Developing Environmental and Patient Safety Guidelines for Nurses in Critical Care Units

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Abstract

Background: Safety during patient hospitalization is the patients' right, and the priority of health professionals. Also, a healthcare free from risks and failures is a goal that should be reached by health professionals and a commitment of professional education. Therefore, changes to the nurses' work environment need to focus on enabling and supporting nurses to provide high-quality and safe care **Aim:** of the study is to develop environmental and patient safety guidelines for nurses in critical care units. **Design:** the methodological design was conduct to achieve the aim of the current study. **Setting**: The study was carried out at critical care units of three university hospitals. **Subject:** the proposed guidelines was distributed to convenient sample of 31 jury members to test its validity and distributed to convenient sample of 162 participant divided to 88 bedside nurses and 74 resident physicians to test the reliability of the proposed guidelines. **Results**. The proposed guidelines' items were increased to 144 items, and sub-categorized to 17 dimensions. **Conclusions:** the validity and the reliability of the proposed guidelines were satisfactory, where it can be used in critical care units. **Recommendations:** use the developed environmental and patient safety guidelines in different critical care units in the selected hospitals and establish a safety committee to facilitate the application of environmental and patient safety committee.

Keywords: Developing, Patient, Environment, Safety, Guidelines

Introduction

Promoting patient safety and excellence in nursing practice is central to the mandate of professional nursing associations and colleges at the provincial, territorial and national levels[(1)]. The patient safety movement emerged in what will be historically recognized as a period of great change in healthcare. Strong forces working broadly in society have converged to shape this movement. These forces include a rise in self-determination, a hypercompetitive economic mindset that has threatened ethical values, other sources of intense cost pressure, an information revolution, and rapid change[(2)].

The World Health Organization (WHO) defines patient safety as "The reduction and mitigation of unsafe acts with in the health-care system, as well as through the use of best practices shown to lead top optimal patient outcomes" [(3)]. The work environment of nurses is characterized by serious threats to patient safety. These threats are related to how the organization is managed, how the workforce is used, work design and the culture of the organization. A healthcare facility environment service function plays a key role in controlling infections. Environmental services professionals must learn to clean for safety and health first then clean for appearance, many times the importance role that environment services personnel play in keeping healthcare facilities safe is overlooked[(4)].

Thus, changes to the nurses' work environment need to focus on enabling and supporting nurses as well as other health care providers to provide high-quality and safe care. To do so, there needs to be significant changes in the way health care is organized that also address nursing workforce resources, training, and competencies. Researchers have found that nurses may experience greater professional fulfillment when strategies are implemented that promote autonomous practice environments, provide financial incentives, and recognize professional status [(5)].

Many adverse events experienced by patients are associated with poor nursing care. Given their proximity to patients and centrality to patient care, nurses fulfil a vital safety role and have the potential to detect errors, omissions and risk before harm eventuates. Organizational conditions such as staffing, organization of work and the work environment can affect how nursing care is provided and is a critical factor in determining patient outcomes.[(6)].

Significance of the study

It has been observed at the studied hospitals that nurses' staff had various problems related to environment and patient safety in critical care units such as patient bed sores, patient falling from bed, no infection control, improper waste management, and medication errors. in critical care units, the gravity of the critical patient add to the complexity of care in a highly technologically advanced environment, together with communication barriers, carrying out a great many activities per patient and per day, considered to be a great challenge for health care providers. Also, the practice of diagnostic procedures and invasive treatments, and the amount and complexity of information received considered risk areas for patient safety. In Egypt **Shaheen, Mahros, Hegazy, & Salem, (2015)** [(7)] showed that 70.9% of the participants had unaccepted practice regarding patient safety, there is a need to develop guidelines about environmental and patient safety in critical care units.

Aim of the study

- The aim of this study is to develop environmental and patient safety guidelines for nurses in critical care units

Research Questions

- What are the guidelines needed for environmental and patient safety in critical care units in selected hospitals?

Subjects and Methods

Research design:

Methodological design was used to develop environmental and patient safety guidelines

Setting:

The study was carried out at critical care units of three university hospitals: Minia University Hospital; Obstetric and Pediatric Minia University Hospital, and Cardiothoracic University Hospital including:

Subjects:

Two samples were used to collect data for the present study:

Frist sample:

Convenience sample: A convenient sample of one thirty experts in the field of patient and environmental safety. The expert group was recruited for testing the face and content validity of preliminary guidelines. The selection was based on their acceptance and agreement to participate

Second sample:

A convenience sample of all available nurses (n= 88) and resident physicians (n=74) who were working in critical care units during reliability phases of proposed tool except nurses and resident physicians who having less than one year of experience in critical care units.

Data Collection Tool:

To achieve the aim of the current study, data were collect by using the following methods which developed by the researcher:

- Critical review of the scientific literature about patient safety to determine environmental and patient safety guidelines. The review resulted in 16 dimensions contained 131 items. Each participant has been asked to rate his / her agreement about proposed guidelines. The level of agreement was rated on a 2 point scale, where (1) Means disagree (2) means agree
- Opinionnaire sheet to examine the validity of the designed tool
- Final environmental and patient safety guidelines: After finishing developing validating and testing the tool reliability, the final format of the proposed tool has been designed.one (bed sore dimension) and 16 items were added to guidelines according to expert modification and 3 items were omitted. Final guidelines contain 17 dimensions and 144 items

Pilot study

The pilot study was carried out on 10 % of total sample (7 resident physicians and 9 bed side nurse) who are working at selected hospitals to test clarity of the guidelines, to estimate the time needed to complete I,t and to add or omit any statement. According to the result obtained from pilot sample, no major modification was needed and the time taken to answer the sheet was estimated from 20 to 30 minute.

Procedures

Prior to data collection, an official permission to conduct the study was obtained from the Dean of Faculty of Nursing- Minia University and forwarded to the general director as well as the nursing director of the selected hospitals. The guidelines development process was started and finisher for almost one and half year (i.e from the first of January 2017 to the end July 2018)

In the current study, a review of the scientific literature and consultation with an expert's panel were done to determine the guidelines dimensions. Then the guidelines has been administered to the participant as a full scale study, the integrity of the tool was assessed according to its validity and reliability criteria

Preparation phase: this phase was done after reviewing the scientific literature about the environmental and patient safety guidelines to determine its all items, hence the researcher has designed the proposed guidelines for environmental and patient safety with initial draft contained 131 items under 16 dimensions

Validity phase of the proposed guidelines: it contained the face validity of the proposed tool which done by jury member as a result of the "thinking aloud" exercise. Moreover, the researcher has designed an opinionnaire sheet to get the overall opinion about the form of the suggested guidelines; the jury member requested to read the proposed guidelines and evaluated the content in terms whether it appeared to reflect environmental and patient safety guidelines. After that, they express their opinions and commented on the proposed guidelines by either adding or omitting some items. Then the opinionaire sheet was reviewed and analyzed where the jury members' responses were entered to a data spreadsheet

The KMO test measured the sampling Adequacy. It should be closed to 0.5 for satisfactory factor analysis in order to proceed**. Kaiser (1974)** [8] recommended 0.5 (i.e. value for KMO test) as minimal accepted value (i.e. barely accepted). Value between 0.7- 0.8 were considered acceptable, and value above 0.9 were highly acceptable (i.e. superb)

After the validity of jury the guidelines modified as 2 items were omitted from 131 items and 16 items were added and one dimension was added to 16 dimensions. Thus guidelines after jury validity were 17 dimensions and 145 dimensions

Reliability phase of the proposed guidelines: the reliability estimated used in the current study was internal consistency reliability. It was used to assess the consistency of the result across items within the test. In internal consistency reliability estimation, the proposed guidelines administered to convenient sample of bedside nurses (88) and resident physicians (74) who are working in critical care units in selected hospitals to estimate its reliability.

There are a wide variety of internal consistency measures in literature. In the current study, the appropriate estimation that used and Cronbach's alpha. Where a coefficient alpha of 0.70 is considered acceptable for according to **(DeVellies 2016)**[9]**.** Modification and redesigning of the proposed tool was done, and not reliable items omitted where the final environmental and patient safety guidelines that developed was 17 dimensions subcategorized with 144 items

Statistical Designs

Upon completion of data collection, the data were scored and analyzed by computer using (SPSS) version 20.0. Descriptive statistical such as frequency, mean and standard deviation were utilized in analyzing data pretended. Relative statistical tests of significance were used to identify the relations among the study variable and to identify the significance of the relations. Level of significance (p value) threshold of significances was fixed at the (5%) >0.05 indicates non-significant while ≤0.05 indicates significant relationship. The validity estimated which used in the current study was internal consistency reliability, the appropriate estimation that used were Cronbach's Alpha.

Results

Table (1): Percentage distribution of the jury members according to their personal data

Personal Data	Experts (31)	
	No	%
Job title		
• Member in faculty of nursing	8	25.8
• Member in faculty of medicine	8	25.8
• Infection control supervisor	9	29.0
• Head nurses of critical care nursing	4	12.9
• Nurses manager	2	6.5
Gender		
• **Male**	9	29.0
• **Female**	22	71.0
Age		
• < 40	18	**58.1**
• 40-49	9	29.0
• 50-59	3	9.7
• > 60	1	3.1
Mean ± SD	40.4 ± 7.6 years	
Level of education		
• Bachelor	15	48.4
• Master	00	00
• Doctorate	16	**51.6**
Years of experience		
• 10-15	16	**51.6**
• 16-20	9	29.0
• 21-25	4	13.00
• 26-30	1	3.2
• >30	1	3.2
Mean ± SD	16.4 ±6.9 years	

As illustrated in **table (1)** less than three quarter of jury member (71%) were female and more than half (58.1%) of them aged less than <40 years old. Otherwise more than half (51.6) of them have doctorate degree and had experience ranged between 10-15 years

Table (2): Percentage distribution of the study sample according to their personal data in the reliability phase

Personal data	Nurses (88)		Resident Physicians (74)	
	No	%	No	%
Age				
• < 30	77	87.5	74	100
• 31-40	8	9.1	0	00
• > 40	3	3.4	0	00
Mean ± SD	24.4 ± 6.5years		27.1 ± 1.4years	
Sex				
• Male	27	30.7	39	52.7
• Female	61	69.3	35	47.3
Hospital				
• Minia University Hospital	34	38.6	28	37.8
• Obstetric & Pediatric University Hospital	17	19.3	27	36.5
• Cardiothoracic University Hospital	37	42.0	19	25.7
Department				
• Medical intensive care unit	11	12.5	8	10.8
• Coronary care unit	23	26.1	8	10.8
• Neurosurgery Intensive care unit	9	10.2	4	4.5
• Intensive care unit.	14	15.9	16	21.6
• Obstetrics intensive care unit.	9	10.2	13	17.6
• Pediatric intensive care unit.	8	9.1	14	18.9
• Cardiothoracic intensive care unit.	7	8.0	4	5.4
• Chest intensive care unit.	7	8.0	7	9.5

Table (2) shows that majority of nurses (87.5%) who worked in critical care unit aged from less than 30 years and more than two third of nurses **(69.3%)** were female, and more than one third of nurses (**38.6%)** worked in Minia University Hospital. Concerning the department, it was noted that about one quarter of nurses worked in coronary care unit

As regarded to resident physician, all of them (100) aged less than 30 years, more than half of resident physicians (52.7%) were male, (37.8%) worked in Minia University Hospital, and one quartered (25.7%) work in Cardiothoracic University Hospital, and less than one quartered worked in intensive care unit.

Table (3): Percentage distribution of jury members' agreement and disagreement regarding to the proposed tool's general opinionnaire sheet in the initial phase

Items	Agree %	Disagree %
1) The proposed guidelines look like to reveal environmental and patient safety guidelines	77.4	22.6
2) The proposed guidelines are applicable	80.6	19.4
3) The guidelines are important to nurses working in critical care unit	77.4	22.6
4) The guideline can be used as guide to nurses working in critical care unit	83.9	16.1
5) The guidelines are included a reprehensive items under every dimensions	41.9	**58.1**
6) The number of guidelines under every dimension of the tool are suitable	48.4	**51.6**
7) The statements of proposed guidelines are clear	74.2	25.8
8) The items were considered specific and understandable words	87.1	12.9

Table (3) revealed that (58.1%) of jury disagree about **"** The guidelines are included a reprehensive items under every dimensions" and 51.6% of jury member disagree that "The number of guidelines under every dimension of the tool are suitable"

Table (4): Labelling the extracted dimension of tool

Dimension/ factor number	Dimension	Number of items	Eigen value	Variance Explained (%)	Cumulative Variance Explained (%)	*KMO index
1.	Administrating medication	24	87.17	53.81	53.81	0.910*
2.	Bedside nurse	6	11.91	7.36	61.16	
3.	Work environment	10	9.30	5.74	66.90	
4.	Infection control	15	7.63	4.71	71.61	
5.	Bed sores	3	6.50	4.01	75.62	
6.	Patient falling	14	5.25	3.24	78.86	
7.	Personal protective equipment	8	4.61	2.84	81.71	
8.	Ventilation	4	3.97	2.45	84.16	
9.	Water safety	4	2.95	1.82	85.98	
10.	Furniture and equipment safety	8	2.59	1.60	87.58	
11.	Handling and storage of materials	4	2.37	1.46	89.04	
12.	Maintenance	3	1.90	1.17	90.22	
13.	Doors and exits	4	1.41	0.87	91.09	
14.	Fire (prevention and protection)	11	1.38	0.85	91.94	
15.	Lighting and electricity	12	1.22	0.75	92.69	
16.	Waste disposal	10	1.12	0.69	93.38	
17.	Housekeeper	5	1.02	0.63	94.01	
	Total	145	1.01	0.54	95.12	

Note: * KMO denote to the Kaiser- Meyer- Olkin test: Value of 0.5 is considered as minimum (i.e. barely accepted), value between 0.7-0.8 is considered as acceptable, and value above 0.9 are considered as highly acceptable (i.e. superb).

Table (4) indicates that the sample size was adequate and the responses which have been given were also adequate (KMO= 0.910). Administrating medication factor had the highest explaining variance (53.81%) followed by bedside nurse factor (7.36%)

Table (5) Cronbach's Alpha values, mean and standard deviations for the proposed environmental and patient safety guidelines

Safety guidelines	Cronbach Alpha α	Mean	±SD	Total Cronbach's α
1) Administrating medication	0.958	47.60	±2.177	0.991
2) Bedside nurse	0.894	11.87	±0.706	
3) Work environment	0.918	19.83	±0.97	
4) Infection control	0.944	29.77	±1.39	
5) Bed sores	0.798	5.96	±0.30	
6) Patient falling	0.936	27.78	±1.28	
7) Personal protective equipment	0.918	15.89	±0.73	
8) Ventilation	0.854	7.94	±0.41	
9) Water safety	0.941	7.97	±0.32	
10) Furniture and equipment safety	0.921	15.87	±0.81	
11) Handling and storage of materials	0.769	7.92	±0.43	
12) Maintenance	0.831	5.95	±0.33	
13) Doors and exits	0.711	7.93	±0.39	
14) Fire (prevention and protection)	0.908	21.83	±0.99	
15) Lighting and electricity	0.937	23.83	±1.101	
16) Waste disposal	0.922	19.85	±0.93	
17) Housekeeper	0.812	9.86	±0.62	

Note : * denote to an excellent reliability; cronbach's @ of ≥0.9 is excellent ; Cronbach's @ of ≥0.8 is good; Cronbach's @ of ≥0.7 is acceptable Cronbach's @ of ≥0.6 is questionable, Cronbach's @ of ≥0.5 is poor and Cronbach's @ of ≥0.4 is unacceptable

Table (5) show that Total Cronbach's Alpha value for environmental and patient safety guidelines was 0.991where the specific reliability coefficient of the proposed guidelines dimensions were range from 0.711 to 958.

Table 6: Goodness of fit indicator of the Environmental and Patient Safety Guidelines

Tool	X^2	Df	X^2/ df	IFI	CFI	RMSEA
Initial	**1525***	**363**	**4.201**	**0.86**	**0.81**	**0.07**
Modified	**1287***	**415**	**3.101**	**0.91**	**0.90**	**0.04**

Note: denote to significances (i.e . p< 0.05). CFI: comparative fit index. IFI incremental fit index. RMSEA: root mean squared error of approximation

Table (6) reveals that the (RMSEA) index was 0.07, the (CFI) was 0.81 and (IFI) was 0.85. These value were reasonable compared with acceptable value of two fit indices which were ≥ 0.90 and the modified tool was satisfactory [X^2 (415)= 1287, P < 0.01]. The (CFI) and (IFI) increase slightly, but (RMSEA) decreased to 0.04.

Table (7): percentage of jury members' agreement and disagreement regarding to the proposed tool's general opinionnaire sheet in the final phase

Items	Agree %	Disagree %
1) The proposed guidelines look like to reveal environmental and patient safety guidelines	100	00
2) The proposed guidelines are applicable	96.8	3.2
3) The guidelines are important to nurses working in critical care unit	100	00
4) The guideline can be used as guide to nurses working in critical care unit	100	00
5) The guidelines are included a reprehensive items under every dimensions	93.5	6.5
6) The number of guidelines under every dimension of the tool are suitable	100	00
7) The statements of proposed guidelines are clear	100	00
8) The items were considered specific and understandable words	96.8	3.2

Table (7) shows that, the most of jury staff agreed with all items of environmental and patient safety guidelines in the final phase.

Discussion

Safety in healthcare has become a central focus of organizations, legislators, accreditation organizations, as well as individual patient care areas and clinicians.. In critical care unit gravely ill and injured patients are treated. Close monitoring, a highly techno- logical environment and the constant presence of nurses are required when treating patients with life-threatening conditions in order to ensure bodily functions. The highly technological environment and the numerous staff constantly present can result in a strenuous and complex environment. So, safety in health care remains a clear priority for health care providers and organizations **(Gilmer et al., 2005)[10].**

In the current study, regarding the personal data of jury members it was noted that less than three quarter of them were female and more than half of them aged between 30-39 years old. Otherwise more than half of them have doctorate degree and had experience range from 11-15 years. Regarding the personal data of the nurses it was noted that the majority of nurses who worked in critical care unit aged from (20-30) years, more than two third of them were female, and more than one third of them worked in Minia University Hospital. Concerning the department, it was noted that about one quarter of nurses worked in coronary care unit. As regarded to resident physician, all of them aged less than 30 years, more than half of resident physicians were male, worked in Minia University Hospital, and one quartered work in Cardiothoracic University Hospital, and less than one quartered worked in intensive care unit

Safety guidelines for critical care units after extensive review of literature

Kredo (2016) mentioned that development of clinical guidelines has greatly assisted in the delineation of good, evidence based practice. **World Health Organization (2004) [11]** stated that Patient safety improvements demand a complex system-wide effort, involving a broad range of actions in performance improvement and environmental safety and risk management, including infection control, safe use of medicines, equipment safety, safe clinical practice and safe environment of care. **State of Victoria (2016)[12]**) added that keeping patients safe in hospital is making sure they get the right treatment, do not pick up infections, do not have falls, do not take the wrong medication and do not develop pressure sores**.**

Concerning to the first identified dimension of environmental and patient safety guidelines in the current study was the medication administration. Joshi (2012)) [13] stated that drugs are the most potent tools in the hands of clinicians for diagnosing the disease and affecting the cure. These medications can also be hazardous to the life of patients if administered incorrectly or negligibility. Ladak et al., (2007)[14] added that a right drug of right quality administered in right dose, at the right time and in right manner may have a lifesaving effect on the patient. Adequate storage space is important for ensuring safety of drugs, and refrigerators are present for storage of cold and cool items. There should be a documented procedure describing medication administration.

In point out to the second dimension identified in the current study, Bedside nurse. **Ibrahim (2018)[15]** stated that nurses' vigilance at the bedside is essential to their ability to ensure patient safety. There is link between nurse staffing ratios and patient safety, documenting an increased risk of patient safety events, morbidity, and even mortality as the number of patients per nurse increases. Moreover nursing workload is likely linked to patient outcomes as well.

Regarding the third identified dimension related to environmental and patient safety guidelines was work

environment. **Ulrich et al.,(2008)**[16] explored that the environment can influence patient safety directly or indirectly. For example, when an environment is designed to reduce the transmission of airborne and contact infectious agents, hospital-acquired infections plummet. In addition, **Smith et al., (2009)**[17] added that the physical design of a setting could hinder communication and teamwork among care providers.

Regarding the fourth identified dimension related to environmental and patient safety guidelines was infection control. **Tremblay (2017)**[18] stated that infection control occupies a unique position in the field of patient safety since it is universally relevant to health workers and patients at every single health-care encounter. Further, the fifth dimension related to environmental and patient safety guidelines in critical care units was patient fall. Preventing falls is difficult and complex **(Dykes, 2010)**[19]**.** Successful strategies include the use of a standardized assessment tool to identify fall and injury risk factors, assessing an individual patient's risks that may not have been captured through the tool, and interventions tailored to an individual patient's identified risks. **(Joint Commission, 2015)**[20]**.**

Following, the sixth identified dimension related to environmental and patient safety guidelines was Personal Protective Equipment (PPE). **Leiss (2014)** [21] mentioned that PPE are the tools that ensure the basic health protection and safety of patients. Also the use PPE and safety medical devices is mandated for healthcare workers to reduce the risk of infection

Looking to the seventh identified dimension related to environmental and patient safety guidelines was the ventilation. **Cho (2019)**[22] stated that airflow and ventilation are particularly important in healthcare premises. The air exchanges control the space temperature and humidity; assist the removal of waste anaesthetic gases; and dilute airborne bacterial contamination. The key is to provide movement of clean conditioned air in the area where the operation is to be performed, and where the sterile instrument and drapes are exposed. This can be achieved by means of a down flow of air from an air filter bank or diffuser over the sterile field of the operation. For different countries

In respect to the eighth identified dimension related to environmental and patient safety guidelines was the water. **Walker and Moore (2016)**[23] mentioned that the availability of hot and cold water supply systems are vital for public health. Healthcare premises are dependent upon water to maintain hygiene and a comfortable environment for patients and staff, and for treatment and diagnostic purposes. Interruptions in water supply can disrupt healthcare activities. The design of systems should ensure that sufficient reserve water storage is available to minimize the consequence of disruption, while at the same time ensuring an adequate turnover of water to prevent stagnation in storage vessels and distribution system.

In the light of the ninth identified dimension related to environmental and patient safety guideline was the equipment and furniture. **Moyimane, Matlala, and Kekana (2017)**[24] asserted that medical equipment is an essential health intervention tool used by nurses for prevention, diagnosis and treatment of disease and for rehabilitation of patients. However, access to functioning medical equipment is a challenge in low- and middle-income countries.

Regarding the tenth identified dimension related to environmental and patient safety guidelines was the handling and storage of materials, **Thompson et al., (2012)**[25] stated that The ICU design should provide adequate storage for all equipment, supplies, reference materials, and other items in current use, and plan for future needs. Storage is needed for personal items be-longing to staff, patients, and visitors. Equipment and supplies should be stored as close as possible to where they are used. Separate storage should be provided for equipment used with patients in isolation, and for clean and soiled supplies and equipment.

In light of the eleventh identified dimension related to environmental and patient safety guidelines was the maintenance**. Hamdi, et al., (2012).**[26] mentioned that medical equipment becomes increasingly more sophisticated and plays a more crucial role in modern healthcare, maintenance and management issues demand ever-increasing attention. Also **Powdrill, Cordero, and Srinivasa**n, **(2010)**[27] added that the primary responsibility for the care and maintenance of equipment rests with the user. Therefore, user's maintenance of equipment improves patient safety.

In respect to the twelfth identified dimension related to environmental and patient safety guidelines were the doors and exits. **Ayllón etal., (2014)**[28] stated that safe, efficient patient care in critical hospital environments requires sliding, swing, and folding ICU doors. With traffic flowing through them 24 hours a day, damage is inevitable, from porters' trolleys, beds, wheelchairs, staff and patients. Cracks, dents and tears in doors can harbour dirt and bacteria as well as compromising hygiene. As patient safety is of paramount importance, a damaged hospital doors and its frame has to be repaired or replaced as soon as possible.

Concerning the thirteenth identified dimension related to environmental and patient safety guidelines was the fire safety. **Medical Facility Fires (2016)**[29] agreed that hospital fires, and especially those in critical care units, affect patient safety, since most of the patients might be unable to escape because they are dependent on invasive monitoring and organ support. **Holla et al., 2016**[30] stated that all healthcare facilities must have a plan for the protection of all persons on their premises and for their evacuation from the building in case of fire. Written copies of this plan must be available to all supervisory personnel. All employees must periodically be trained and informed of their duties in implementing the plan.

Regarding the fourteenth identified dimension related to environmental and patient safety guidelines was the electrical safety. **Reilly and Lee (2010)**[31] mentioned that electrical safety is very important in critical care units as patients may be undergoing a diagnostic or treatment procedure where the protective effect of dry skin is reduced. Also patients may be unconscious or anaesthetised and may not respond normally to an electric current. Further, electrically conductive solutions, such as and saline, are often present in patient treatment areas and may drip or spill on electrical equipment which can affect the patient safety.

In respect to the fifteenth identified dimension related to environmental and patient safety guidelines was waste disposal. **Rasheed et al., (2005**) [32] mentioned that all individuals in critical care units are exposed to hazardous waste are potentially at risk. Waste management is crucial to promote high quality of healthcare and safe environment within hospital**. Dixit, et al., (2017)** [33] mentioned that plastic bags were used for many types of solid or semisolid infectious waste, bottles, flasks, or tanks can be used for liquid, use of packaging that maintains its integrity during storage and transport, closing the top of each bag by folding or tying as appropriate for the treatment or transport, placing liquid

wastes in capped/ tightly stopped bottles, do not compact infectious wastes before treatment.

Housekeepers identified as one of environmental and patient safety guidelines. It was the sixteenth dimension in current study. **Mathur (2014)** [34] stated that housekeeper help make sure that hospital wards and other units are clean, safe and attractive places for patient care. The role of housekeeping is to create a peaceful, infection free and pleasant atmosphere required for the speedy recovery of the patients. A hospital has to be clean in order to prevent infection and provide quality service. Managerial staff, including head housekeepers, must communicate the importance of safety to each worker to promote the best possible environment for everybody.

Bed sores is the dimension that added by jury members as a dimension of environmental and patient safety guidelines. This was consistent with (**González et al.,2017**)[35] who mentioned that pressure ulcers constitute a health problem with significant impact on patient morbidity and mortality, and the quality of life of those affected and their families. Patients admitted to ICU are at particularly high risk of developing a bed sores.

The result of Validity and reliability of the proposed Environmental and Patient Safety Guidelines for Nurses in Critical Care Units

The psychometric properties of psychological test are related to the data that have been collected on the test to determine how well it measures the construct of interest **(Salters, 2018)** [36]**.** In order to develop a good psychological test, the new test is subject to statistical analysis to ensure that it has good psychometric properties. There are two broad types of psychometric properties that a test must have in order to be considered a good measure of a particular construct: reliability and validity. In simple word psychometric properties refer to reliability and validity of the instrument **(Alvior, 2013)** [37]**.**

In the initial phase of the proposed, guidelines, the general opinionnaire with two scale of agree and disagree, and the proposed environmental and patient safety guidelines with two point scale of agree and disagree were formulated. The guidelines were sent by hand to the jury group including 8 members from medicine faculty – Minia University, 8 members from Nursing Faculty from Mina and Assuit University, 9 members of infection control supervisors in selected hospital, 2 nurse managers and 4 members worked as head nurses in critical care units.

The jury experts were requested to specify whether an item was necessary for operating a construct in a set of items or not be carefully reading the proposed guidelines and evaluating the content in terms of whether it appears to reflect the environmental and patient safety guidelines. They were also requested to assess the overall guidelines in terms of relevancy, clarity and simplicity criteria and to added their suggestion and recommendations. The first finding of the general opinionnaire recommended some suggestion about clarity of the proposed guidelines and adding one dimension to 16 dimensions.

The current result found that the "Administrating medication" factor was the main factor of environmental and patient safety guidelines in critical care units explained with (53.81%) of the variance followed by " Bedside nurse" factor was explained with "7.36%" of variance, then the "work environment" factor explained with "5.74%" of the variance.

Alshammari (2016) [38] mentioned that drug safety is one of the hottest topics in daily medical practice, All drugs have side effects, but the extent of their impact and severity varies from mild to severe However, the serious problem is that some of the drugs' side effects are not previously known or have not been noticed, and the real risk here is whether they would exert a severe deleterious impact on the patients who are using them. **AbdAlla (2017)**[39] added that nurses are vital for patient safety and there is a focus of recent efforts on keeping patients safe can also be viewed as a public health problem and a human rights issue.

The next phase was the reliability one, the reliability estimated used in the current study was the internal consistency reliability guided by Crronach's Alpha coefficient to assess the consistency of the results across items within a test. In internal consistency reliability estimation, the proposed guidelines of environmental and patient safety in critical care units were administered to staff nurse and resident physicians to analyze its reliability.

Cronbach's alpha coefficient is the most frequently used statistic to show internal consistency reliability, especially by nurse researchers **(Polit & Beck, 2004)** [40]**.** Cronbach's alpha's reliability coefficient normally ranges between (0 and 1); however there is actually no lower limit to the coefficient**.** The closer Cronbach's alpha coefficient is to 1.0, the greater the internal consistency of the items in the scale. **(Cronbach's, 1951)**[41]**. George and Mallery (2003)**[42] provided the following rules of thumb for Cronbach's Alpha interpretation as : α 0f ≥ 0.9 considered excellent, $0.9 > \alpha \geq 0.8$ is considered good, $0.8 > \alpha \geq 0.7$ is considered acceptable, , $0.7 > \alpha \geq 0.6$ is considered questionable, , $0.6 > \alpha \geq 0.5$ is considered poor, and , $\alpha \leq 0.5$ is considered unacceptable.

In the current study's finding, the Cronbach's alpha value of the revised scale was 0.991 the result revealed that the final guidelines constantly assess what intended to measure as indicated by **(Copper & Phillips, 2004)**[43] where the reliability coefficients of the dimensions consider excellent ≥0.90.The current value was relatively more than the reported by **Assefa etal., (2012)**[44] about Patient safety practices and medical errors, where, their alpha value for the overall tool was 0.70.

On the other hand and due to the absolute correspondence of the tool, the indicators applied in a competent strategic analysis were: Goodness of Fit Index (GFI) and the Index of Corresponding Values and Approximate Error Expressed as in the Root mean Square Error of Approximation (RMSEA). In GFI, the higher value is the higher one with correspondence where the (GFI) value is between 0 to 1 and closeness to indicate a very good fit **(Bartholomew & Tzamourani, 1999)** [45]**.**

Accordingly in the current findings, the obtained value for the modified tool guidelines the modified guidelines was satisfactory [X2 (415) = 1287, P < 0.01]. The (CFI) and (IFI) increase slightly, but (RMSEA) decreased to 0.04

RMSEA is an indicator based on an appreciative error that occurs due to the expected degree of freedom within the population**.** The lower the indicator is, the higher the correspondence is. Acceptable correspondence is under the value of 0.08, but some authors the value as even under 0.10**(Sivo, et al., 2006)**[46]**.** In the current study the modified tool had value of (0.04) which according to **(Siva, et al., 2006)**[46] was considered as an indicator of good correspondence.

After application of all needed statistical test and further modifications, the finalized guidelines was sent again to the

jury members to read it, evaluate the content in terms of whether it appear to reflect the guideline of environmental and patient safety and assess the overall guidelines in terms of relevance, clarity, and simplicity criteria using two point scale of agree and disagree. The finding of finalized tool's percentage of agreement / disagreement were supported by most of jury members' agreement as the most of jury staff agreed with all items of environmental and patient safety guidelines in the final phase.

Conclusion:

Overall, the current study concluded that the validity and the reliability of the developed guidelines were satisfactory. The guidelines were developed in response to a need for environmental and patient safety in critical care units.

Recommendations:

- Use the developed environmental and patient safety guidelines in different critical care units in the selected hospitals.
- Establish a safety committee to facilitate the application of environmental and patient safety committee.
- Ensuring that the organization's annual budget includes adequate resources to implement and evaluate health and safety activities.
- Ensuring the implementation of accident/injury reporting system in order to analyze the causes and set a plan for improvement.

References

1) Canadian nurses association (CAN). Position statement patient safety. Ottawa: Authors, (2009) Available at http://docplayer.net/58761787-Frameworks-for-patient-safety-in-the-nursing-curriculum.html
2) Chenot. T. Frameworks for Patient Safety in the Nursing Curriculum, published doctoral dissertation University Of North Florida, College Of Education And Human Services, (2007) pp 26 Available @ http://docplayer.net/58761787-Frameworks-for-patient-safety-in-the-.nursing-curriculum.html
3) Royal College of Physicians and Surgeons. The Canadian patient safety dictionary, (2007). Ottawa: Author
4) Walls-Nini, B. Quality Workplace Update. SRNA Newsbulletin, (2004).6(4), 8.
5) Hughes, R. G. Creating a Safe and High-Quality Health Care Environment--Patient Safety and Quality: An Evidence-Based Handbook for Nurse, (2008). Rockville, MD: Agency for Healthcare Research and Quality
6) Dubois, C. A., D'amour, D., Tchouaket, E., Clarke, S., Rivard, M., & Blais, R. Associations of patient safety outcomes with models of nursing care organization at unit level in hospitals. International Journal for Quality in Health Care (2013), 25(2), 110-117.
7) Shaheen, H. M., Mahros, O. A., Hegazy, N. N., & Salem, S. S. Health care Providers practice toward Patient Safety in El-Ebor family health centers, (2016) Egypt, and Menoufia Medical Journal. 29. 1048-1054. 10.4103/1110-2098.202488
8) Kaiser, H. F. An index of factorial simplicity. Psychometrika, (1974). 39(1), 31-36.
9) DeVellis, R. F. Scale development: Theory and applications (Vol. 26) (2016). London, UK, Sage publication.
10) Gilmer, T., Schneiderman, L. J., Teetzel, H., Blustein, J., Briggs, K., Cohn, F., ... & Young, E. The costs of nonbeneficial treatment in the intensive care setting, (2005). Health Affairs, 24(4), 961-971
11) Kredo, T., Bernhardsson, S., Machingaidze, S., Young, T., Louw, Q., Ochodo, E., & Grimmer, K. Guide to clinical practice guidelines: the current state of play (2016). International Journal for Quality in Health Care, 28(1), 122-128.
12) World Health Organization. World alliance for patient safety (2004). forward programme 2005
13) State of Victoria. Security and safety at hospital - Better health channel [homepage on the Internet]. [cited 2016 Aug 1]. Available from: https://www.betterhealth.vic.gov.au/health/…/security-and-safety-at-hospital?viewAs
14) Joshi. SK. safety management in hospital, Jaypee Brothers Medical Publishers (P) Ltd (2012), 1st ed, ch 1 pp 3-22
15) Ladak, S. S., Chan, V. W., Easty, T., & Chagpar, A. Right medication, right dose, right patient, right time, and right route: how do we select the right patient-controlled analgesia (PCA) device? (2007). Pain Management Nursing, 8(4), 140-145.
16) Ibrahim, A. A. N. Caregivers of critical care departments for the effects of long hours on their vigilance and patient safety ¦Doctoral dissertation (2018), AL-Quds University).
17) Ulrich, R. S., Zimring, C., Zhu, X., DuBose, J., Seo, H. B., Choi, Y. S., & Joseph, A. A review of the research literature on evidence-based healthcare design (2008). HERD: Health Environments Research & Design Journal, 1(3), 61-125
18) Smith, T. J., Schoenbeck, K., & Clayton, S. Staff perceptions of work quality of a neonatal intensive care unit before and after transition from an open bay to a private room design (2009). Work, 33(2), 211–227.
19) Tremblay, N., Musa, E., Cooper, C., Van den Bergh, R., Owiti, P., Baller, A., & Gasasira, A. Infection prevention and control in health facilities in post-Ebola Liberia: don't forget the private sector (2017)!. Public health action, 7(1), S94-S99
20) Dykes, P. C., Carroll, D. L., Hurley, A., Lipsitz, S., Benoit, A., Chang, F., & Middleton, B. Fall prevention in acute care hospitals: a randomized trial (2010). Jama, 304(17), 1912-1918.
21) Joint Commission. Preventing falls and fall-related injuries in health care facilitie, (2015). Sentinel Event Alert, (55), 1
22) Leiss, J. K. Safety climate and use of personal protective equipment and safety medical devices among home care and hospice nurses (2014). Industrial health, 52(6), 492-497
23) Cho, J. Investigation on the contaminant distribution with improved ventilation system in hospital isolation rooms: Effect of supply and exhaust air diffuser configurations (2019). Applied Thermal Engineering, 148, 208-218

24) Walker, J., & Moore, G. Safe water in healthcare premises. Journal of Hospital Infection, (2016), 94(1), 1.
25) Moyimane, M. B., Matlala, S. F., & Kekana, M. P. Experiences of nurses on the critical shortage of medical equipment at a rural district hospital in South Africa: a qualitative study (2017).Pan African Medical Journal, 28(1), 157
26) Hamdi, N., Oweis, R., Zraiq, H. A., & Sammour, D. A. An intelligent healthcare management system: A new approach in work-order prioritization for medical equipment maintenance requests. Journal of medical systems, (2012). 36(2), 557-567
27) Powdrill, S., Cordero, I., & Srinivasan, V. Training for equipment maintenance and repair. Community eye health, (2010). 23(73), 30
28) Ayllón, N. G, Montero, P. R. Acebes, M. F., & Sánchez, J. Z. Open door intensive care unit: perspective of the professionals. Enfermeria intensiva, (2014). 25(2),72-77.
29) Medical facility fires. Topical Fire Report Series Web site. [Accessed November 14 2016]. https://www.usfa.fema.gov/downloads/pdf/statistics/v9i4.pdf .
30) Holla, R., Darshan, B., Unnikrishnan, B., Thapar, R., Mithra, P., Kumar, N. & Kumar, A. Fire Safety Measures: Awareness and Perception of Health Care Professionals in Coastal Karnataka. Indian Journal of Public Health Research & Development, (2016). 7(3).
31) Reilly, R. B., & Lee, T. C. II. 4. Biosensors. Basic Engineering for Medics and Biologists: An ESEM Primer, (2010). 152, 109.
32) Rasheed, S., Iqbal, S., Baig, L. A., & Mufti, K. Hospital Waste Management in the Teaching Hospitals of Karachi (2005). JPMA, 55, 192
33) Dixit, H. D., Tiwari, R. V., Thumati, M. R., & Bhattacharjee, A. P. Waste Disposal Management and Intensive Care Unit-A Review, International Journal of Humanities and Social Science Invention (2017), Volume 6, Issue 3, PP.44-48
34) Mathur, P. Role of Hospital Housekeeping and Materials Management Including Disinfection and Waste Management (2014). In Hospital Infection Prevention (pp. 81-89). Springer, New Delhi.
35) González-Méndez, M. I., & López-Rodríguez, L. Safety and quality in critical patient care (2017). Enfermería Clínica (English Edition), 27(2), 113-117.
36) Salters, K. P. Psychometric properties in a BPd test (2018). Available at https://www.verywellmind.com/psychometric-properties-425262
37. Alvior, M. G. statistic: what are the psychometric properties of a research instrument (2013). Available at " https://simplyeducate.me/2013/10/17/what-are-the-psychometric-properties-of-a research-instrument..
38) Alshammari, T. M. Drug safety: The concept, inception and its importance in patients' health (2016). Saudi Pharmaceutical Journal, 24(4), 405-412
39) AbdAlla, A. Nurses are a Key to Ensure Patient Safety: A systematic Review, International Journal of Research Studies in Medical and Health Sciences (2017). Volume 2, Issue 9, PP 10-15.
40) Polit, D. F., & Beck, C. T. Nursing research: Principles and methods. Lippincott Williams & Wilkins (2004).
41) Cronbach, L. J. Coefficient alpha and the internal structure of tests. Psychometrika, (1951).16(3), 297-334.
42) George, D., & Mallery, P. Reliability analysis. SPSS for Windows, step by step: a simple guide and reference (2003). Boston: Allyn & Bacon, 222, 232
43) Cooper, M. D., & Phillips, R. A. Exploratory analysis of the safety climate and safety behavior relationship (2004). Journal of safety research, 35(5), 497-512
44) Assefa, T., Woldie, M., Ololo, S., & Woldemichael, K. Patient safety practices and medical errors: Perception of health care providers at Jimma University Specialized Hospital, Southwest Ethiopia (2012). Open Journal of Preventive Medicine, 2(02), 162.
45) Bartholomew, D. J., & Tzamourani, P. The goodness of fit of latent trait models in attitude measurement (1999). Sociological Methods & Research, 27(4), 525-546.
46) Sivo, S. A., Fan, X., Witta, E. L., & Willse, J. T. The search for" optimal" cutoff properties: Fit index criteria in structural equation modeling (2006). The Journal of Experimental Education, 74(3), 267-288