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Caring within a Web of Paradoxes: The Critical Care Nurses' Experiences of Beneficial and Harmful Effects of Technology on Nursing Care

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Authors' contributions

This work was carried out in collaboration between all authors. Author BB designed the study, wrote the protocol, managed the literature search, conducted interviews, transcribed and analyzed them. Authors TM and AR managed data collection and analysis. Author SS wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Technology plays a major role in caring for critically ill patients. Its' use in patient care can improve patient safety, save patients' lives, facilitate nurses' work and save time for them and reduce hospital costs. However, along with these benefits, technology can lead to some risks for patient, if the nurse is unaware of the principles of proper technology use. The aim of the present study was to describe the experiences of intensive care nurses regarding beneficial and harmful effects of technology on nursing care.
Method: In a qualitative descriptive study, semi-structured, in-depth interviews were conducted with 9 intensive care nurses in south east of Iran during 2015. Interviews were transcribed and analyzed

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using qualitative content analysis.
Findings: Two themes emerged from analyzing data included: “support”, and “adversity”. These two themes had seven categories. The theme of “support” is composed of saving nurses’ time, improving decision making and saving patients’ lives, while “adversity” is consisted of 4 categories: patients’ hardship, nurses’ distress, dependency and emerging challenges.
Conclusion: Although technology was facilitative and supportive, but effective application of technology in patient care needs some infrastructures such as proper education of newcomer nurses for working in a technological environment, organizing continuous education programs about working with new advanced machines for those who are working in such environments, and organizational and managerial supports for nurses working in technological environments.

Keywords: Critical care; intensive care; nurses’ experiences; technology; qualitative design; content analysis.

1. INTRODUCTION

The nurses working in critical care units perform much of their daily care with assistance of advanced technological equipments [1]. Using technology in an appropriate manner, can assist nurses in better management of patient care and increase safety and efficacy of their actions [2]. Technology enables nurses to better know their patients [3], improves patients’ outcomes and nurses’ decision making abilities [4].

However, some researchers argued that technology is in contrast to nursing science [5]. They state that unlike nursing philosophy which insists on presence and closeness to the patient bedside, technological philosophy emphasizes separation and distance [6]. They believe that too much trust and reliance solely on technology results in reduction of patients’ human dignity to the level of an object or information piece [7]. Patients in such environments, often feel that they are not seen as human, but more as an object of care or an equipments extension. Moreover, it seems that technological tasks take precedence over their basic needs [5]. Based on the previous studies, when nurses use technology to care, their knowledge and competency is one of the most effective factors on the quality of care [2,3,8-12]. Therefore, one way to improve the quality of technology-based nursing care is education. On the other hand, educational programs must design based on situational analysis or needs assessment studies. Therefore, in recent years, some researchers have quantitatively assessed the perception of critical care nurses regarding positive and negative aspects of use of technology in nursing care [8-11].

In some studies, the majority of participants were aware of positive influences of technology on nursing care but were not familiar with most negative aspects of technology [8]. However, the researchers argued that it is essential for nurses to have a two-dimensional view regarding technology and nursing, and pay enough attention to the both positive and negative aspects of technological influences, because all of these dimensions are necessary for good nursing care [5].

As it is clear, cultural and governmental issues may affect nurses’ experiences and consequently their educational needs, when they provide technology-based cares. As we know, there is little information on experiences of Iranian critical care nurses when they use technology for patient care. This insufficiency of information can lead to less effective educational programs and then unqualified patient care.

The aim of this study was to describe the Iranian critical care nurses’ experiences of beneficial and harmful effects of using technology in patient care.

2. METHODS

Qualitative content analysis was the method used for conducting the study. Content analysis is a research method for making repeatable and reliable conclusions, based on the study context. The aim of this method is gaining succinct and comprehensive expressions regarding the phenomenon of interest [13]. It helps the researcher to gain deeper understanding of the intensive care nurses’ perceptions toward advantages and disadvantages of using technology in nursing care [14].

This study was approved by the ethics Committee of Kerman University of Medical Sciences (KMU EC 93/249), and hospitals

officials gave permission for doing the interviews. All the participants informed verbally about the study aim and signed informed consent. Confidentiality and anonymity of the participants maintained through mentioning them by number (the study participant no. 1 to 9).

2.1 Participants and Procedure

The present study was conducted in intensive care units of educational hospitals of Kerman University of Medical Sciences. The participants were from cardiac, neurologic, and general surgery as well as general intensive care units and had the experience of caring for critical care patients in the intensive care units for at least one year. In these units, nurses often do not receiving training or take courses on working with technology in the acute-care setting, and the training that is received, is often takes place informally, during the first days of their work in the unit and through observing the experienced nurses and mentors. The nurse to patient ratio ranges from 1 to 2 in the cardiac and neurosurgery ICUs and 1 nurse to 3 or 4 patients in general surgery and medical ICUs. All of these units have high admission and bed occupancy rates, so a high workload and staff shortage is perceptible in these areas. All of these units are equipped with central monitoring systems which provide nurses with data regarding function of vital organs of the body. Moreover, presence of various technological tools such as ventilators, balloon pumps, infusion pumps and etc. makes it possible for nurses and other professional team members to support patients' life and deliver a more accurate and timely care to critically ill patients. Purposive sampling method was the technique used for selecting the study participants. In this way, the participants were selected based on their experiences of working in an intensive care unit and willingness to participate to the study. Previous background of the principle researcher and his work experience in ICU was helpful in selecting the eligible participants and acquiring their trust to participate to the study. The aim of the study was fully explained for the participants and they were informed that they would be able to withdraw from the study at any time they wish. The participants permitted to being audio-recorded during the interview

2.2 Data Collection

Data was collected using individual, in-depth, semi structured interviews with the intensive care nurses. The interviews started with this question: "please tell us about your experience of working with technology in the intensive care unit" and was followed by these questions: "what are the positive and negative aspects of technology for the nurse and the patient?", "what are the challenges of working with technology for the nurse?" In addition, the follow-up questions were asked such as "Do you mean that…" "Please explain more" "would you give me an example", "How did you feel then? "The interviews lasted for 40-90 minutes and took place in a quiet room near the ward or in the other place based on the participants' preferences. All interviews were digitally recorded transcribed verbatim using Microsoft office word and analyzed using MAXQ data software.

2.3 Data Analysis

The interviews were analyzed using the conventional qualitative content analysis. Content analysis is a research method for analyzing text data [15]. Its' aim is gaining a deep knowledge and understanding of the phenomena of interest [16]. There are three types of content analysis. Conventional content analysis, directive and summative content analysis [15]. Conventional content analysis is usually used for studies which their aim is describing a phenomenon. This design is useful when existing theories or researches about the phenomenon are limited [17]. In this method of analysis, the researcher suspends all previous knowledge about phenomenon of interest and allows categories and their names emerge directly from the data [16]. It also named as inductive category development [18]. At first, each interview text was read thoroughly several times by one of the principal investigators which had the experience of working in a general intensive care unit for several years, as a registered nurse. From this detailed reading, word or phrases which were related to the purpose of the study; the critical care nurses' experiences of beneficial and harmful effects of technology on the nurse's care, were identified and organized as codes. Then, these codes, based on similarities and differences in their meaning and purpose, were sorted into subcategories and categories. Finally, layers of meaning were discovered through the categories and themes formed.

2.4 Rigor

Guba and Lincoln's criteria were used to establish the trustworthiness of the findings

included credibility, fittingness, dependability and confirmability [19].

2.4.1 Credibility

Previous experience of the researcher in nursing care in critical care unit (9 year experience) led to prolonged engagement of the researcher with the real life context of ICU and interaction of the researcher with the study participants. It was also helpful in selecting the participants which could provide rich descriptions of their experiences of working in an intensive care environment and the challenges of working in such an environment as well as in establishing a mutual and trustful relationship with the study participants.

Parts of the interview text along with assigned codes and emerged categories were sent to a number of the study participants, and to the research team (who were familiar with the qualitative analysis) to check the accuracy of assigned codes and categories. In this stage, any disagreements between the principle researcher and the research team were modified by referring back to the interview texts.

2.4.2 Dependability and confirmability

The study findings were sent to a number of critical care nurses who had not participated to the study, and they confirmed the accuracy of our findings.

2.4.3 Transferability

We implemented the maximum variation sampling technique and selected our study participants from the various types of adult ICUs. Finally, we precisely recorded the study process in detail to make it possible for others to follow up and audit the research project.

3. FINDINGS

Totally, 9 ICU nurses (one male and 8 female) participated in the study. They were between 31 and 49 years old (mean=38.5) and had 2 to 20 years of ICU work experience. The majority of them (7 nurses) were married, 5 participants were Master of Science and the rest of them were bachelor's degree.

The analysis revealed two main categories, with 7 themes (Fig. 1). These themes and categories are presented here with examples of the participants' statements.

3.1 Support

In the present study, the critical care nurses (CCNs) described technology as an agent which facilitates nursing care, accelerates completion of nursing duties, and contributes to proper use of nurses' time.

3.1.1 Saving nurse's time

Technology gives the nurse the opportunity to spend more time with the patient and consequently, nurses could provide qualified care with less staff.

> *"Technology helps nurses to better use of their time. Instead of taking the patients vital signs manually, the monitor does it and I spent my time doing more important things for the patient."*

Technology helps nurses diagnose life-threatening conditions much faster and act timely to resolve the condition and save patients' life.

> *"I feel that with technology I don't miss golden time. For example, in case of myocardial infarction or massive hemorrhage, if you want to do the tasks bit by bit, it takes too long, but if the patient is connected to the cardiac monitoring and has all of the connections, this can reduce the time at least 10 times."*

3.1.2 Improvement of decision making

In addition to objective information about the patients' condition provided by technological devices, these devices make nurses' clinical decision making much easier and faster and such decisions are more reliable and accurate.

> *"When I see the patients' blood pressure has dropped, I can control the patients' heart rate much faster by looking at his/her cardiac monitor, rather than I wanted to count the patients' heart rate for one minute, I can take a strip and tell the physician with document, that at the time of hypotension, the patient had arrhythmia too."*

Technological tools make the continuous observation of the patient possible. This observation helps the nurse to monitor patients' response to the therapies performing. In the cases of drug incompatibility or occurrence of conditions such as cardiac arrest or life

threatening changes in patients' vital parameters, the nurse will be notify immediately. This information produced a feeling of calmness in our study nurses because they could make better decisions.

> *"When a patient is monitoring in the ICU, cardiac monitoring is showing his heart rate, the ventilator properly ventilate patients' lungs, pulse oxymeter is showing patients' oxygen saturation, the nurse's stress is much less and her decisions will be more effective."*

3.1.3 Life saving

Our study nurses stated that with technological devices, they could deliver high quality care and such caring had better outcomes for the patient. The study participants believed that technology plays a very important role in qualified caring of ICU patients. They stated that technology has increased patients' survival, and in the absence of some of the equipment, the patients' lives were threatened.

> *"Technology has an important role in cardiac intensive care patients, because all of the patients are dependent to technology. From the beginning of the anesthesia, they are connected to the cardiopulmonary machine, their surgery is done while they are connected to the machine, and after the surgery they transfer to ICU and are connected to ventilator, cardiac monitoring, balloon pump and many other devices, and without these devices he/she will be expired."*

3.2 Adversity

This theme is consisted of four sub- themes which describe difficulties and problems that technology can directly or indirectly cause. These include the following:

3.2.1 Patients' hardship

The study participants stated that technology can cause discomfort for the patient. Presence of various complex equipments, with annoying sounds, in an unfamiliar environment can cause fear and anxiety in a patient recovering from cardiac surgery anesthesia in an ICU, or a patient with loss of consciousness following

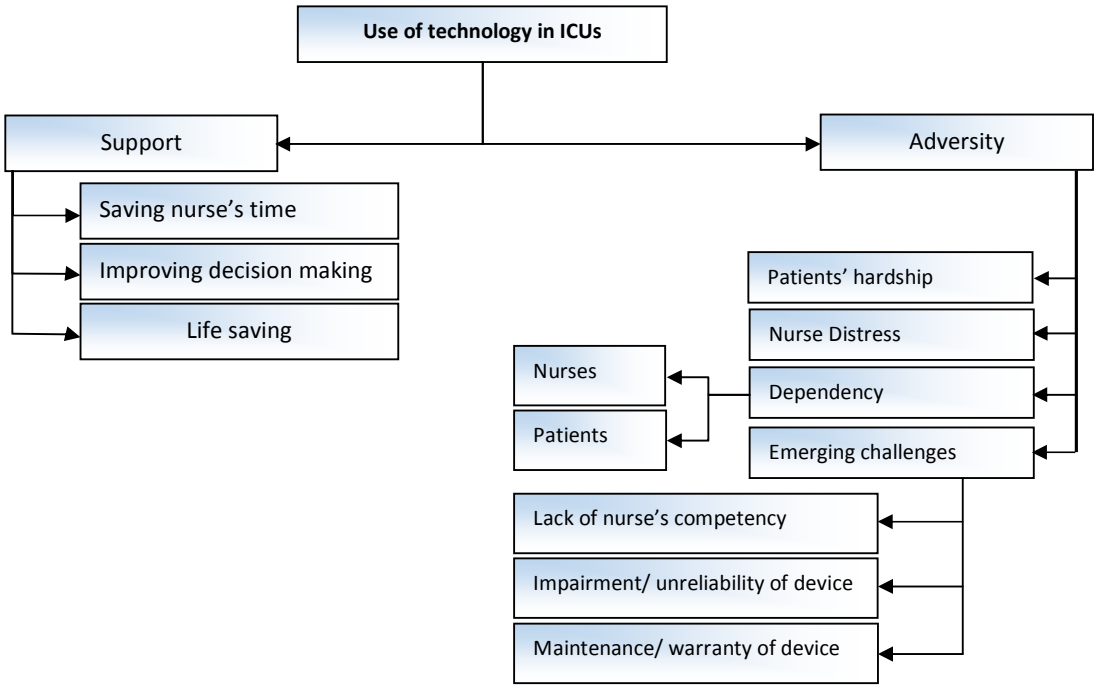

Fig. 1. Effects of use of technology in intensive care units in Iran

metabolic disorders or cerebro-vascular accidents, gradually regaining his/her consciousness in such an alien environment.

> *"The patient wakes up, sees various devices, there is a tube in his throat, all of these are frightening for the patient… "*

Normal functioning of a number of technological devices produces some level of sound. However, in cases malfunction, the device produces louder alarms to warn ICU staffs of its dysfunction. These sounds could disturb patients' sleep and makes them agitated.

> *"In general, one of the main disadvantages of technology is that it can disturb alert patients' sleep, make patient agitated, even, we have seen that unconscious patients had been affected by the device alarms and had gotten restless."*

They also stated that technological devices function in some cases is not consistent with the normal functioning of the patients' body and causes mismatch which is annoying for the patient. A number of technological procedures, such as endotracheal suctioning are painful for patient as well and impairs patients comfort.

> *"There may be mismatch between patient and the ventilator and the nurse is not looking, the patient wants to exhale but ventilator inhale him or vice versa, you see how difficult this can be for the patient, How can it be distressing? "*

Our study participants felt that technological advances, in some patients, have only prolonged patients' painful lives. They stated that, even with the assistance of technological devices, the patients' lives have a very low quality and is so painful.

> *"Unfortunately, technological advances which, on the one hand, have increased the patients' longevity, at least with my experiences, in many cases have caused the patient endure huge pain and suffering, falsely caused prolongation of patients' lives. That's mean, the majority of them will eventually die, they only live for longer duration and endure more pain and suffering"*

And even, some of the participants believed that technology has led to dehumanization of the patient and has degraded him to the level of an object.

> *"I think that even the physical care which we provide for patient, downgrades the patients' dignity. That' mean that, although the patient's heart is beating, and his pupils are reactive, but the patient is in a state in which, I don't like to be in such position, at all. I do not like that these various devices connected to me."*

Paying too much attention to adjusting, maintenance and proper function of technological equipments make nurse negligent of the other aspects of caring and especially humanistic aspects such as emotional and psychological caring and in fact, the patient is considered as the extension of the equipment. This means that the nurses rather than dealing with the patient, work with the equipment connected to the patient.

> *"I think we should pay attention to the humanistic aspects of the patient lying in the bed. I mean that, the aim of technology was the same but its' manner is not correct and exactly convert the patient to an object.*"

3.2.2 Nurse's distress

In this study, CCNs believed that working with technology can impose psychological burden on the nurse. Inability to communicate and understand the meaning of patients dependent to technology is one of the major reasons for psychological suffering of the nurse.

> *"The patient tried to communicate nonverbally through facial cues, but I could not understand what he meant, and working with these patients was so hard… and if I tried I could not understand what he meant, and that was honestly painful, you saw one lying there but no one could understand him."*

On the other hand, caring for patients who are medically hopeless, with poor health outcomes which there is not any reasonable hope for their cure, makes nurses feel depressed.

> *"You do a lot of work for the patient you know eventually dies, and you feel in long term it will affect you. That's mean, caring for the patient you know it will not work causes exhaustion. You are working but you know it is futile, you know it makes persecution."*

3.2.3 Dependency on technology

This category refers to the problems which occur because of dependency of nurses or patients on technology, in absence of or disconnection from technological devices.

3.2.4 Dependency of nurse on technology

Our CCNs described that after weaning from ventilator or disconnecting cardiac monitor or other equipment, nevertheless the patient needs more caring and attention, in the absence of technology, accurate monitoring of the patient has become more difficult. Sometimes, these difficulties may contribute to negligence and lead to the problems for the patient which could not be compensated.

> *'When a technological device is disconnected, patient is totally forsaken, he will transfer to the post ICU, and he will not be monitoring there, sometimes cardiac arrest occurs for the patient there and then he will be expired because no monitoring device is connected to him."*

Prolong application of a number of technological tools for calculating high-alert medication dose (such as dopamine, dobutamine, and etc.), and their infusion speed, could contribute to dependence of nurse to the device so that in case of failure or malfunction of that device, the nurse could not calculate the drug dose and its' infusion speed easily or correctly.

> *" A nurse who has been injecting drugs with infusion pump for years, now if the pump fails, the nurse will be in trouble because she has not referred to his mind to calculate the droplets of medicine for a long time, and now it is hard to calculate the number of drops."*

From the perspective of the study participants, the dependency of nurse on technological tools and equipments, in some cases can cause damage to the patient and delay in the normal process of weaning.

3.2.4.1 Dependency of patient on technology

Dependency of patient on technology that prevent weaning from technological equipment and delay the patient's recovery process and his/her discharge of the ICU, is another challenge expressed by the study participants. This dependency may be physical. In this case, the patient's weaning from the device is associated with serious problems for the patient's life.

> *"It is true that ventilator is a good breathing assistant but for the elderly patients, especially those admitted with pulmonary disease, there are some problems so that we can't wean them from the device, because when the device gives the patient breath, given that the patient's muscles are getting atrophy and losing their activities, eventually the patients will be strongly dependent on the ventilator, they may stay here for three months and we can't wean them from the device and it eventually results in worse subsequent complications... "*

The dependency could also be psychological so that the thought of equipment failure or inability to sustain patient's life, creates intense anxiety for the patient.

> *"A patient who uses ventilator for a while if we wean the patient from the device or the patient feels that the device may be corrupted, he/she feels extremely anxious because he/she's not able to breathe without the ventilator... It means dependency".*

3.2.5 The challenges of working with technology

From the perspective of nurses participating in this study, working with technology requires a series of prerequisites and infrastructures, and without them, proper application of these tools is difficult. This category includes the subcategories of the lack of knowledge, failure to support, dependency, poor management and the unreliability of technology.

3.2.5.1 Impairment or unreliability of technology

One of the major problems which the majority of the participants pointed out was sudden failure of technological tools, following temporary outages of electricity, or the impairment of device function. This could be associated with tension and anxiety for the nurse, threatening the patient's life and disruption in the patient care. The nurses believed that, at the time of failure of the technological tools, the nurse is able to replace only some works done by technology, but with less accuracy.

"Many times it has happened…, so we had to ignore other tasks and ventilate the patient manually, it is very stressful that we may lose the patient or the patient may be hypoxic or hypo ventilated…"

One of the major disadvantages of the technology in the interviews was the unreliability of the technology, making it difficult to work with the technological equipment, was the unreliability of technology. The study participants stated that technological devices are not complete without supervision of a nurse. Technological equipments' need for accurate control by a nurse, makes them unreliable alone, and the nurse's reliance on these tools, in some cases makes irreversible harm to the patient.

"It is true that technology has helped but the holistic care is still needed. The nurse has to pay attention to both the patient and the device to prevent the occurrence of problem."

Providing incorrect information which are inconsistent with real patients' clinical condition, by the devices which have malfunction, or are not able to precisely control the patient's vital parameters for some reasons such as the coldness of patient's extremities, weakness of pulse, drop in blood pressure, needs nurses' vigilance to diagnose the problem and re-check the parameter. On the other hand, recognizing that the information provided by the device is inconsistent with real clinical condition of the patient requires the skill and experience of nurse. The novice and less experienced nurses rely on data provided by the device that this issue can be problematic for patient.

"Many times the system is wrong, we have to again go back to our previous techniques, measure the patient's blood pressure manually again, Then we adjust it with the device to see whether the device is correct or not, sometimes the mistake is made and there is a so called mismatch, if a nurse doesn't care about it and only relies on the devices, most of the times some errors will occur ..."

3.2.5.2 Lack of knowledge and specialized skills

Nurse's misinformation and little knowledge about how to set up and maintain the technological equipments were the issues commonly described by the participants. The complexity of the devices connected to the patient and unfamiliarity with the device's language on one hand and insufficient education regarding new equipment by the manufacturer on the other hand, made it difficult for nurses to work with them. Insufficient training of newcomer nurses in the intensive care units, nurse shortage, high workload and time shortage to attend the training courses on working with technology, were other reasons for the nurse's lack of knowledge of working with the devices.

"Now, the most problem in the ICU is that nurse come to work at the ICU without any trainings ... these nurses don't know how to work with the device. This is stressful both for them and their colleagues, as well as it is threatening for the patient"

In addition, the data on patient's status and vital parameters provided by the technological equipment, requires nurse's enough knowledge of the basic values and his/her capability to interpret the data received by technological equipment. The participants suggested that if the nurse does not have sufficient skills to work with the technological equipment or incorrect information is entered, this supportive and life-saving technology can be converted to a serious threat to the patient's life.

"Another disadvantage of technology is possible damage to the patient. Since the nurse is entering the initial information to the device and doing the initial configuration of the device, so false information can cause harm to the patient."

Lack of organizational support for training all intensive care nurses on how to work with technology, and presence of few persons who are familiar with the device operation, but due to financial interests, they tend to monopolize their abilities to adjust and work with the technological equipment, was also another problem of working with technology, which was stated by a number of our study participants

"We had a person in the hospital who knew the operation of all the devices, but due to maintain his own position and in order to make any staffs won't learn how to do this work themselves, and the operating fee which is paid to him due to problem-solving of the devices won't eliminate, he didn't share these information with anyone and had collected all the brochures of the devices…

the organization itself was valuing this person and doesn't support the rest they should support all the staff by saying that this brochure of device should be in your ward or by holding training course."

3.2.5.3 Support deficiency

Insufficient support of manufacturer companies in time of trouble and equipment malfunctions, as well as the lack of an expert in the center that if a malfunction occurs, he/she can solve the problem quickly and return the device to normal operation were other problems mentioned by the participants.

"Devices support is also another problem. Vendor companies are just selling, but about training, it is true that they hold a series of training at the beginning but that is all. How should the device be disinfected, how should we connect the patient to the device, how device should be disconnected, all these are we should learn by ourselves… "

"We face the lack of personnel with expertise in medical equipment, those who come to teach or repair the device, and these cause people aren't easily able to use the devices."

Given that coordination to repair, maintain and disinfect the equipment, is not performed sufficiently or in the proper time, it leads to premature device failure or the transmission of infection through the device and an increased prevalence of drug-resistant nosocomial infections in the intensive care unit.

"When the device's going to be transported from one patient to another, all detachable fixtures and equipments which are going to be used for new patient must be washed and sterilized. There is a series of management issues, I'm a nurse, I can't go to sterilize these parts myself. The authorities of the unit must be responsible for this and supervise this work… all the ICU infections and nosocomial infections are resistant to treatment, patients will be infected very quickly and they are resistant to treatment. I think that it's mostly because of defects in management."

4. DISCUSSION

This study aimed to describe the critical care nurses' experiences of beneficial and harmful effects of using technology in nursing care. Analysis of the study was resulted in the emergence of two categories with seven themes. Each of these themes described the critical care nurses' experiences of facilitating and inhibiting effects of technology on delivering appropriate nursing care.

The critical care nurses of our study expressed that technology could support nurses in their daily care, help them to complete their duties faster and facilitate nursing care. Therefore, it could compensate the nurse shortage. Their experiences were similar to the critical care nurses' experiences in Tunlind el al. [1] described technology as a facilitator of bedside nursing. Many other researchers [8,9,11,20] also, have stated that using technology could lead to easier and faster completion of nursing duties. However, the nurses in the study of Alasad [21] stated that even after acquisition of skill and expertise in using technological equipment, application of these tools is time consuming for the nurse. In the study of Kongsuwan and Loscin [22] the critical care nurses stated that they are responsible for proper care of technological equipment used in the patient care, so the involvement of technology in care was time consuming for them.

Previous research has illustrated that technology can enhance the quality and effectiveness of nursing care [8,20], which is compatible with our study nurses mentions regarding achieving higher quality and better outcomes by delivering accurate care using technological equipment. In the present study, the critical care nurses believed that technological tools provide objective data on patients' condition which create a sense of confidence and help them to make accurate clinical decisions. In contrast, in a qualitative study, participants were disagree with the statement and believed that technology is not easy to handle [10].

Based on our results, technology helps nurses to retain the golden time for saving patient's life. In the study of Tunlind et al. [1] the critical care nurses stated that technology makes nurse and patient feel safe and secure. The critical care nurses in the studies of Kiekkas et al. [23] Laila et al. [8] and Adel et al. [20] understood technology as a factor increasing patient safety through timely and proper detection of complications.

According to the critical care nurses of our study, technology is the savior of patients. In the

absence of most advanced medical technological equipment, survival is impossible for most patients. Historically, there has been an association between ventilator and saving patient's life. This means that ventilator has been a symbol of life support and a critical part of the intensive care image which has been constructed by the society [24].

Despite all the above advantages, the CCNs of the present study believed that using technology in caring patients is associated with some difficulties for nurses and suffering for patients.

Normal functioning of most technological equipment is associated with production of some degrees of noise. Moreover, these tools are set so that in the case of device malfunction or problem for the patient, produce warning alarms. These noises and alarms, according to our study participants, can disturb the patients' sleep and create fear and anxiety for the patient. In addition, the unfamiliar and bizarre technological environment itself could create stress in patients. Graham and Cvach [25] in their study showed that many of these alarms were unnecessary or false, because the monitoring equipment did not adjust according to each patients' condition.

Johansson et al. [26] stated that due to their severe critical condition, the ICU patients need to advanced treatments and high levels of staff activity during day and night. These two can produce high levels of sounds which could be uncomfortable for patients and create feelings of fear, insecurity and helplessness in these patients. Other researchers (Akansel & Kaymakci, 2008; Xie, Kang, & Mills, 2009) have demonstrated that the majority of intensive care unit noises are produced by the ICU personnel themselves. Christensen [27] has reported that the knowledge of acoustic sound is limited among the ICU staffs. Johansson et al. [26] have suggested that proper education of the ICU personnel in regard to reducing sound level in the unit and designing devices so that they produce less noise, could help to reduce the problem.

Our study participants believed that technology, despite preserving and saving patients' life, in cases of medically hopeless patients, could simply prolong the patient's life, but not a useful and high-quality life. In the present study, caring for these patients could cause ethical dilemma. These findings are consistent with the study of Kongsuwan and Locsin [22], which the participants believed that using technology to preserving life in medically hopeless patient is suffering. They also understood that this was not their responsibility to direct patient's family to withdraw technology from their dying patient. In the study of Wikstrom et al. [28] anesthetists experienced ethical dilemma when making decisions about ending patients' life and the study nurses expressed frustration because they were not sufficiently informed and involved in such decisions. Kanjakaya [11] stated that making decision regarding whether to continue or withdraw technological treatment for end oflife patients creates dilemma for medical team.

Even, in the cases of the patients with end stage disease, our study participants believed that prolonging patients' life with technological equipment could contribute to degrade patients' dignity and create a disgusting image of the patient, even in view of the nurse and medical team. Sandelowski [29] believed that technology is context-dependent, not only in terms of its definition and classification, but also in terms of its application and use. Caring for the semi-conscious or awake patients, which due to their better condition did not need to a number of technological equipment such as ventilator, was a major challenge for our study participants, although the patients' condition seems to be improved. The critical care nurses in the study of Laerkner et al. [30] have stated that caring for non-sedated patients increases nurses' uncertainty because of their unpredictable and uncontrollable conditions in comparison to sedated mechanically ventilated patients. Moreover, these patients need close supervision and they are at greater safety risks than alert or unconscious patients.

Due to dependency of patients' lives to a number of technological tools such as ventilator, and the sense of control which comes from knowing what is happening to the patient, sudden failure in technological equipment caused stress and anxiety for our study nurses and they believed that this failure could be even life threatening for the patient. In the study of Alasad [21] the participants stated that technology helped them to know what is happening to the patient and this makes them feel safe. Sandelowski [31] found that technology has seen as a more accurate method to see, hear, feel and care by nurses.

The nurses of the present study believed that patients were also dependent to technology psychologically so that failure in technological

equipment made them anxious. Stayt and Tutton [32] argued that patients agreed with the view of nurses that technology is an integral part of the caring process and view it as the major life-saving factor in an intensive care environment.

Our study participants believed that insufficient knowledge of ICU staff about setting up, maintaining and monitoring technological devices, is one of the difficulties of working in technological environments. They believed that there is also a lack of knowledge about interpreting the information received by technology. The critical care nurses of the study of Tunlind et al. [1] had explained that the reason for technological equipment does not work properly is that knowledge of nurse about the specific equipment is inadequate. Some researchers have noted the importance of proper education regarding safer application of technology in caring [1,33,34]. Ray [35] indicated that "caring is technology" meaning that nurses should be able to interpret the meaning of the information receiving from technology and plan their actions according to that interpretation. Many other researchers has emphasized the importance of nurses' knowledge and competency of how to operate technology and how to interpret the received data to make appropriate clinical judgment [11,22,36].

Managerial and organizational problems, such as assigning untrained staff to work with technology, failure to provide adequate support for maintenance and periodic control of technological equipment and continuous education of the staff, inadequate financial support and lack of emotional support for intensive care nurses which contribute to feelings of despair and frustration in the staffs, were other challenges described by our study participants. Bridges et al. [37] argued that organizational support have an important role in enabling practitioners to engage with the patients and if the support is weak, it can contribute to emotional discouragement and apathy of the nurse. The critical care nurses in the study of Cox et al. [34] have highlighted the importance of gaining clinical and emotional support while their narratives were indicative of lack of receiving emotional support, which is similar to the descriptions of our study participants.

Insufficient support from manufacturer companies and failure to repair broken equipment were some of the main difficulties of working with technology in the present study. In the reviewed studies, none of the study participants had not mentioned to such issues. In our region, almost all of the intensive care equipment is purchased from a representative company which imports the equipment from the manufacturer country and has located in the capital. In cases of failure or defect in one of the devices, or periodic control of equipment, the company sends its' representative. Financial issues and failure to timely payment by the hospitals lead to delay in dispatching the representatives by the company and resolving equipment problems. These are the reasons for poor support from manufacturer companies.

The critical care nurses of the present study have mentioned that one of their difficulties of working in technological environments is their dependence to a number of technological devices in such a way that in the absence of the device they were not able to do some actions. Moreover, they asserted that technology is not always trustworthy. They believed that technology is not perfect on its own and needs to supervision and control by nurses. Sandelowski [29] defines technological dependency "as the short or long-term reliance on devices and techniques, to evaluate or satisfy or resolve health-related needs or problems". Campbell et al. [38] have argued that some degree of dependence on any technological tool is reasonable and inevitable because of tangible benefits which these tools have for the user, but it is different from overdependence on technology in which users begin to rely solely on the technological innovations without thinking that these tools may make mistake and provide incorrect information, similar to what was mentioned by our study participants. This finding was compatible with the other studies [1,5,28]. Some researchers have asserted that putting too much reliance on technology has detrimental effect on the patient care [34,39]. Brown & Cook [39] in their study revealed that the experienced nurses had a higher reliance on monitoring devices so that they lost their vigilance on the patient care. While Tunlind et al. [1] found that most the experienced nurses did not solely rely on technology and had more reliance on their own experiences and senses. Cox et al. [34] assert that sensory skills such as look, listen and feel, as well as nurses' intuition, play significant role in caring in a technological environment. Ray [35] believed that the experience of care in a critical care environment is a process of growth and maturation. These expressions support our study findings.

5. CONCLUSION

Although technology saves patients' lives and increases their longevity, working with technology needs infrastructures such as proper training and preparation of newcomer nurses for working in a technological environment, as well as continuing education of trained nurses for work with new advanced technologies, and organizational and managerial supports. The critical care nurses of our study believed that technology is useful but cannot replace nurse's observation and experience. Caring in a technological environment with absolute reliance on technology and without supervision of nurse can cause detrimental effects on patient's life.

These findings have implication for nursing education, practice, management and research. Given that technology has an established position in contemporary nursing, it is recommended that familiarity with culture of technological care, and the patient's specific needs while receiving technological care to be included in nursing education programs. In practice, continuing education of nurses for working with new technological tools, and education of newcomer nurses for work in a technological environment can contribute to improve the quality of care and patients' outcomes. It is recommended that nursing and organizational managers pay more attention to emotional needs of nurses working in such environments, by allocating more financial benefits and vacations to them to reduce their stress and tension of working with critically ill patients. Further researches should undertake to determine the factors improving quality of care in high technological environments from the perspectives of nurses and patients.

6. STUDY LIMITATIONS

Due to small sample size of the study, findings of present study are not applicable to technology in large health setting, although, generalizability is not concern in qualitative studies. Finding of this study provides insight which helps us improve benefits of using technology and reduce its' harmful effects on nursing care.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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