

Barriers to Green Practice regarding Waste Management among Operating Room Nurses

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Abstract

waste reduction is another way in which nurses can “green” the operating room in addition to proper segregation. Because many nurses may support environmental practices on a personal level, nurses can add valuable information and recommendations to reduce, reuse, and recycle municipal solid waste. **The aim** of this study was to assess the barriers to the green practice regarding waste management among operating room Nurses. **Research design:** A descriptive exploratory study was done. **Setting:** This study was conducted at general operating rooms in El-Demrdash Hospital, Cairo, Egypt. **Sample:** A convenient sample of 45 nurses who accepted to participate in the study. **First tool; Nurse’s self-administrated questionnaire** was used which included two parts: (1) demographic characteristics of studied nurses. (2) Nurse’s knowledge about green practice regarding waste management. **Second tool:** Waste reduction and prevention checklist. **Third tool:** Barriers of green practice regarding waste management questionnaire. **Results:** Studied nurses had unsatisfactory total knowledge and practice about medical waste management and green practices in operating rooms. Closer to half of studied nurses reported human barriers as one of the barriers facing the application of green practice regarding waste management in the operating room. There was no statistically significant relation between the studied nurse’s knowledge and training and years of experience. And there was no statistically significant relation between the studied nurse’s practice and educational level, training and years of experience. **Conclusion:** The result of current study concluded that all of studied nurses had lack of knowledge and practice regarding green practice in operating room so human resources came at the first as a barrier followed by infrastructure so the study recommended the importance of implementation educational program for nurses regarding green practice in operating rooms.

Keywords: green practice, operating room, waste management.

Introduction

As the climate continues to change, risks to health systems and facilities including hospitals, clinics and community care centers are increasing, decreasing the ability of health professionals to protect people from a range of climate hazards. As health care facilities can be responsible for large emissions of greenhouse gases (GHGs) Health care facilities are the first and last line of defense to climate change impacts (**World Health Organization [WHO], 2020**).

According to the Global Green and Healthy Hospital Agenda: “Hospitals generate significant environmental health impacts both upstream and downstream from service delivery, through products and the

natural resources they consume, as well as through the waste they generate. The global climate footprint of the health sector is very substantial (**Bandoophanit, Breen & Barber, 2018**).

Healthcare service facilities contribute to the disease control, prevention, and treatment and so represent an important dimension of sustainability. The health sector in any country consumes a significant portion of financial and human resources, thus reflecting the economic dimension of sustainability (**Alharbi, Alhaji & Qattan, 2021**).

Surgical rooms generate most of the daily waste volume of hospitals. Waste

management is one of the most important issues faced by hospitals. A single surgical operation may generate more waste than an average family of four generates in a week (*DÖnmez, Aslan & Giersbergen, 2019*).

The need for surgery is also increasing. The Lancet Commission on Global Surgery outlined some of the scale of the surgical disease burden in its report Global Surgery 2030, noting that 143 million additional surgical procedures are required each year to save lives and prevent disability. This emphasizes the significance of encouraging sustainable surgical practices. Sustainable surgery is surgery that is both environmentally sound and cost effective (*Aldoori, Hartley & MacFie, 2021*).

Healthcare workers in operating rooms (ORs) play an important role in providing care that has a low environmental impact. Everyone has the responsibility for environmental protection by thinking globally and acting locally in their daily practice. Healthcare professionals may take action to minimize waste by reducing waste production, conserving energy, using green or environment-friendly products, recycling, and reusing resources and materials in the OR. Waste reduction strategies hold the potential to reduce the environmental impact of hospitals without compromising the health of patients (*DÖnmez et al., 2019*).

Nurses commit to first doing no harm. Nurses engage in holistic care and have a responsibility to serve the community. Nurses are highly represented in most levels of management, governance and quality control, putting them in an ideal position to advocate for green programs. The Lancet Commission into Health and Climate recently asserted that health professionals have a vital role to play in tackling the health impacts of climate change and calls on them to lead the response and advocate for

environmentally sustainable change (*Schwerdtle, 2015*).

Some studies indicated lack of training, lack of awareness, staff resistance, managerial poor commitment, lack of adequate resources, and unfavorable attitude of the healthcare staff were the main identified challenges (*Yazie, Tebeje & Chufa, 2019*). Change can be uncomfortable, but leaders must see innovation as the key to success, creating a culture of innovation that incorporates environmental awareness into every decision. A clear understanding that “being green” equals “being healthy” should permeate every action of every health care organization (*Weiss et al., 2016*).

Significance of the study

In 2018 according to Ministry of health and population in Egypt stated that the average quantity of medical wastes delivered in health care facilities in all governorates of Egypt is 100566 kg/day and only 77884 (Kg/day) can be treated (*World Bank document, 2018*). Therefore, it is important to assess the barriers to the green practice regarding waste management among operating room nurses.

Aim of the Study

The current study aimed to assess the barriers to the green practice regarding waste management among operating room nurses.

Research Question

What are the barriers to green practice regarding waste management among operating room nurses?

Subjects and Method

Research design:

A descriptive exploratory study design was used to assess the barriers to the green practice regarding waste management among operating room nurses. Usually field studies in natural settings, provide the least control over variables. The data collected either contribute to the development of theory or

explain phenomena from the perspective of the persons being studied.

Research setting:

This study was conducted at (9) general operating rooms in El-Demrdash Hospital affiliated to Ain Shams University, Cairo, Egypt. operating rooms provides different health care services to large number of surgical care patients which contain (three general surgical rooms, two ENT surgical rooms, three urology surgical rooms and one neurology surgical room). The hospital provides different health care services to large number of patients.

Subject:

A convenient sample of all available nurses (45 nurses) assigned to work in the above mentioned settings during data collection period and who accepted to participate in the study.

Data collection tools:

The following tools were used for data collection:

First tool: Nurses' self-administrated questionnaire:

It was designed by the researcher in simple arabic language after reviewing the related literature and studies (*Chartier et al., 2014, Ghasemi & Yusuff, 2016, Khan et al., 2019, Wysusek, Keys & Zundert, 2019 & Wu & Cerceo, 2021*). It was written in the form of close ended questions (in the form of multiple choice questions) to suit the understanding level of the study subjects, it consisted of two parts:

- **Part I:** It was used to assess demographic characteristics of nurses such as (Age; sex, marital status, area of residence, educational level, qualification, years of experience, have received any training on medical waste management in operating rooms and have received any training on green practices in operating rooms).

- **Part II:** This part was designed to assess nurses' knowledge about green practice regarding waste management in operating room. It included 62 questions under eleven categories as follows: Climate change (four MCQ), Operating room (three MCQ), Medical waste (5 MCQ), Sustainability (three MCQ), Green practices (17 MCQ), Medical waste classification (7 MCQ), Medical waste segregation (9 MCQ), Medical waste collection (two MCQ), Medical waste transportation (three MCQ), Medical waste storage (three MCQ) and Medical waste treatment (6 MCQ).

Scoring system:

The studied nurses' answers were cross-coded with a model key answer prepared by the researcher. Each question was scored as the following: correct answer was scored by "one" and the incorrect answer was scored by "zero".

These scores summed-up and converted in to a percent score.

- Satisfactory if the score was $\geq 70\%$ (≥ 43.5 grade)
- Un Satisfactory if the score was $< 70\%$ (< 43.5 grade)

Second tool: Waste reduction and prevention checklist:

It was used to assess green practice regarding waste management among operating room nurses. It is adapted from (*Practice Green Health Organization, 2011 & United Nations Development Programme, Global Environment Facility, & World Health Organization, 2012*) and modified by researcher. It included 52 items under five categories as follows: Green practices for Waste Reduction (ReduceWaste- reuse - recycle)(20 items), Waste classification (6 items), Waste Segregation (10 items), Waste collection,

transportation and storage (9 items) and Waste treatment and disposal (7 items).

Scoring system:

Each step done correctly and completely was scored by "one" and each step done incorrectly was scored by "zero". These scores summed-up and converted in to a percent score.

- Done correctly if the score was $\geq 70\%$ (≥ 36.4 grade)
- Done incorrectly if the score was $< 70\%$ (< 36.4 grade)

Third tool: Barriers of green practice regarding waste management questionnaire:

It was used to assess barriers of green practice regarding waste management among operating room nurses. It was developed by the researcher after reviewing the relevant and most recent literatures (*Muduli & Barve, 2012, Yazie, Tebeje & Chufa, 2019 & Yeoh et al., 2020*). It was written in the form of close ended questions (yes, no or don't know response). It included 31 items under four categories as follows: Administrative Barriers (11 items), Barriers to people (10 item), Financial Barriers (four items) and Infrastructure Barriers (6 items).

Scoring system:

Each statement was answered by don't know which scored by "zero", No which scored by "one", Yes which scored by "two".

Content Validity:

Content validity was ascertained by panel of seven experts in medical surgical nursing (five professors and two assistant professor of medical surgical nursing in Faculty of nursing–Ain Shams University to review the tools clarity, relevance and comprehensiveness. Based on their recommendations correction, addition and / or omission of some items were done.

Reliability:

Data collection tool reliability was

tested for its internal consistency by Cronbach's Alpha test. It was 0.878 for Nurse's self-administrated questionnaire 0, 710 for Waste reduction and prevention checklist and 0.828 for Barriers of green practice regarding waste management questionnaire.

Pilot study:

A pilot study was done on 10% (5 nurses) of the expected sample size nurse to test the feasibility of the study, application of tools, content validity and estimate the time required for filling the tool and no modifications were done. So the nurses who included in the pilot study were included in the study sample.

Field work:

The study was carried out two days (Sunday-Monday) per week during morning, evening shift over two month period from February 2022 to April 2022. The researcher introduced self to nurses, explained the aim of the study and its implications and how to fill Nurses' self-administrated questionnaire and Barriers of green practice regarding waste management questionnaire. First the researcher filled the waste reduction and prevention checklist by self then distributed the questionnaire to nurses in their working setting.

The time estimated to fill Nurse's self-administrated questionnaire, Waste reduction and prevention observational checklist and Barriers of green practice regarding waste management questionnaire was ranged from 40 to 50 minutes. Each participant filled in the questionnaire and handed it back to the investigator in the same day.

Ethical considerations:

Prior study conduction, ethical approval was obtained from the scientific research ethical committee of the faculty of nursing, Ain Shams University. The researcher met both medical and nursing directors of the mention hospitals where the nurses worked to clarify the aim of the study and take their

approval. The researcher also met the study subjects to explain the purpose of the study and to obtain their approval to participate. They were reassured about the anonymity and confidentiality of the collected data, which was used only for the purpose of scientific research. The subjects' right to withdraw from the study at any time was assured.

Administrative design:

An official letter requesting permission to conduct the study was directed from the dean of the faculty of nursing Ain-Shams University to El-Demerdash hospital director and the nursing director to obtain their approval to carry out this study. This letter included the aim the study and photocopy from protocol in order to get their permission and help for collection of data.

Statistical analysis

Data entry and statistical analysis were done using (SPSS) statistical software package. Quality control was at the stage of coding and data entry. Data were presented using descriptive statistics in the form of frequencies and percentage for qualitative variables; mean and standard deviation for quantitative variable. Qualitative categorical variables were compared Chi-square test; Pearson correlation co-efficient (r) was used for assessment of the inter-relationship among quantitative variables. Statistical significance was considered at (P-value <0.05).

Results

Table (1): Distribution of the studied nurses according to their demographic characteristics (n=45).

Age	frequency	Percent
20≤ 29 years	17	37.78%
30≤ 39 years	16	35.56%
40≤ 49 years	10	22.22%
50≤ 60 years	2	4.44%
Gender		
Male	4	8.89%
Female	41	91.11%
Area of residence		
Urban	41	91.11%
Rural	4	8.89%
Educational level		
Technical Institute Diploma	26	57.78%
Bachelor of Nursing	19	42.22%

Table (1) shows that 37.78% of studied nurses were age between 20-29 years old, 91.11% of them were female, 91.11% of them resident at urban area and 57.78% of them were holding Technical nursing diploma.

Table (2): Distribution of the studied nurses according to their experience and training (n=45).

Years of experience In operating rooms	frequency	Percent
less than one year	14	31.11%
1 < 5 years	6	13.33%
5 ≤10 years	5	11.11%
More than 10 years	20	44.44%
Have you received any training on medical waste management in operating rooms?		
No	23	51.11%
Yes	22	48.89%
Have you received any training on green practices in operating rooms?		
No	45	100.00%

Table (2) reports 44.44% of studied nurses' working experience was ten years and more. 51.11% of them had not received any training on medical waste management in operating rooms and 100% of them had not received any training on green practices in operating rooms.

Table (3): Distribution of the studied nurses' knowledge about green practices regarding waste management in the operating room (n=45).

Item	Satisfactory		Unsatisfactory	
	Frequency	Percent	Frequency	Percent
Climate change	2	4.44%	43	95.56%
Operating room	25	55.56%	20	44.44%
Medical waste	0	0.00%	45	100.00%
Sustainability	4	8.89%	41	91.11%
Green practices (reduce waste - reuse - recycle)	3	6.67%	42	93.33%
Waste classification	5	11.11%	40	88.89%
Waste Segregation	0	0.00%	45	100.00%
Waste collection	31	68.89%	14	31.11%
Waste transportation	23	51.11%	22	48.89%
Waste storage	5	11.11%	40	88.89%
Waste Treatment and disposal	2	4.44%	43	95.56%
Total Knowledge	0	0.00%	45	100.00%

Table (3) observes that 100% of studied nurses had unsatisfactory knowledge about medical waste and waste segregation, 93.33% of them had unsatisfactory knowledge about green practice, 88.89% of them had unsatisfactory knowledge about waste classification and storage and 95.56% of them had unsatisfactory knowledge about climate change and waste handling. The highest score according to satisfactory knowledge obtained in waste collection 68.89%.

Table (4): Distribution of the studied nurses' practice about green practices regarding waste management in the operating room (n=45).

Items	Done correctly		Done incorrectly	
	Frequency	Percent	Frequency	Percent
Green practices for Waste Reduction (Reduce Waste-reuse - recycle)	0	0.00%	45	100.00%
Waste classification	0	0.00%	45	100.00%
Waste Segregation	0	0.00%	45	100.00%
Waste collection, transportation and storage	45	100.00%	0	0.00%
Waste treatment and disposal	45	100.00%	0	0.00%
Total Practice	0	0.00%	45	100.00%

Table (4) presents that 100% of studied nurses had done incorrectly green practice and waste (classification- segregation) while 100% of them had done correctly waste (collection- transportation and storage) and treatment and disposal.

Figure (1): Percentage distribution of the studied nurses' total knowledge about green practices regarding waste management in the operating room (n=45).

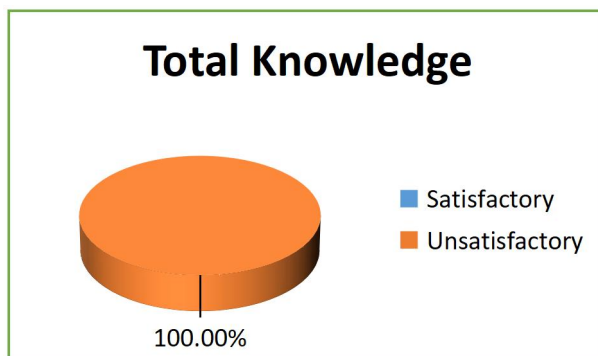


Figure (1) shows that 100% of studied nurses have unsatisfactory total knowledge about green practices regarding waste management in the operating room.

Figure (2): Percentage distribution of the studied nurses' total practice about green practices regarding waste management in the operating room (n=45).

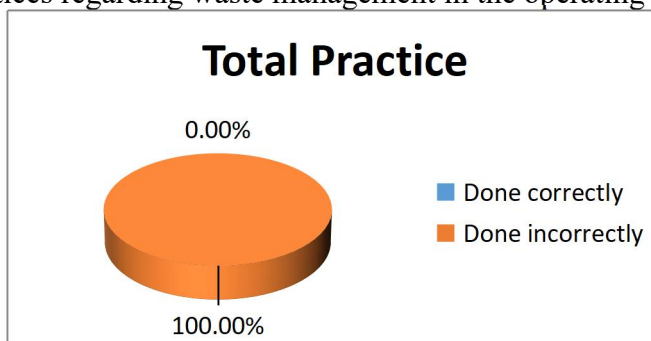


Figure (2) shows that 100% of studied nurses have done incorrectly total practice about green practices regarding waste management in the operating room.

Table (5): Correlation of total studied nurses' knowledge and total practice about green practice regarding waste management (n=45).

Dimensions	Pearson Correlation	
	r	P Value
Knowledge / Practice	-0.25	0.10161

*P value is significant at level <0.05

Table (5) shows that no statistically significant correlation between the studied nurses' knowledge and practice about green practice regarding waste management in operating room.

Table (6): Distribution of the studied nurses barriers to the application of green practice regarding waste management in the operating room (n=45).

Items	No		Yes		I don't know	
	frequency	Percent	frequency	Percent	frequency	Percent
A- Administrative Barriers	4	8.88%	36	80.00%	5	11.1%
B- Human barriers	21	46.66%	22	48.8%	1	2.22%
C-Financial Barriers	5	11.11%	11	24.44%	29	64.44%
D- Infrastructure Barriers	9	20%	30	66.66%	6	13.33%

Table (6) shows that 46.66% of studied nurses reported human barriers as one of the barriers facing the application of green practice regarding waste management in the operating room being the highest percentage achieved among all operating room nurses, 20% of studied nurses reported that infrastructure barriers as one of the barriers facing the application of green practice regarding waste management in the operating room, 66.66% of studied nurses did not know about financial barriers and 80% of them reported that no administrative barriers found.

Discussion

Many environmental issues in the health sector are directly related to waste generation and disposal methods. Hospitals worldwide are struggling to become more sustainable, and evidence suggests that developing countries face more challenges in this area (*Azmal et al., 2014*).

Medical waste is consistently and inappropriately segregated, resulting in environmental pollution, resource misallocation, and increased costs for medical facilities. 90% of all operating room waste is non-hazardous and potentially recyclable; however, 30% to 90% of this waste is incorrectly disposed of as hazardous or regulated medical waste (*Fraifeld et al. (2021)*). In control of the operating room one variable that the

surgical team can change is waste. Several authors have proposed various strategies

for reducing surgical waste while remaining environmentally friendly (*Van et al., 2018*).

Regarding age of the studied nurses, the present study showed that more than one-third of studied nurses were in the age group between 20-29 years old. This result came in line with *Ahmed et al. (2018)* who conducted a study titled "knowledge and practice of staff nurses related to health care waste management" and reported that more than one-third of nurses were less than 30 years old.

Also, the current study came inconsistent with *Ameen & Abdullah (2017)* who studied "Knowledge and Attitude of nursing staffs about medical waste management in Primary Health care centers in ERBIL CITY, IRAQ" and

reported that only 2.2% of nurses were less than 30 years old.

Regarding gender of studied nurses, majority of studied nurses were female. This result came in line with **Musa et al. (2020)** who studied "Assessment of Nurses Practice and Potential Barriers Regarding the Medical Waste Management at Hamad Medical Corporation in Qatar: A Cross-Sectional Study" and found that majority of them were female. Also, the current study came inconsistent with **AL-Hraishawi & Naji (2015)** who studied "Impact of Nurses' Knowledge upon the Infection Control in Primary Health Care Centers at AL-Amara City" and reported that moreover, 65.7% of nurses were male. This is may be due to that male reluctance to practice nursing and to pursue other specialties due to dissatisfaction with the nursing profession.

Regarding educational level of studied nurses, the present study showed that about more half were holding nursing technical diploma. This result agrees with **Khedre et al. (2020)** who conducted a study titled "assessment of healthcare wastes management at Egyptian hospital: case study at qotour general hospital" and reported that 60% of nurses had nursing diploma. Also, the current study came inconsistent with **Kumar (2019)** who studied "A Study to Access the Knowledge Level on Bio-Medical Waste Management among the Nurses in Tamilnadu" and reported that 88% of nurses were Bachelors in nursing.

Regarding years of experience of studied nurses, the current study result showed that more than one-third of studied nurses working experience were ten years and more. This result came in agreement with **Sarker et al. (2020)** who conducted a study titled "Medical waste management practices in a selected district hospital" which stated that 47.6% were ten years of

experience and more. The present study result came in disagreement with **Eskola et al. (2016)** who conducted a study titled "Workplace culture among operating room nurses" which stated that 40% of nurses were less than ten years of working experience in operating room.

Regarding medical waste training of studied nurses, the current study result showed that more than half of studied nurses did not receive any training on medical waste management. This result came on the same line with **Khedre et al. (2020)** who conducted a study titled "assessment of healthcare wastes management at Egyptian hospital: case study at qotour general hospital" which revealed that half of the nurses no received any training about waste management. The present study result came inconsistent with **Ahmed et al. (2018)** who conducted a study titled "knowledge and practice of staff nurses related to health care waste management" which revealed that all nurses had attending training program in waste management. The difference may be due to the awareness of administrators and healthcare personal and their commitment

Regarding green practice training of studied nurses, the current study result shows that all of nurses did not receive any training on green practices in operating rooms. This result is consistent with **Dönmez et al. (2019)** who conducted a study titled "Environment-Friendly Practices in Operating Rooms in Turkey" which revealed that OR staffs are not educated on greening. This may be due to lack of awareness about greening and green practice to medical waste management and its impact on the environment and public health.

Regarding nurses' knowledge about climate change, the present study showed that the majority of studied nurses had unsatisfactory knowledge about climate

change. This result came in line with **Buriro et al. (2018)** who conducted a study titled "Nurses' Perception, Knowledge and Information Sources on Climate Change and Health at Dow University Hospital Karachi" and reported that the majority of the nurses have insufficient knowledge. Also, the current study came disagrees with **Xiao et al. (2016)** who conducted a study titled "Nurses' knowledge and attitudes regarding potential impacts of climate change on public health in central of China" and reported that were that most nurses possessed knowledge on climate change. This may be due to the lack of awareness and education resources about climate change and its impact on public health.

Regarding studied nurses' knowledge about green practices (reduce waste - reuse - recycle) in the operating room, the present study showed that the majority of studied nurses had unsatisfactory knowledge about green practice in operating room. This result agrees with **Kumar et al. (2020)** who conducted a study titled "Knowledge and Practice of Biomedical Waste Management and Awareness of 3 'R's Concept Among Staff Nurses in the Hospital—A Cross-sectional Study" and reported that there is inadequate awareness on 3 'R's (reduce-reuse-recycle) concept and its implementation as most are focusing on only biomedical or hazardous component not on solid waste generated in the hospital. Also, this result came in line with **John et al. (2016)** who studied "A Survey of the American Society of Anesthesiologists Regarding Environmental Attitudes, Knowledge, and Organization" and reported that they lack adequate information on recycling and sustainability in operating rooms. This may be due to a lack of time due to the nature of their work,

as well as the current focus on infection control due to the spread of the Corona virus.

Regarding the studied nurse's knowledge about medical waste classification, the present study showed that the majority of studied nurses had unsatisfactory knowledge about waste classification. This result came in line with **Mohammed (2019)** who conducted a study titled "Knowledge, Attitude and Practice of Health Care Personnel about Medical Waste Management in Selected Family Health Centers in Mansoura, Egypt" and reported that less than one-quarter of them had correct knowledge about medical waste classification and types.

Also, the current study came inconsistent with **Madhukumar & Ramesh (2012)** who studied "Awareness and practice of biomedical waste management among healthcare providers in a Tertiary Care Hospital of West Bengal, India" and reported that 81.9% of nurses knew about categories and the treatment of health care waste (HCW) correctly. This may be because they are very careful with implementation and attending health care waste management training programs.

Regarding the studied nurses' knowledge about medical waste segregation in operating rooms, the present study showed that all studied nurses had unsatisfactory knowledge about waste segregation. This result came in line with **Malini & Eshwar (2015)** who conducted a study titled "Knowledge, Attitude and Practice of Biomedical waste management among health care personnel in a tertiary care hospital in Puducherry" and reported that the most of the nursing staff (50%) had poor knowledge regarding the colour coding for segregation of waste and also were not aware that segregation had to be done at the point of generation.

Also, the current study result disagrees with *Tabish et al. (2018)* who studied "Knowledge, Attitude and Practice regarding Biomedical Waste Management among the Health Care Workers in Hospitals of Kashmir" and reported that all nursing staff were having awareness about segregation. This might be due to a lack of training and educational programs as a result of a lack of time.

Regarding the studied nurses' knowledge about medical waste collection and transportation in the operating room, only one third of studied nurses had satisfactory knowledge about waste collection and less than half of them had satisfactory knowledge about waste transportation.

This study inconsistent with *Ahmed et al. (2018)* who reported that majority of nurses had satisfactory knowledge about waste collection and transportation. This is might be due to that nurses had attended training program.

Regarding the studied nurses' knowledge about medical waste storage, treatment and final disposal in the operating room, majority of nurses had adequate knowledge about final disposal of pathological waste (human organ or tissue). This study came in line with *Hassan (2022)* who studied "The knowledge, Attitude and Practice of health workers regarding medical waste management" and reported that majority of them have adequate knowledge about disposal of human tissue remains.

Regarding studied nurses' practice about green practices (reduce waste - reuse - recycle) in the operating room, the present study showed that all studied nurses had unsatisfactory practice about green practice in operating room. This result came in line with *Mugabi et al. (2018)* who studied "Assessing Knowledge, Attitudes, and Practices of Healthcare

Workers Regarding Medical Waste Management at a Tertiary Hospital in Botswana: A Cross-Sectional Quantitative Study" and reported that staff nurses had poor knowledge regarding presence of recycling.

Also, this result agree with *Abah & Ohimain (2011)* who studied "Healthcare waste management in Nigeria: A case study" and reported that management practices for healthcare wastes generated at the health facility studied is unsustainable and there is no existing policy or plan and no systems in place for sustainable management of HCW. This may be due to lack of awareness program about sustainability.

Regarding studied nurses' practice about waste segregation in operating rooms, the present study showed that all of studied nurses had unsatisfactory practice about waste segregation in operating room. This result is consistent with *Tabish et al. (2018)* who reported that none of nurses practicing segregation. Also, the current study came inconsistent with *DÖnmez et al. (2019)* who studied "Environment-Friendly Practices in Operating Rooms in Turkey" and reported that Waste separation practices were found to be satisfactory. Lack of segregation practices may be related to the hospital's policy of placing all waste generated from operating room inside the red bag and the sharps in the safety box.

Regarding the studied nurses' practice about waste treatment and disposal in operating rooms, the present study showed that all of studied nurses had adequate practice about waste treatment and final disposal. This result disagrees with *Mohammed et al. (2019)* who reported that 62% of nurses follow final disposal of waste.

Regarding the studied nurses total knowledge about green practices regarding

waste management in the operating room, the present study shows that all studied nurses have unsatisfactory total knowledge about green practices regarding waste management in the operating room.

This study came in line with *Mustafa et al. (2012)* who conducted a study titled "Development of a waste management protocol based on assessment of knowledge and practice of healthcare personnel in surgical departments" and found that all most of nurses had unsatisfactory knowledge about health care waste management before the implementation of educational program about medical waste management.

Also, this study results came in line with *Aanandaswamy et al. (2019)* who study "Assessment of knowledge, attitude, and practices regarding biomedical waste management among operation room personnel in a tertiary care center" and identified deficiencies in the knowledge.

This study results disagrees with *Gupta (2015)* who conducted a study titled "Study to assess the knowledge, attitude and practices of biomedical waste management among healthcare personal at tertiary care hospital in Haryana" and stated that knowledge score as satisfactory was highest among nursing staff.

Also, this study inconsistent with *Ellenkil et al. (2021)* who conducted a study titled "knowledge, attitude, and practices to biomedical waste management among staff of a tertiary care government teaching hospital in Lucknow" and reported that mean score of knowledge about biomedical waste management rule was high staff nurses.

Regarding the studied nurses' total practice about green practices regarding waste management in the operating room, the present study shows that all studied nurses have unsatisfactory total practice about green practices regarding waste management in the operating room. This study agrees with *Aanandaswamy et al. (2019)* who identified deficiencies in practices of biomedical waste management among operating room nurses. This may be due to lack of knowledge and awareness program about green practice and lack of training program.

Also, this study consistent with *Nema & Singh (2015)* who studied "Awareness and practices about health care waste management among hospital staff of a medical college hospital in Bhopal, central India" and reported that observation of actual health care waste management practices were found to be inadequate.

This study inconsistent with *Gupta (2015)* who reported the practice score of biomedical waste management was satisfactory in nursing staff (78%). Also, this study inconsistent with *Ellenkil et al. (2021)* who reported that mean score practice about biomedical waste management rule was high among staff nurses.

Regarding correlation of total studied nurses' knowledge and practice, this study show that there was weak negative correlation between the studied nurses' knowledge and practice about barriers to green practice regarding waste management. This study disagrees with *Ahmed et al. (2018)* who reported that there was statistically significant correlation between the studied nurses' knowledge and practice.

Also, this study disagrees with *Leoncie (2017)* who reported that there is a positive association between knowledge and practice. Also, this study inconsistent with *Rutayisire et al. (2019)* who studied

"Knowledge and Practice for Bio-Medical Waste Management among Healthcare Personnel at Kabgayi District Hospital, Rwanda" and reported that Bio-medical waste management knowledge and bio-medical waste management practices were significantly associated.

Regarding studied nurses' about barriers to the Application of Green Practice regarding Waste Management in the Operating Room, the present study showed that there was closer to half of studied nurses reported human barriers as one of the barriers facing the application of green practice regarding waste management in the operating room being the highest percentage achieved among all operating room nurses, lower than one third of studied nurses reported that infrastructure barriers as one of the barriers facing the application of green practice regarding waste management in the operating room, two thirds of studied nurses don't know about financial barriers and of them reported that no administrative barriers.

This study came in line with *Mugabi et al. (2018)* who reported that The most common obstacles reported was "lack of knowledge and training" identified by 63.1%, followed by the fact that majority of nurses do not see waste separation as their area of concern according to 52.2% of nurses, 47.7% thought the greatest barrier to recycling was lack of knowledge.

This study inconsistent with *Leoncie (2017)* who indicates that lack of equipment was reported as the first perceived factors affecting knowledge (71%) and practice followed by negligence(66%), lack of awareness and training toward medical waste management(57%) and lack of coordination(45%) were the first four factors reported.

Similarly to the study done by *Muduli & Barve (2012)* who studied "Barriers to Green Practices in Health Care Waste Sector: An Indian Perspective" and found that lack of coordination, medical waste management committee, operation strategy ,lack of awareness and training toward medical waste management, lack of pressure and lack of appropriate equipment are the major challenge against medical waste.

Petre et al. (2019) who conducted a study titled " A national survey on attitudes and barriers on recycling and environmental sustainability efforts among Canadian anesthesiologists: an opportunity for knowledge translation" and reported barriers to recycling in the OR included (63.5%) reported a lack of support from hospital/OR leadership and (62.8%) reported inadequate information/education.

Musa et al. (2020) reported that Lack of training and time constraint 33.3% among operating room nurses, As a Barriers Regarding the Medical Waste Management. *Sarker et al. (2014)* who studied "Evaluation of Knowledge, Practices, and Possible Barriers among Healthcare Providers regarding Medical Waste Management in Dhaka, Bangladesh" and reported that Insufficient PPE in the hospital was the top barrier among nurses followed by lack of instrument for final disposal, insufficient MWM-related staff, lack of guideline or policy, and lack of an incinerator are the top five barriers.

Conclusion

Based on the findings of the present study, it can be concluded that there was weak negative correlation between the studied nurses' knowledge and practice about green practice regarding waste management ($p=0.10161$, $r= -0.25$). Closer to half of studied nurses reported that human barriers is the main barriers facing

the application of green practice regarding waste management in the operating room being the highest percentage reported by operating room nurses, followed by infrastructure barriers, financial barriers and administrative barriers.

Recommendations

The following recommendations were reached in the light of the study results:

1. Nurses should receive specific training regarding the new concept of sustainability and green practice and waste management.
2. Policy maker should be encouraged to purchase environmentally friendly supplies and materials used in operating room.
3. Activating the color code system to dispose of all types of wastes generated inside the operating rooms.
4. Operating room nurses should be encouraged to prevent wasting generation and to decrease surplus materials, and reusable materials should be given preference over disposable materials.
5. Recycling practices can be improved by adopting proper segregation of waste generated all along the patient pathway (before, during, and after the surgery).
6. Efforts should be made to build environment-friendly teams “green team” in the operating rooms to follow green practices and applications.

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