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Green practice guideline program regrading waste management on nurses' knowledge and practice in intensive care units

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Abstract---Background: Hospitals all over the world looking forward to become more sustainable and get rid of medical waste which resulting in environmental pollution, misallocation and increased costs for medical facilities. The study was carried out at Ain shams University Hospitals and which included surgical, medical and cardiac (ICU). A convenient sample of 60 nurses were included. Study tools: A structured self-administrated questionnaire, waste reduction and prevention checklist, and barriers of green practice regarding waste management questionnaire. Results: (91.7%) of the studied nurses have unsatisfactory level of total knowledge about green practice pre guideline program implementation while (93.3%) of them improved to satisfactory level post implementation and slightly decreased to (90%)

at follow-up phase. Also, (93.3%) of the studied nurses have unsatisfactory level of total practice pre guideline program implementation while (94.6%) of them improved to satisfactory level post program implementation and slightly decreased to (93.1%) at follow-up phase. mean and standard deviation of the barriers of application of green practice regarding waste management in ICU as; administrative barriers was 1.12 ± 0.87 in the surgical ICU nurses compared to 1.45 ± 1.110 and 1.37 ± 0.94 in the medical and cardiac ICU nurses. Conclusion: the educational guideline program for green practice regarding waste management in ICU was effective to enhance nurses' knowledge and practice score among ICU nurses. Recommendation: Continuous training program about green practice and waste management among critical care nurses is crucial.

Keywords---green practice, guideline, program, waste management, nurses, knowledge, practice, intensive care units.

Introduction

Intensive care is a specific diagnostic and treatment process for patients with critical disruption of vital functions and/or for patients expected to have decompensation in those functions over a period in the immediate future. Presently, the application of intensive care for life-saving conditions is based on an orderly system, which is regulated and developed in detail in all of its versatile aspects. The regulated scope of green practices regarding waste management in intensive care units defines the measures that should be implemented well by health care providers, it will lead to the proper management of medical waste and a reduction in the environmental and health problems (Elsayed et al.,2020).

The volume of healthcare waste (HCW) has dramatically increased over the last 30 years, with hospitals and medical centers across the world generating more waste than ever before (Sarkees, 2018). The USA is reported to generate approximately 3.6 million tons of HCW per year, while in South Africa (SA) 42 000 tons of HCW were generated in 2014 with the cost of its safe disposal estimated to be in the region of R 71 million/year. In addition to the direct costs of HCW disposal, there are additional costs such as transporting biohazardous waste material from hospitals to sites where it can be safely disposed of, capital, maintenance, utility and management overhead costs (Adekunle , et al., 2017)

Medical waste includes all the materials used while administering treatment to patients as well as all items contaminated by hazardous fluids, for example, blood, urine, feces, and other body fluids. Medical waste poses an important global challenge because of potential hazards to the environment and public health. Unfortunately, world health organization (WHO,2018) reports suggest that almost 80% of medical wastes are mixed with general waste, especially in developing countries, also it estimated the amount of waste in intensive care unit for each patient is about 1.5 kg daily. In the course of providing healthcare services (preventative, promotive or curative), it is inevitable that medical waste will be generated (Kumar , 2019) .The process and method adopted for waste

management should be technically and financially sustainable in the long run. It has to also be ensured that there are no adverse health and environmental consequences of waste handling, treatment, and disposal activities (Mugabi, et al., 2020).

Many of the challenges associated with managing HCW can be attributed to lack of knowledge about its safe disposal. The knowledge and practices of health care team specifically nurses working in the intensive care units has been shown to play an important role in successfully managing HCW, with the lack of adequate knowledge and practices being shown to result in an increase in the spread of infectious diseases, among other consequences (Ahmed, et al., 2018). The South African Government, through the Health Professions Council of South Africa, has developed an extensive waste management guideline for health practitioners to ensure that medical waste 'is handled so as to ensure that it is segregated at source, contained in packaging that holds the contents to the point of disposal, and disposed of in a manner that is practical and efficient yet minimizes any hazard'. The guideline further stipulates that HCPs should ensure that they are conversant with the operational approaches for handling and storing HCW safely, and should remain updated with the current trends and knowledge on its safe management through training (Gamal, et al., 2018)

The management of health care waste is of great importance due to its infectious and hazardous nature that can cause undesirable effects on human health and the environment. Government regulations and growing public awareness regarding health care waste issues have forced health care units to adopt suitable strategies for managing this waste. Many efforts have been made by environmental regulatory agencies and waste generators to better manage the waste from healthcare facilities in recent years. In fact, new technologies and instruments have been developed to handle health care wastes. However, there are barriers among health care worker to apply green practice in the intensive care unit including; administrative barrier involve (managerial poor commitment & improper hospital waste management operational strategy & lack of guidelines regarding green practice) , human barrier such as (lack of awareness & training program , staff resistance , financial barrier (as lack of sufficient budget & expensive of equipment required for), and infrastructure barrier concerning with interpretive structural modelling (Musa, et al .,2020)

Around the world, health care organizations are increasingly paying attention to environmental sustainability, and in fact the Global Green and Healthy Hospitals Network is connecting and supporting healthcare services globally to become more environmentally conscious. The United Nations sustainable development agenda (inclusive of 17 sustainable development goals) exemplifies a more inclusive approach to change. Key stakeholders, including the International Council of Nurses, are prioritizing the climate action needs of high-risk countries. Nursing has a pivotal role in application green practice in intensive care unit as nurses act 60% from health care team worldwide (Ayelet,2019).

Operational definition of green practice: green practice is the practice of segregation, collection, handling, transferring, and storage & dispose medical

wastes in ways that conserve natural resources, improve ICU environmental quality and reduce pollution.

Significance of the study

Medical waste is consistently and inappropriately segregated, resulting in environmental pollution, resource misallocation, and increased costs for medical facilities. Control of the waste of intensive care units is one variable that the nurses can change or reduce it, while remaining environmentally friendly (Fraifed et al, 2021). According to Ministry of Health and population in Egypt records in 2018 the average quantity of medical waste delivered in health care facilities in all governorates of Egypt is 100566kg/day and only 77884 kg/day of them can be treated (World Bank documentation, 2018). So that, the current study design green practice guideline program regarding waste management in order to improve nurses' knowledge and practice in intensive care units.

Aim of the Study

This study aimed to assess the effect of green practice guideline program on nurses' knowledge and practice regarding waste management in intensive care units.

Hypotheses of the Study

- The implementation of green practice guideline program will have a significant improvement in knowledge, and practice of ICU nurses regarding waste management post implementation compared to pre implementation of the program.

Materials and Methods

Study design

One-group quasi-experimental (pre-post) research design was utilized to accomplish the aim of the current study.

Study Setting

The study was carried out at ICU units in Ain Shams University Hospitals which included surgical, medical, and cardiac intensive care units.

Study sampling

ICU Nurses' (60) were recruited using a convenience sampling technique at previously mentioned setting, who accepted to participate in the study. The Study duration extended over a period of five months from the 1st of September 2021 to the end of January 2022.

Tools of Data Collection

Three tools were used for data collection:

Tool I: A structured self-administrated questionnaire: It was developed by the researchers in the Arabic language in the form of close ended questions (MCQ), and it consisted of two parts.

Part 1: It involved questions concerned with demographic characteristics of the studied nurses such as age, gender, residence, educational level, marital status, training courses related green practice of ICU waste management, work experiences, and unit work.

Part 2: Nurses' knowledge Questionnaire: It was developed by the researchers after reviewing the related literature and studies (Khan et al., 2019; Wyssusek, Keys & Zundert, 2019 ; and Wu & Cerceo, 2019) , it included 62 questions distributed into eleven categories as follow: knowledge about climate change (4 MCQ), ICU design (3 MCQ), medical waste (5 MCQ), sustainability (3 MCQ), green practice (17 MCQ), medical waste classification (7 MCQ), medical waste segregation (9 MCQ), medical waste collection (2 MCQ), medical waste transportation (3 MCQ), medical waste storage (3 MCQ), and medical waste handling & disposal (6 MCQ). Scoring system: the questionnaire contained 62 knowledge assessment question each question was scored (0 – 1) as (0) for incorrect answer and (1) for correct answer. The total score of each nurse was categorized into “unsatisfactory knowledge” when the nurse achieved less than < 70% (< 43.5 grade) of the total score and “satisfactory knowledge” was considered when the nurse achieved more than & equal $\geq 70\%$ (≥ 43.5 grade) of the total score.

Tool II: Waste reduction and prevention checklist: mIt was used to assess green practice regarding waste management among ICU nurses, it was adapted from (Practice Green Health Organization, 2011; and world Health Organization, 2018) and modified by the researchers. It included 52 steps distributed in to five categories as follow: Green practice for waste reduction (reduce waste- reuse- recycle) (20 steps), waste classification (6 steps), waste segregation (10 steps), medical waste collection, transportation and storage (9 steps), and waste handling and disposal (7 steps). Scoring system: the questionnaire contained 52 statement each statement was scored (0 – 1) as (0) for done incorrectly and (1) for done correctly and completely. The total score was categorized into “unsatisfactory practice” when the nurse achieved less than < 70% (< 36.4 grade) of the total score and “satisfactory practice” was considered when the nurse achieved more than & equal $\geq 70\%$ (≥ 36.4 grade) of the total score.

Tool III: Barriers of green practice regarding waste management questionnaire: It designed to assess barriers of green practice regarding waste management among ICU nurses. It was developed by the researchers after reviewing the related literature (Muduil & Barve, 2012; Yazie, Tebeje & Chufa, 2019; & Yeoh et al., 2020). It was written in form of close ended questions (Yes, No or don't know). It included 13 items distributed in to four categories as follow: Administrative barriers (11 items), human barriers (10 items), financial barriers (4 items) and infrastructure barriers (10 items). Scoring system: the questionnaire contained 31

statement each statement was scored on scale from (0 – 2) as (0) for don't know, (1) for No and (2) for Yes answer. The total score of each nurse opinion was categorized into “disagree” when the nurse achieved less than $< 70\%$ (< 21.7 grade) of the total score and “Agree” was considered when the nurse achieved more than & equal $\geq 70\%$ (≥ 21.7 grade) of the total score.

Operational Design

Preparatory phase

This phase included a literature review for developing the tools, as well as testing the validity and reliability of the study developed tools. This included a review of the past and current related literature and studies, using available books, periodicals, magazines, and articles to get acquainted with the various aspects of the study research problems. The developed tool was tested for their reliability by using Cronbach's alpha coefficient test in SPSS program version 21 by a statistician to splits all questions on instrument and computes all correlation value for them. It was carried out on 10% of studied nurses ($n=6$) and the results were Cronbach's $\alpha = 0.878$ for knowledge, 0.710 for waste reduction and prevention checklist, and 0.828 for barriers of green practice regarding waste management questionnaire.

Ethical Considerations

The research approval was obtained .As well as oral consent was obtained from each nurse after the researchers informed them about the aim of the study. Moreover nurses, who agreed to participate in the study, informed that all data gathered during the study were confidential. Also, they have the right to withdraw from the study at any time.

Administrative approval

Necessary official approval to conduct the study was obtained from Ain Shams University Hospital including ICU units. Oral permissions were obtained to conduct the study from the head of ICU units.

Pilot study

A pilot study was carried out with a sample of 6 nurses. It carried out before data collection to evaluate the feasibility, time, cost, adverse events, and improve upon the study design before the performance of a full-scale research study. There were no modifications were accordingly done so the participants in the pilot study were included in the sample.

Fieldwork

The researchers attended at ICU units (surgical, medical, and cardiac intensive care units) 2 days weekly for each unit, at the morning shift from 9.00 a.m. to 1.00 p.m. Data collection extended over a period of 5 months period from the 1st of September 2021 to the end of January 2022 for pretest, educational guideline

program session implementation, posttest, and follow-up. The researcher started by introducing herself to nurses and simply explaining the aim of the study. Data collection was carried out through distributing the questionnaire to ICU nurses. Time consumed for full the questionnaire was 30 minutes.

The framework of the study

Assessment phase: assessment of nurses' knowledge about green practice regarding waste management in intensive care unit before the implementation of the educational guideline program was done.

Planning phase: based on the findings of the assessment phase; goals, priorities, and expected outcomes was formulated to meet nurses' needs of knowledge about green practice regarding waste management in intensive care unit.

Implementation phase: The current intervention's theoretical framework was a guideline educational program designed by the researchers based on nurses needs and develop after reviewing the related literature and studies (United Nations Development Program, 2012; Weiss et al., 2016; Van, Vanessa & Fiegen, 2018;and The Global Fund Organization,2020). Preparation of suitable media such as booklet, CD, and brochures for teaching the nurses. The illustrated guideline program handouts was distributed to 6 groups; each group included ten nurses. Implementation of the educational program was carried out at the previously mentioned settings. The educational guideline program consisted of five sessions once every week & every session continued for 45-60 minutes. Three nursing college professors revised the program before implementation. The 1st session included concept of green practice, benefits of waste management and skills of waste, reuse, recycle, and waste classifications. The 2nd session focused on improved nurses' awareness regarding climate change, ICU design, medical waste, sustainability and understanding medical waste segregation, medical waste collection, and medical waste transportation. 3rd session: Techniques for waste segregation, and medical waste collection and transportation. 4th session: focused on understanding importance and methods of medical waste storage, and medical waste handling & disposal. 5th session: training on waste storage, handling and waste disposal.

Evaluation and follow up phase: reevaluation of nurses' knowledge and practice related green practice regarding waste management in ICU was carried out using the same assessment tools immediately post implementation of the educational program and follow-up (post 3 months) and were compared with pretest levels.

Statistical Analysis

Data were organized, categorized, result were presented in tables. Data were analyzed using a compatible personal computer using the Statistical Package for the Social Sciences (SPSS Inc; version 21; IBM Corp., Armonk, NY, USA). Qualitative data were described using numbers and percentages. Continuous variables were presented as means \pm standard deviation. An ANOVA test is a type of statistical test used to determine if there is a statistically significant difference between two or more categorical groups by testing for differences of means using variance. Cochran's Q test is used to determine if there are differences on a

dichotomous dependent variable between three or more related groups. The results were considered significant when the probability of error is less than 5% ($p < 0.05$) and highly significant when the probability of error is less than 0.1% ($p < 0.001$).

Results and Discussions

Table (1) Distribution of studied ICU nurses related to their characteristics (n=60)

Items	No	%
Age:		
- 20 - <35	19	31.7
- 35 - <50	30	50
- ≥ 50	11	18.3
Mean (SD)	39.58 \pm	
8.69		
Gender:		
- Male	24	40.0
- Female	36	60.0
Educational level:		
- Diploma of nursing	18	30.0
- Technical health institute	15	25.0
- Bachelor of nursing	18	30.0
- Postgraduate	9	15.0
Residence:		
- Urban	55	91.7
- Rural	5	8.3
Marital status:		
- Married	51	85.0
- Unmarried	9	15.0
Experience:		
- <5 years	25	41.7
- 5 – 10 years	20	33.3
- >10 years	15	25
Training courses about green practice in ICU:		
- Yes	4	6.7
- No	56	93.3
Unit work		
- SICU	22	36.7
- MICU	21	35
- CICU	17	28.3

As shown in table (1), the study was conducted including 60 nurses. Regarding their characteristics, (50%) aged from 30 to less than 40 years old with mean 39.58 \pm 8.69 years old. (60 %) are females. As regard their Level of education, (30 %) are diploma and bachelor nurses. (91.7 %) are from urban area. (85%) are married. Concerning experience, (41.7%) have less than 5 years. In addition, (93.3%) didn't attained training courses about green practice. As well, (35%) work at MICU unit.

Table (2) Comparison of studied nurses' satisfactory knowledge score about green practice regarding waste management in ICU pre, post, and follow up (n=60)

knowledge	Pre	Immediate	Follow-up	Pre vs. immediate		Immediate vs. follow-up	
	Mean ± SD	Mean ± SD	Mean ± SD	t-test	p-value	t-test	p-value
Climate change	1.22±1.29	3.17±1.03	3.55±0.70	-9.157	<0.001	-1.291	0.357
ICU design	3.00±1.45	3.83±0.94	4.20±0.82	-3.734	<0.001	-1.186	0.477
Medical waste	1.42±1.01	2.20±0.75	2.37±0.71	-4.802	<0.001	-1.157	0.417
Sustainability	2.13±1.41	5.22±1.32	5.47±1.13	-12.393	<0.001	-1.039	0.513
Green practice (reduce-reuse-recycle waste)	1.38±1.25	3.52±0.95	3.63±1.01	-10.535	<0.001	-0.608	0.994
Waste classification	3.60±1.76	6.10±1.53	6.58±1.11	-8.318	<0.001	-1.288	0.289
Waste segregation	1.42±1.00	4.83±1.01	4.72±0.98	-18.642	<0.001	0.598	0.276
Waste collection	3.00±1.45	3.83±0.94	4.20±0.82	-3.734	<0.001	-1.186	0.477
Waste transportation	2.12±1.40	5.21±1.31	5.46±1.12	-11.392	<0.001	-1.038	0.512
Waste storage	1.22±1.25	3.17±1.05	3.55±0.71	-9.155	<0.001	-1.293	0.353
Waste handling and disposal	3.60±1.73	6.10±1.50	6.58±1.13	-8.315	<0.001	-1.286	0.286

Table (2) concerned with satisfactory level of nurses' knowledge pre, post, and follow-up. It clarified that, there is a highly statistically significant difference between immediate and follow-up tests compared to pre according to their total score of knowledge with ($P < 0.001$) in pre vs. immediate tests; while immediate vs. follow-up (p -value > 0.05).

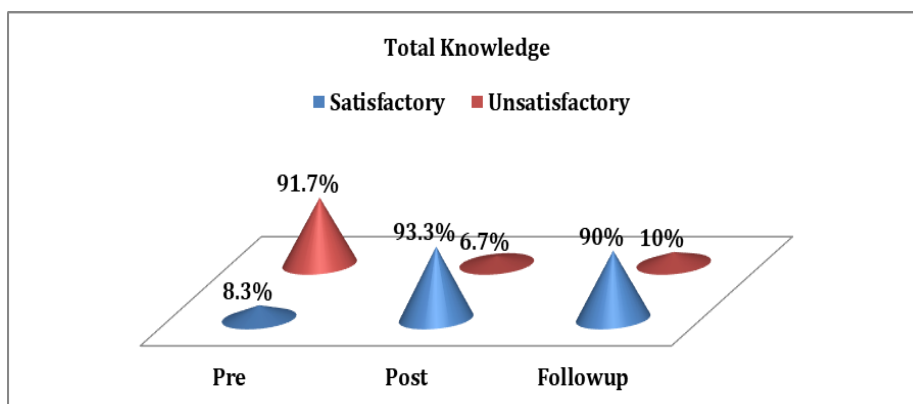


Figure (1) Distribution of studied nurses related their knowledge about green practice regarding waste management in ICU pre, post, and follow up (n=60)

Figure (1) illustrates that, (91.7%) of the studied nurses have unsatisfactory level of total knowledge about green practice pre guideline program implementation while (93.3%) of them improved to satisfactory level of total knowledge post guideline program implementation and slightly decreased to (90%) at follow-up phase.

Table (3) Comparison of studied nurses' satisfactory practice score about green practice regarding waste management in ICU pre, post, and follow up (n=60)

knowledge	Pre	Immediate	Follow-up	Pre vs. immediate		Immediate vs. follow-up	
	Mean ± SD	Mean ± SD	Mean ± SD	t-test	p-value	t-test	p-value
Green practice (reduce-reuse-recycle waste)	10.67±3.44	23.38±3.08	25.10±3.30	-	21.336	<0.001	-0.94 0.349
Waste classification	8.53±2.06	20.97±2.91	21.88±2.84	-	26.997	<0.001	-0.74 0.276
Waste segregation	8.67±2.21	20.77±2.13	22.10±2.01	-	26.385	<0.001	-0.73 0.274
Waste collection, transportation and storage	8.87±2.31	21.00±2.54	22.13±2.01	-	27.385	<0.001	-0.71 0.263
Waste handling and disposal	7.70±2.36	19.32±2.04	20.12±1.76	-	28.859	<0.001	-0.30 0.112

Table (3) concerned with satisfactory level of nurses' practice pre, post, and follow-up. It clarified that, there is a highly statistically significant difference between immediate and follow-up tests compared to pre according to their total score of practice with ($P < 0.001$) in pre vs. immediate tests; while immediate vs. follow-up ($p\text{-value} > 0.05$).

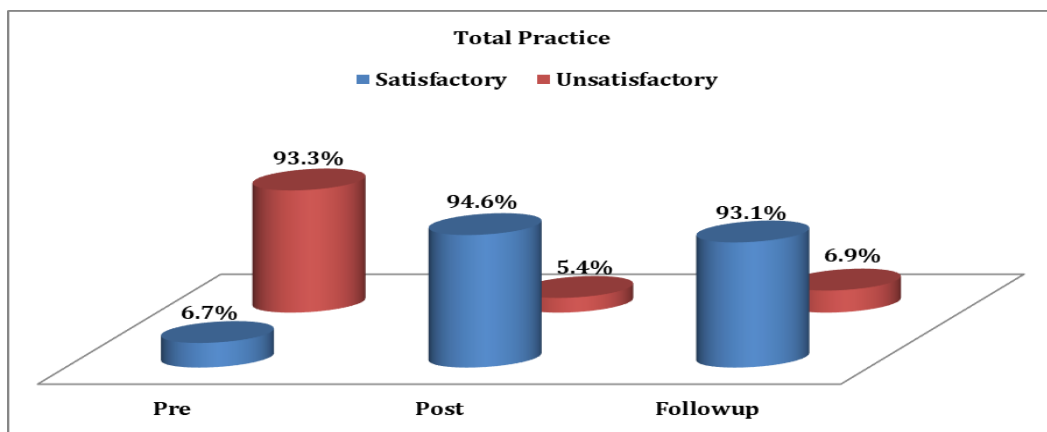


Figure (2) Distribution of studied nurses related their practice about green practice regarding waste management in ICU pre, post, and follow up (n=60)

Figure (2) illustrates that, (93.3%) of the studied nurses have unsatisfactory level of total practice about green practice pre guideline program implementation while

(94.6%) of them improved to satisfactory level of total practice post guideline program implementation and slightly decreased to (93.1%) at follow-up phase.

Table (4) Mean and standard deviation of the barriers of application of green practice regarding waste management in ICU as perceived by nurses at surgical, medical and cardiac ICU (n=60)

Barriers	SICU (n=22) Mean ± SD	MICU (n=21) Mean ± SD	CICU (n=17) Mean ± SD
Administrative barriers	1.12 ± 0.87	1.45 ± 1.110	1.37±0.94
Human barriers	0.93 ± 0.71	0.98 ± 0.75	1.13±0.70
Financial barriers	1.23±0.87	1.20 ± 0.78	0.77±0.74
Infrastructure barriers	1.02 ± 1.08	1.17 ± 0.92	0.97±0.64
t-test	60.54	66.68	59.7
P-value	<0.001	<0.001	<0.001

Table (4) showed mean and standard deviation of the barriers of application of green practice regarding waste management in ICU as; administrative barriers was 1.12 ± 0.87 in the surgical ICU nurses compared to 1.45 ± 1.110 and 1.37 ± 0.94 in the medical and cardiac ICU nurses. In addition, the mean and standard deviation of Human barriers was 0.93 ± 0.71 , Financial barriers was 1.23 ± 0.87 and Infrastructure barriers was 1.02 ± 1.08 in surgical ICU nurses compared to 0.98 ± 0.75 , 1.20 ± 0.78 and 1.17 ± 0.92 respectively in medical ICU nurses and to 1.13 ± 0.70 , 0.77 ± 0.74 , and 0.97 ± 0.64 respectively in cardiac ICU nurses with highly statistically significant $P < 0.001$.

Table (5) Correlation of studied nurses' knowledge, practice and barriers about green practice regarding waste management in ICU pre, post, and follow up (n=60)

Variables	Pearson Correlation	
	r	p-value
Knowledge/practice	-1.000	0.00
Knowledge / Barriers	0.130	0.29
Practice/ Barriers	-0.011	0.001

Table (5) shows that there was a statistically significant negative correlation between the studied nurses' knowledge and practice ($r = -1.000$, $p < 0.00$), also between the studied nurses' practice and barriers ($r = -0.011$, $p < 0.01$) about green practice regarding waste management in ICU. While, there was a statistically significant positive correlation between the studied nurses' knowledge and barriers ($r = 0.130$, $p < 0.29$) about green practice regarding waste management in ICU.

Discussion

Medical waste is considered as a worldwide problem in the 21st century with increasing effect on health care systems. The prevalence of health hazards is

rising in both industrialized and developing countries regarding medical wastes. Unsafe medical waste management leading to increase morbidity and mortality and cost of health care. Nurses should be well trained about green practice regrading safe medical waste management in order to enhance the quality of care and prevent spread of infectious diseases. (World Health Organization, 2018). So that, the current study design green practice guideline program regrading waste management in order to improve nurses' knowledge and practice in intensive care units.

Regarding demographic characteristics of the studied nurses the current study results showed that, half of them were in the age from 30 to less than 40 years old with mean 39.58 ± 8.69 years old. This result in the same line with Ahmed et al., (2018) who conducted study entitled "knowledge and practice of the staff nurses related to health care waste management" which sated that more than one third of the studied nurses were less than 30 years old.

Concerning gender of the studied nurses, the present study results revealed that about two thirds of them were females. This is may be due to the greater fraction of the nurse in Egypt was female and my also related to the studying of nursing in Egypt were exclusive for female only till few years ago. This result in agreement with Musa et al. (2020) who carried out study entitled "Assessment of nurses practices and potential barrier regarding the medical waste management" which mentioned that majority of sample were female.

As regard Level of education of the studied nurses, one third of them are diploma and bachelor nurses. This might elaborate the current condition of nursing qualification in Egypt. The result is consistence with Khedre et al. (2020) who conducted study entitled "assessment of heath care management at Egyptian hospital" which reported that more than two third of the studied nurses in their study had nursing technical diploma. As well as, the pervious study result according to level of education is homogenous with Kumar (2019) who carried out study entitled "A study to access the knowledge level on biomedical waste management among the nurses in Taminadu" which reported that most of the studied nurses were bachelor's nursing.

According to residence of the studied nurses in the current study it was found that majority of them are from urban area also most of them are married. The present study result inconsistence with Tewabe et al., (2017) who conducted study entitled with" Knowledge, practice and barriers of health care wates segregation among health care providers in university of Gondar comprehensive specialized hospital" and clarified that two third of nurses were single. Concerning experience, the current study result illustrated that more than one third of studied nurses had less than 5 years of working in intensive care units. This finding may be due to that most of the nurses under study were recently graduated, work stress, and occupational hazards that facing them in ICU, all of this prevent nurses from continuing work in the intensive care unit. This result disagreement with Sarker et al., (2020) who implemented study entitled "medical waste management practices and district hospital" and stated that less than half of nurses had ten years of experience and more.

In addition, the present study showed that most of them didn't attain training courses about green practice regrading waste management. As well, more than one third of them work at MICU unit. This may be due to shortage of staff, work load, lack of training courses about the waste management of time in intensive care unit. This result came in the same line with Khedre et al. (2020) who revealed that half of the nurses no receive any training courses about waste management.

Regarding satisfactory level of studied nurses' knowledge pre, post, and follow-up, the current study results clarified that, there is a highly statistically significant difference between immediate and follow-up tests compared to pre according to their total score of knowledge with ($P < 0.001$). from the researchers' point of view green practice guideline program had a significant improvement in knowledge of the studied nurses about green practice regrading waste management post implementation compared to pre implementation of the program. Also, because medical waste management is a common procedure in intensive care units, and nurses must provide proper and safe care to critical ill patients to prevent complications associated with hospital acquired infection. result is supported with Mohamed (2019) who conducted study entitled with "knowledge, attitude and practice of health care personnel about selected family health centers in Mansoura, Egypt" and reported that less than one quarter of nurses had correct knowledge about medical waste management and this related to lack of training and educational courses regrading waste management.

The current study results illustrated that, majority of the studied nurses had unsatisfactory level of total knowledge about green practice pre guideline program implementation while improved to be the majority of them had satisfactory level of total knowledge post guideline program implementation and slightly decreased to at follow-up phase. From the researchers' point of view the rational for knowledge improvement among the studied nurses throughout the different assessment periods might be related to the provision of guideline program about waste management for nurses. Also, the curiosity of the studied nurses to know up to date regrading health care waste management in intensive care unit. While, there are a number of barriers were observed by the researchers during implementation of this study that may explain unsatisfactory of nurses' knowledge due to lack of resources pre guideline program implementation. This is in the same line with Center for Disease control and prevention, (2017); it recommended that the significant improvement of ICU nurses' knowledge after using learning program regrading environmental infection control strength their skills and update their knowledge and improve quality of care provided to the hospital clients

Concerning majority of the studied nurses' majority of them had unsatisfactory level of total practice about green practice pre guideline program implementation while improved to be the majority of them had satisfactory level of total practice post guideline program implementation and slightly decreased at follow-up phase. This could be due to lack of standardized nursing care records, procedure books, training courses and lack of advanced devices. This finding is supported by Donmez et al., (2019), who mentioned that implementation of standards improves nurses' practice and ensure continued quality of care.

As regards to barriers of application of green practice regarding waste management among the studied nurses in ICU as; administrative barriers were 1.12 ± 0.87 in the surgical ICU nurses compared to 1.45 ± 1.110 and 1.37 ± 0.94 in the medical and cardiac ICU nurses. These results came in the same line with Olaniyi et al. (2021) who conducted study entitled with “challenge of effective management of medical waste in low resources settings: south Africa” which stated that the challenges identified by health worker include poor understanding of medical waste guidelines and poor compliance; lack of regular training’ poor attitude of medical waste generators; insufficiency of waste management equipment and sub-standards central storage room , most of these challenges were found to be linked to inadequate training of health worker

In addition, the mean and standard deviation of Human barriers was 0.93 ± 0.71 , the current study showed that majority of the studied nurses did not know about sustainability and its goal and also majority of them did not know about green practice inside intensive care units, environmentally preferable supplies and equipment, this may be due to the lack of awareness about greening in health system and its application and the extent of its impact on the environment. This result in consistence with Alharbi et al. 2021 who conducted study entitled with “toward sustainable environment management of healthcare waste” and mentioned that there are a number of challenges facing the sustainability of the Saudi waste management including lack of coordination among key stakeholder and absence of social responsibility.

Financial barriers were 1.23 ± 0.87 and Infrastructure barriers was 1.02 ± 1.08 in surgical ICU nurses compared to 0.98 ± 0.75 , 1.20 ± 0.78 and 1.17 ± 0.92 respectively in medical ICU nurses and to 1.13 ± 0.70 , 0.77 ± 0.74 , and 0.97 ± 0.64 respectively in cardiac ICU nurses with highly statistically significant $P < 0.001$. this result in agreement with Yeoh et al., (2020) who carried out study entitled with” challenges of going green in the operating room” which stated that cost is one of the major barriers to environmental endeavors in the operating room. Also, the pervious study results similarly to the study conducted about “barrier and facilitators influencing the sustainability of the hospital based on intervention” by Cowie et al. (2020) and revealed that most frequently reported barriers to sustainability was inadequate staff resourcing usually as results of staff shortage and high turnover of staff.

The current study revealed that, there was a statistically significant negative correlation between the studied nurses' knowledge and practice ($r = -1.000$, $p < 0.00$), also between the studied nurses' practice and barriers ($r = -0.011$, $p < 0.01$) about green practice regarding waste management in ICU. While, there was a statistically significant positive correlation between the studied nurses' knowledge and barriers ($r = 0.130$, $p < 0.29$) about green practice regarding waste management in ICU. This may be related to harmony among studied nurses regarding to setting from hot area such as surgical, medicine and cardiac intensive care units of governmental hospitals. On other hand, the concept of green practice (reduce, reuse & recycle) regarding waste management within intensive care units is a new concept and had more clarifications to be applied inside health care systems.

Conclusion

In the light of the current study results and hypothesis, it can be concluded that majority of the studied nurses had inadequate knowledge and practice for green practice regarding waste management in ICU pre implementing educational guideline program. Meanwhile, educational guideline program was effective to enhance nurses knowledge and practice score among them.

Recommendations

- Continuous training program about green practice regarding sustainability, green practice and waste management among critical care nurses is crucial.
- Further studies should target large numbers of nurses in all hospital units not only the ICU units to assess barriers affecting application of green practice regarding waste management in all units and measure level of nurses knowledge and practice regarding green practice.

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