusing on gaps identified during competency assessments and routine monitoring activities. If cleaning services are contracted out, the training requirements and content should be specified by the healthcare facility in the service level agreement.

In this regard **Kaur, Arora & Biswal, (2018) and Aucamp, (2016),** are reported that cleaning is considered a menial job in South Africa, these jobs are delegated to hospital attendants (lower job categories) with poorer educational levels who are usually untrained in cleaning protocols and practices resulting in poor outcomes and an increased risk of contamination. This concept is observed in high- and low-income countries. Newly appointed cleaning staff must be trained upon commencement of duties. The other cleaning staff must be trained at least on an annual basis and as needed when problems with environmental cleaning occur or when there is a change in the cleaning routine or cleaning products. Training records must be kept for audit and assessment purposes. In contrast, visual inspection is a good alternative with the

benefit of allowing for many more observations than more resource-intensive monitoring processes, provided that the monitoring is done by a trained, impartial observer and results are continually discussed with cleaning staff. Visual observation of actual cleaning practices has also been shown to be effective in improving cleaning practices in Sweden, as part of a multifaceted intervention to decrease VRE acquisition **(Knape, Hambraeus, Lytsy., 2015).**

World Health Organization (WHO), (2016) and National Institute for Health and Care Excellence (NICE), (2017), reported that, the instances of non-compliance to the environmental standards highlight the need for great attention in cleaning procedures and improvement of the protocols previously adopted. The monitoring of adhesion for cleaning-sanitization procedures and behavioral norms can provide findings that should be communicated and discussed with the personnel involved, thus raising their awareness. Also, the improvement of work conditions could facilitate compliance to prevention measures and operative protocols.

Birlie et al, (2021) also found poor cleaning practice among nurses in Ethiopia and noted that the major barrier for cleaning perceived by head nurses was the lack of supplies needed for cleaning, shortage of reusable supplies. Lack of training was also raised by head nurses as a barrier to cleaning because it obviously increases knowledge and compliance and help nurses improve their cleaning practice with the available resources. Therefore, nurses need to get training on the care of routinely used noncritical medical devices and other infection control measures. Proper supply of materials needed to clean these devices need to be also secured. **Shobowale, Adegunle & Onyedibe, (2016)** emphasized that cleaners in Nigeria are often supervised by a nurse or cleaning supervisor who usually do not have specialized training on cleaning healthcare spaces. Standardized competency training and proper supervision including verification checks are essential and should be carried out routinely with the results

being presented to the IPC Committee for further guidance.

The present study explained that a significant association was documented between studied nurses' total knowledge with age, education, and years of experience. But there was not any association between studied nurses' total performance with their demographic characteristics. Moreover, there was not any association between studied cleaners' total knowledge and total performance with their demographic characteristics.

In agreement with the current study **Desta et al, (2018) and Gulilat & Tiruneh, (2014)** they conducted a study reported that education is a method of equipping the health workforce with up-to-date knowledge and skill of infection prevention and control practice in Ethiopia with confidence utilization of recommended guidelines and the available supply. The educational level was increased, infection prevention and control practices were better than the health workforce, which has a low educational level. Also, the current results matched with **Teshager, Engeda, & Worku, (2015)** findings in Ethiopia. Also, several associations were found between HCWs' knowledge and experience, training and working abroad as **Geberemariyam et al, (2018), Ogoina et al, (2015),** studies in Southeast Ethiopia and Nigeria respectively.

Assessment and feedback of cleaning performance is a critical part of environmental infection prevention. Traditionally, environmental services management was monitoring of cleaning used visual inspection of the area. **(Labarca, 2014; Provincial Infectious Diseases Advisory Committee (PIDAC), 2018; Doll et al., 2018 and CDC, 2019),** studies conducted in South America, Canada, Virginia, and South Africa respectively have questioned the accuracy of visual inspection compared to both microbiological sampling methods and non-microbiological sampling methods. In Sweden **(Knape et al., 2015)** revealed that the results of monitoring are tracked monthly through the infection control committee and are used in ongoing education with environmental services staff to maintain the benefits in cleaning effectiveness.

Conclusion

Poor knowledge and improper performance regarding operating room cleaning process was observed among majority of the studied nurses whereas good knowledge and improper performance was observed among cleaners. Significant association documented between studied nurses' total knowledge with age, education, and years of experience.

Recommendation:

In-service training program regarding cleaning process in operating rooms and designing protocol about operating rooms environmental cleaning for health care workers. Providing training programs including the core competence of hospital, infection control standard precautions and cleaning process in operating rooms at regular intervals for newly hired nurses. Regular supervision and monitoring of nurses' and cleaners' performance for environmental cleaning and strict adherence of standard precaution of infection control.

Reference

Abuduxike, G., Vaizoglu, S. A., Asut, O., & Cali, S. (2021). An assessment of the knowledge, attitude, and practice toward standard precautions among health workers from a hospital in northern cyprus. *Safety and health at work, 12*(1), 66-73.

Agency for Healthcare Research and Quality. (2020). *Environmental Cleaning for the Prevention of Healthcare-Associated Infections (HAI).* https://effec tiveh ealth care. ahrq.gov/sites/ defau lt/files/ pdf/healt hcare-infections_resea rch-proto col.pdf. Published August 25, 2014. Accessed June 5, 2020.

Allegranzi, B., Kilpatrick, C., Storr, J., Kelley, E., Park, B. J., & Donaldson, L. (2017). Global infection prevention and control priorities 2018–22: a call for action. *The Lancet Global Health, 5*(12), e1178-e1180.

Aluko, O. O., Adebayo, A. E., Adebisi, T. F., Ewegbemi, M. K., Abidoye, A. T., & Popoola, B. F. (2016). Knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers. *BMC research notes, 9*(1), 1-14.

Aucamp M. (2016). Housekeeping and Linen Management. International Federation of Infection Control (IFIC) Basic Concepts of Infection Control, 3rd edition, 2016. Available at: https://www.theific.org/wp-content/uploads/2016/04/23-HkpgLaundry_2016.pdf. Accessed 1/4/2022

Aziz, A. M. (2014). Supporting infection prevention in the operating room. *Journal of Operating Department Practitioners, 2*(3), 121-129.

Banno, M; Tsujimoto, Y; Kataoka, Y (2020). "*The majority of reporting guidelines are not developed with the Delphi method: a systematic review of reporting guidelines*". *Journal of Clinical Epidemiology. 124:* 50–57. doi:10.1016/j.jclinepi.2020.04.010. P MID 32302679

Birlie, T. A., Amare, A. T., Tassew, S. F., Emiru, T. D., Feleke, D. G., & Chanie, E. S. (2021). Nurses' cleaning practice of non-critical medical equipment in the era of COVID 19: A cross-sectional study in Debre-Tabor comprehensive specialized hospital. *Heliyon, 7*(7), e07626.

Branch, R., & Amiri, A. (2020). Environmental Surface Hygiene in the OR: Strategies for Reducing the Transmission of Health Care–Associated Infections. *AORN journal, 112*(4), 327-342.

Carling P. C. (2016). Optimizing Health Care Environmental Hygiene. *Infectious disease clinics of North America, 30*(3), 639–660. https://doi.org/10.1016/j.idc.2016.04.010

Carling PC & Huang SS. (2013). improving healthcare environmental cleaning and disinfection: current and evolving issues.

Infect Control Hosp Epidemiol. 2013;34(5): 507-513.

Centers for Disease Control and Prevention (CDC) (2019). Best practices for environmental cleaning in healthcare facilities in resource-limited settings. GA: US Department of Health and Human Services, CDC; Cape Town, South Africa: Infection Control Africa Network; 2019. Available at: https://www.cdc.gov/hai/prevent/resource-limited/index.html and http://www.icanetwork.co.za/icanguideline2019 Last accessed 19th February 2022.

Centers for Disease Control and Prevention. (2020). Operational considerations for personal protective equipment in the context of global supply shortages for coronavirus disease 2019 (COVID-19) pandemic: non-US healthcare settings.

Curryer, C., Russo, P. L., Kiernan, M., Wares, K. D., Smith, K., & Mitchell, B. G. (2021). Environmental hygiene, knowledge and cleaning practice: a phenomenological study of nurses and midwives during COVID-19. *American journal of infection control, 49*(9), 1123-1128.

Dallolio, L., Raggi, A., Sanna, T., Mazzetti, M., Orsi, A., Zanni, A., ... & Leoni, E. (2018). Surveillance of environmental and procedural measures of infection control in the operating theatre setting. *International journal of environmental research and public health, 15*(1), 46.

Dancer, S. J. (2014). Controlling hospital-acquired infection: focus on the role of the environment and new technologies fordecontamination. *ClinicalMicrobiology Reviews, 27*(4), 665-690.

Dancer, S.J., White, L.F., Lamb, J. et al. (2009). Measuring the effect of enhanced cleaning in a UK hospital: a prospective cross-over study. BMC Med 7, 28 (2009). https://doi.org/10.1186/1741-7015-7-28

Darawad Muhammad W, Al-Hussami Mahmoud. (2013). Jordanian nursing students' knowledge of, attitudes towards, and compliance with infection control precautions. Nurse Educ Today [Internet] 2013;33(6):580e3. https://doi.org/10.1016/j.nedt.2012.06.009.

Desta, M., Ayenew, T., Sitotaw, N., Tegegne, N., Dires, M., & Getie, M. (2018). Knowledge, practice and associated factors of infection prevention among healthcare workers in Debre Markos referral hospital, Northwest Ethiopia. *BMC health services research, 18*(1), 1-10.

Dexter, F., Parra, M. C., Brown, J. R., & Loftus, R. W. (2020). Perioperative COVID-19 defense: an evidence-based approach for optimization of infection control and operating room management. Anesthesia and analgesia.

Doll, M., Stevens, M., &Bearman, G. (2018). Environmental cleaning and disinfection of patient areas. International *Journal of Infectious Diseases, 67,* 52-57.

Forrester JA, Powell BL, Forrester JD, Fast C, Weiser TG. (2018). Surgical instrument reprocessing in resource-constrained countries: a scoping review of existing methods, policies, and barriers. Surg Infect. 2018;19(6):593–602.

Geberemariyam, B. S., Donka, G. M., & Wordofa, B. (2018). Assessment of knowledge and practices of healthcare workers towards infection prevention and associated factors in healthcare facilities of West Arsi District, Southeast Ethiopia: a facility-based cross-sectional study. *Archives of Public Health, 76*(1), 1-11.

Giard, M., Laprugne-Garcia, E., Caillat-Vallet, E., Russell, I., Verjat-Trannoy, D., Ertzscheid, M. A., ... & Savey, A. (2016). Compliance with standard precautions: results of a French national audit. *American journal of infection control, 44*(1), 8-13.

Gould, C. V., Umscheid, C. A., Agarwal, R. K., Kuntz, G., Pegues, D. A., & Healthcare Infection Control Practices Advisory Committee. (2010). Guideline for prevention of catheter-associated urinary tract infections 2009. *Infection Control & Hospital Epidemiology, 31*(4), 319-326.

Gulilat, K., & Tiruneh, G. (2014). Assessment of knowledge, attitude and practice of health care workers on infection prevention in health institution Bahir Dar city administration. *Sci J Public Health, 2*(5), 384-3.

Jain, M., Dogra, V., Mishra, B., Thakur, A., & Loomba, P. S. (2015). Knowledge and attitude of doctors and nurses regarding indication for catheterization and prevention of catheter-associated urinary tract infection in a tertiary care hospital. *Indian journal of critical care medicine: peer-reviewed, official publication of Indian Society of Critical Care Medicine, 19*(2), 76.

Jemal, K., Gashaw, K., Kinati, T., Bedada, W., & Getahun, B. (2020). Clean and safe healthcare environment: knowledge, attitude, and practice of infection prevention and control among health workforce at north showa zone Oromiya region. *Journal of environmental and public health, 2020.*

Kaur K, Arora P, Biswal M. (2018). Hospital Surface Disinfection: Need, Gaps, Challenges and Management for "Basin and Mop" Method. J Hosp Med Manage; 2018: 4:10.

Knape, L., Hambraeus, A., & Lytsy, B. (2015). The adenosine triphosphate method as a quality control tool to assess 'cleanliness' of frequently touched hospital surfaces. *Journal of Hospital Infection, 91*(2), 166-170.

Kramer, A., & Assadian, O. (2014). Survival of microorganisms on inanimate surfaces. In *Use of Biocidal Surfaces for*

Reduction of Healthcare Acquired Infections (pp. 7-26). Springer, Cham.

Labarca, J. A. (2014). Assessment of hospital daily cleaning practices using ATP bioluminescence in a developing country. *The Brazilian Journal of Infectious Diseases : An Official Publication of the Brazilian Society of Infectious Diseases, 18*(6), 675–677.

Lien, L. T. Q., Chuc, N. T. K., Hoa, N. Q., Lan, P. T., Thoa, N. T. M., Riggi, E., ... & Stålsby Lundborg, C. (2018). Knowledge and self-reported practices of infection control among various occupational groups in a rural and an urban hospital in Vietnam. *Scientific reports, 8*(1), 1-6.

Lin D, Ou Q, Lin J, Peng Y, Yao Z. (2016). A meta-analysis of the rates of Staphylococcus aureus and methicillin-resistant S. aureus contamination on the surfaces of environ- mental objects that health care workers frequently touch. *Am J Infect Control* 2016;45:421–9.

Markmann, C., Spickermann, A., von der Gracht, H. A., & Brem, A. (2021). Improving the question formulation in Delphi‐like surveys: Analysis of the effects of abstract language and amount of information on response behavior. *Futures & Foresight Science, 3*(1), e56.

Mauksch et al. (2020). Who is an expert for foresight? A review of identification methods. In: Technological Forecasting and Social Change. Vol. 154, 119982, doi:10.1016/j.techfore.2020.119982

McGarity AL, Salgado C. (2019). Improving and sustaining environmental cleaning compliance in a large academic hospital using fluorescent targeting audits, education, and feedback. *Am J Infect Control.* 2019; 47(suppl 6):S20.

Menegueti, M. G., Ciol, M. A., Bellissimo-Rodrigues, F., Auxiliadora-Martins, M., Gaspar, G. G., da Silva Canini, S. R. M., ... & Laus, A. M. (2019). Long-term prevention of catheter-associated urinary tract infections among critically ill patients through the implementation of an educational program and a daily checklist for maintenance of indwelling urinary catheters: A quasi-experimental study. *Medicine, 98*(8).

Munoz-Price, L. S., Bowdle, A., Johnston, B. L., Bearman, G., Camins, B. C., Dellinger, E. P., ... & Birnbach, D. J. (2019). Infection prevention in the operating room anesthesia work area. *Infection Control & Hospital Epidemiology, 40*(1), 1-17.

Murrell, L. J., Hamilton, E. K., Johnson, H. B., & Spencer, M. (2019). Influence of a visible-light continuous environmental disinfection system on microbial contamination and surgical site infections in an orthopedic operating room. *American Journal of Infection Control, 47*(7), 804–810. https://doi.org/10.1016/j.ajic.2018.12.002

National Institute for Health and Care Excellence. Surgical Site Infections: Prevention and Treatment. NICE Clinical Guideline CG74; RCOG Press: London, UK, 2017.

Negrini, S., Armijo-Olivo, S., Patrini, M., Frontera, W. R., Heinemann, A. W., Machalicek, W., ... & Arienti, C. (2020). The randomized controlled trials rehabilitation checklist: methodology of development of a reporting guideline specific to rehabilitation. *American Journal of Physical Medicine & Rehabilitation, 99*(3), 210-215.

Niederberger, M., & Spranger, J. (2020). Delphi technique in health sciences: a map. *Frontiers in public health,* 457, https://doi.org/10.3389/fpubh.2020.00457.

Ogoina, D., Pondei, K., Adetunji, B., Chima, G., Isichei, C., & Gidado, S. (2015). Knowledge, attitude and practice of standard precautions of infection control by hospital workers in two tertiary

hospitals in Nigeria. *Journal of infection prevention, 16*(1), 16-22.

Ogunsola, F. T., & Mehtar, S. (2020). Challenges regarding the control of environmental sources of contamination in healthcare settings in low-and middle-income countries-a narrative review. *Antimicrobial Resistance & Infection Control, 9*(1), 1-9.

Olans, R. N., Olans, R. D., & DeMaria Jr, A. (2016). The critical role of the staff nurse in antimicrobial stewardship—unrecognized, but already there. *Clinical Infectious Diseases, 62*(1), 84-89.

Pacella, F., Collini, S., Angelucci, F., Agostinelli, E., Guzzo, A. S., Cerza, C., &Pacella, E. (2017).Infections in hospital departments. What is Hospital Responsibility?. *La ClinicaTerapeutica, 168(4)*, e266-e270.

Provincial Infectious Diseases Advisory Committee(PIDAC). (2018). Best practices for environmental cleaning for prevention and control of infections in all health care settings(3rd edition). *Ontario Agency for Health Protection and Promotion.*

Pyrek KM. (2020). Room turnover times: 'trash-and-dash' approach jeopardizes patient outcomes. *Infection Control Today.* https://www.infec tionc ontro ltoday. com/view/room-turno ver-times-trash-and-dashapproach-jeopa rdizes-patie nt-outcomes. Published September 17, 2015. Accessed June 30, 2020.

Rutala, W. A., & Weber, D. J. (2019). Best practices for disinfection of noncritical environmental surfaces and equipment in health care facilities: A bundle approach. *American Journal of Infection Control, 47*, A96-A105.

Sampathkumar, P., Barth, J. W., Johnson, M., Marosek, N., Johnson, M., Worden, W., ... & Thompson, R. (2016). Mayo clinic reduces catheter-associated urinary tract infections through a bundled 6-C approach. *The Joint Commission Journal on Quality and Patient Safety, 42*(6), 254-AP4.

Shobowale, E. O., Adegunle, B., & Onyedibe, K. (2016). An assessment of hand hygiene practices of healthcare workers of a semi-urban teaching hospital using the five moments of hand hygiene. *Nigerian medical journal: journal of the Nigeria Medical Association, 57*(3), 150.

Spruce, L., & Wood, A. (2014). Back to basics: environmental cleaning. *AORN journal, 100*(1), 54-64.

Suleyman, G., Alangaden, G., & Bardossy, A. C. (2018). The role of environmental contamination in the transmission of nosocomial pathogens and healthcare-associated infections. *Current infectious disease reports, 20*(6), 1-11.

Teshager, F. A., Engeda, E. H., & Worku, W. Z. (2015). Knowledge, practice, and associated factors towards prevention of surgical site infection among nurses working in Amhara regional state referral hospitals, Northwest Ethiopia. *Surgery research and practice, 2015.*

Wang, X; Chen, Y; Yang, N; Deng, W; Wang, Q; Li, N; Yao, L; Wei, D; Chen, G; Yang, K (2015). "Methodology and reporting quality of reporting guidelines: systematic review". *BMC Medical Research Methodology. 15 (74): 74.* doi:10.1186/s12874-015-0069-z. PMC 4579604. PMID 26395179.

Watson PA, Watson LR, Torress-Cook A. (2016). Efficacy of a hospital-wide environmental cleaning protocol on hospital-acquired methicillin-resistant *Staphylococcus aureus* rates. *J Infect Prev.* 2016;17(4):171-176.

World Health Organization. (2020). [Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level].

World Health Organization. (2016). Global Guidelines for the Prevention of Surgical Site Infection; The WHO Guidelines Development Group: Geneva, Switzerland, 2016.

Original Article