

## Nurses' Performance Regarding ICU Devices Alarms

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### Abstract

**Background:** Most patients in the critical care units cannot speak for themselves hence cannot pinpoint when their condition. It is therefore important to assess the nurses' performance when managing clinical alarms. **Aim of the study:** The study was aiming to assess the nurses' performance regarding devices alarms in intensive care units. **Study Design:** A descriptive exploratory design was followed to achieve the aim of this study. **Setting:** The study was conducted at the open heart intensive care unit at Academy of Heart affiliated to Ain shams University Hospitals. **Sample:** A Convenience sample of nurses (30) in ICU unit at Ain Shams University Hospital. **Tools of data collection:** A structured self-Administered knowledge assessment Questionnaire nurses, Observational check list and Nurses' attitude rating scale. **Results:** The results of this study showed that more than three quarters of studied nurses had unsatisfactory knowledge and majority of them had unsatisfactory practice and more than half of the study group of nurses had positive attitude regarding management of devices alarms. Furthermore, there was a highly statistical significant correlation between total studied nurses' knowledge and total practice and there was a highly statistical significant correlation between total studied nurses' practice and attitude. **Conclusion:** The current study concluded that, more than two third of the studied nurses had unsatisfactory level of knowledge and practice. **Recommendations:** The study recommended the importance of implementing an in service training program to improve nurses' performance regarding dealing with ICU devices alarms.

**Key words:** ICU devices alarms, Nurses' performance

### Introduction:

Alarms on clinical devices are intended to call the attention of caregivers to patient or device conditions that deviate from a predetermined "normal" status. They are generally considered to be a key tool in improving the safety of patients. The purpose of alarm systems is related to "communicating information that requires a response or awareness by the operator." (Siebig et al., 2010).

A very interesting review of goals and indications for monitoring by Hudson: "Monitoring is making repeated or continuous observations or measurements of the patient, physiological function and the function of life

support equipment, for the purpose of guiding management decisions, including when to make interventions and assessment of those interventions" (Ruppel, Funk, & Whittemore, 2018).

The alarm design should adequately represent the underlying situation. The various goals of device alarms are: to detect the life threatening situations, detect imminent danger, diagnose (diagnostic alarms, they indicate a pathophysiological condition e.g. shock), detection of life threatening device malfunction e.g. disconnection from the patient, occlusion of the connection to the patient, disconnection from power, gas etc and detection of imminent device malfunctions (Schmid, Goepfert & Reuter 2013).

The value of technology is allied with human competence, since clinical alarms are considered an essential and life-saving key tool. The Joint Commission on Accreditation of Healthcare Organizations defines clinical alarm as “any alarm that is intended to protect the individual receiving care or alert the staff that the individual is at increased risk and needs immediate assistance” (Cospers et al., 2017).

The purpose of equipment alarms is to alert professionals for potential problems and serious or dangerous situations. However, they might also compromise the quality of work of nurses and patient safety due to the abundance of false positives. False positive alarms are understood as those that do not assume clinical relevance at the time or are caused by technical problems or artifacts. These may be generated not only by the equipment’s hypersensitivity, but also by the inadequacy of the parameters’ limits to the clinical condition of each patient (Cospers et al., 2017)

Effective alarm management in an intensive care unit (ICU) can be influenced by various factors; the culture of the department, nursing practice and technology. The aim of effective alarm management in ICU is to create an environment conducive to patient safety. ICU environments deliver advanced care for patients that are critically ill and thus they require close constant monitoring of their condition. In an ICU environment nurses are also dependent on clinical alarms of the various monitoring devices/ equipment being used (Ramlal, 2015)

The purpose of clinical alarms is to ensure that nurses are given an alert or warning that the patient is requiring urgent attention and/or alerting them that there is a change in patients’ condition that could be related to a potential problem. Nurses do rely on these clinical alarms to notify them of changes in the patient’s condition (Ramlal, 2015)

Alarm hazards are a critical issue in patient safety. Of all health care providers, nurses are the ones most directly affected by the multitude of clinical alarms (American Association for Critical-Care Nurses, 2015)

The ECRI Institute, a nonprofit health services research organization, named alarm hazards as No. 1 of the top 10 health technology hazards for the years 2012 through 2014. The American Association of Critical-Care Nurses has made alarm safety a priority; the organization has produced an online toolbox of evidence-based resources, including a practice alert on alarm management and webinars. The Joint Commission recently established a National Patient Safety Goal on alarm management (Cospers et al., 2017)

The role of the nurse in cardiac care unit (CCU) is to observe the information that is provided by the different device systems and to decide whether the readings they get from the devices exceed or are lower than certain limits so that they can intervene. They also perform certain routine tasks to determine the biophysical parameters of the patients every few hours. Nurses therefore respond to alarms and initiate actions. They may therefore end up relying on the alarms entirely if the alarms are dependable or they may ignore the cues from the alarms if most of the alarms that are set off are false alarms (Meng’anyi, Omondi, & Muiva 2017)

Although alarms are an important indispensable and lifesaving feature, they can be a nuisance and can compromise quality and safety of care by frequent false positive alarms. Nurses should therefore be familiar of the alarm modes and should check and reset the alarm settings at regular intervals or after a change in clinical status of the patient (Meng’anyi et al., 2017)

Nurses are concerned about the impact of alarm fatigue on nurses and patients, recognize the importance of nurses’ role in reducing noise pollution, and offer valuable insight into strategies that can mitigate alarm hazards (Funk, Clark, Bauld, Ott, & Coss, 2014)

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The value of technology is allied with human competence, since clinical alarms are considered an essential and life-saving key tool. The Joint Commission on Accreditation of Healthcare Organizations defines clinical alarm as "any alarm that is intended to protect the individual receiving care or alert the staff that the individual is at increased risk and needs immediate assistance" (Cosper et al., 2017).

### **Significance of the study:**

Intensive care units (ICUs) are complex work environments where false alarms occur more frequently than on non-critical care units. The Joint Commission National Patient Safety Goal.06.01.01 targeted improving the safety of clinical alarm systems and required health care facilities to establish alarm systems safety as a hospital priority by July 2014. An important initial step toward this requirement is identifying ICU nurses' perceptions and common clinical practices toward clinical alarms, where little information is available (The Joint Commission, 2017)

Changes in patients' condition can present suddenly and requires immediate emergency medical intervention or it can be a gradual process which will not be immediately identified but can be determined through the analysis of more than one patient vital

parameter or trends. The great dependence on physiological monitoring devices to assist in closely monitoring patients and also alerting the nursing staff to an actual or potential problem is standard practice. The response to these alarming limits is important in managing patient safety and care (Graham & Cvach, 2010)

Of all health care providers, nurses are the ones most directly affected by the multitude of clinical alarms. Nurses are constantly exposed to the cacophony of alarms and must attend to, interpret, and act on alarm signals, all while completing their usual patient care duties. Yet, research on nurses' perception of alarms is limited.

As there no research on the same title in Egypt. So, the current study will measure and assess the nursing performance regarding devices alarm in intensive care units.

### **Aim of the Study:**

The present study was conducted to fulfill the following aim:

Assess the nurses' performance regarding devices alarms in intensive care units through the following:

- 1- Assess nurses' knowledge level regarding devices alarms in intensive care units.
- 2- Assess nurses' practice level regarding devices alarms in intensive care units.
- 3- Assess Nurses' attitude pattern regarding devices alarms in intensive care units.

### **Research Question:**

This study was conducted for answering the following questions:

- 1- What are the nurses' knowledge level regarding devices alarms in intensive care units?
- 2- What is the nurses' practice level regarding devices alarms in intensive care units?
- 3-What are the nurses' attitude pattern regarding devices alarms in intensive care units?

### **Subjects and Methods**

**This study were portrayed under the four main designs as the following:**

- 1-Technical design
- 2-Operational design
- 3-Administrative design
- 4-Statistical design

**1-Technical design:**

The technical design includes research design, setting, subjects and tools of data collection used in this study.

**Research design:**

A descriptive exploratory design was conducted to achieve the aim of this study.

**Operation definitions:**

Performance: means knowledge and practice

**Setting:**

This study was conducted at open heart intensive care unit in 8<sup>th</sup> floor at Academy of Heart affiliated to Ain shams University Hospitals which included twelve ICU beds.

**Subject:**

A Convenience sample was composed of all the available nurses working in the above mentioned setting, 9 of them was male and 21 were female.

**Tools of data collection:**

**I-Self-administered questionnaire (AppendixI):**

The self-administered questionnaire was used to assess nurses' level of knowledge regarding devices alarms in intensive care units. It was developed by the researcher after reviewing the related literature: (AACN, 2015; Edworthy, 2013; Institute ECRI, Top 10 health technology hazards for 2013; Sendelbach et al., 2013; Funk et al., 2014; The Joint Commission, 2017; Association for the Advancement of Medical Instrumentation, 2015; Cho et al., 2016; Koch et al., 2012).It was translated by the researcher in simple Arabic language. It was filled by the study subjects. It consisted of two parts:

**Part I: Demographic characteristics of the studied nurses:** it included age, qualifications, clinical experience of the studied nurses, and training.

**Part II: It** used to assess nurses' level of knowledge regarding devices alarms in intensive care units. The questionnaire consisted of 59 questions in the form of multiple choice questions (MCQ) and true/false questions.

**This tool was divided into four parts as the following:**

- **The 1<sup>st</sup> part:** To assess nurses' knowledge about devices alarms (24 True/ false and MCQ questions).

- **The 2<sup>nd</sup> part:** to assess nurses' knowledge of monitor alarms in critical care setting: this part consists of three parts:

A- It included questions about setting and parameters (8 MCQ questions)

B- It included questions about setting of applied ECG in hemodynamic monitor (3 True / false questions).

C- It included questions about measurement of Spo2 in hemodynamic monitor (5 True / false questions).

- **The 3<sup>rd</sup> part:** to assess nurses' knowledge regarding ventilator device alarms: it includes nurses' knowledge regarding setting of ventilator and alarms types (10 true/ false and MCQ questions).

- **The 4<sup>th</sup> part:** It concerned with the assessment of nurses' knowledge regarding syringe pump and infusion devices in critical care setting (9true/false and MCQ questions).

**Scoring system:**

- Alarm management is very critical in the management of critically ill patients, the scores would all be from around 90% to 100 %.(Meng'anyi, et al., 2017).And alarm management means to provide a safe patient environment (Dominguez, 2015)

- **The total score of knowledge** was 59 marks. Each correct answer was given one mark and the incorrect answer was given zero.

- $\geq 85\%$  = Satisfactory level of knowledge.
- $<85\%$  = unsatisfactory level of knowledge.

### II-nurses' practice assessment observation checklist (Appendix II)

It was developed by the researcher after reviewing the related literature to assess nurses' level of practice regarding management of patients connected with devices in critical care units. This tool used in English language from: (AACN, 2015; Association for the Advancement of Medical Instrumentation, 2015; ECRI Institute, 2015; Koch et al., 2012). It was 90 questions done /not done.

#### Scoring system:

- **The total score of practice** was 90 marks. Each correct answer was given one mark and done incorrectly / not done was given zero.

- $\geq 85\%$  = Satisfactory level of the practice.

- $<85\%$  =unsatisfactory level of the practice.

### III-Nurses' attitude rating scale Assessment (Appendix III)

- It was developed by the researcher based on comprehensive reviewing of recent literatures (Funk et al., 2014; Sowan et al., 2015; Bitan et al., 2004; Baillargeon, 2013; Cvach).

The questionnaire consisted of 15 statements (8 positive statements and 7 negative statements) to assess nurses' attitude regarding ICU devices alarms. Nurses were asked to respond to statements on a-3 point Likert scale (always, sometimes and rarely)

#### The scoring system:

Classified as follows; the highest possible score of nurses' attitude was 45. The attitude scale included both positive and negative statements. Positive attitude statement

were scored 3= always, 2= sometimes, 1= rarely conversely negative attitude statements were scored 1= rarely, 2= sometimes, 3= always.it was considered that a score less than 85% (39 <grades) was negative attitude and a score equal or more than 85% (>39grades) was considered positive attitude.

### 2- Operational design:

The operational design included preparatory phase, ethical considerations, validity and reliability, pilot study, field work and limitation of the study.

#### Preparatory phase:

It included reviewing of relevant literature, and theoretical knowledge of various aspects of the study using books, articles, internet, periodicals and journals to develop data collection tools.

#### Validity and reliability:

**Testing validity** of the proposed tools by using face and content validity. Face validity aimed at inspecting the items to determine whether the tools measure what supposed to measure. Content validity was conducted to determine whether the content of the tools cover the aim of the study. This stage developed by a jury of 7 experts, three of them professors, one assistant professors, two of them lecturers of medical surgical nursing at faculty of nursing, Ain Shams University, one consultant of ICU and biomedical engineer. The experts reviewed the tools for clarity, relevance, comprehensiveness, simplicity and applicability; minor modification was done.

**Testing reliability** of proposed tools was done statistically by alpha Cronbach test for the following:

- Questionnaire sheet = 0.881
- Observational checklist = 0.7626
- Attitude scale = 0.7312

**Pilot study:**

A pilot study was conducted to test feasibility and applicability of the study tools used in this study. It was carried out on 10% of total study subjects (6 nurses). There was no modifications on tools were done based after pilot study, so that, the nurses who included in the pilot study were included in the main study group.

**Field Work:**

To carry out the study, an approval was obtained from the hospital directors and nursing directors of ICU units at Ain Shams University Hospital. A letter was directed to them from the faculty of nursing Ain Shams University explaining the aim of the study in order to obtain permission and cooperation to conduct the study.

Data were collected in three months, from beginning of October 2017 to the end of December 2017. The researcher visited the study setting 5 days/week at morning, afternoon and night shifts in the study setting. The researcher filled the observational checklist in the morning, afternoon and night shifts during actual nurses' work and documented steps of care for patients connected with ICU devices alarms. The observational checklist was used prior to administration of the questionnaire to ensure the maximal realistic observations of the nurses' performance and minimize the possibility of bias. The nurses' practice was assessed by the researcher while they are caring for patients connected with ICU devices alarms. It took about 20-30 minutes for each tool. The self-administered questionnaire was filled by the nurses providing the care for patient connected with clinical ICU devices; it took 30-45 minutes. The answer recorded by the nurses themselves.

**3- Administrative design:**

An official letter was issued from the faculty of nursing ain Shams university to the director of academy of heart hospital and the director of ICU open heart Unit at which the study was conducted, explaining the purpose of

the study and requesting the permission for data collection from the study group.

**Ethical Considerations**

The ethical research considerations in this study included the following:

1- The research approval of protocol was obtained from Scientific Research Ethical Committee in Faculty of Nursing at Ain Shams University before starting the study.

2- The researcher clarified the objective and aim of the study to the nurses included in the study.

3- The researcher assured maintaining anonymity and confidentiality of the subject data.

4- Nurses were informed that they allowed choosing to participate or not in the study and they had the right to withdraw from the study at any time without giving any reasons.

5- Ethics, values, culture, and beliefs were respected.

**4- Statistical design:**

The collected data were organized, analyzed using appropriate statistical significant tests. The data were collected and coded. Then, the data were analyzed with the program (the statistical package for social science) (SPSS) under windows version 11.0.1. Number and percentage for qualitative variable were done. For relation between variables, fisher's exact test and paired t-test were used. Also, alpha Cronbach test was used to test reliability of tools. Test of significance was used and regarding significance of the result, the observed differences and associations were considered as follows:

- Non-significant (NS)  $p > 0.05$
- Significant (S)  $p < 0.05$
- Highly significant (HS)  $p < 0.001$

## Results

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**Table 1:** Shows the distribution of the study group of nurses according to their characteristics. Regarding gender, the results revealed that 70% of studied group were females. As regards to age, 66.7% of them were more than 30 to 40 years old. In relation to educational level, 53.3% of them were nursing diploma. While regarding the years of experience 66.6% of them had experience equal or more than 15 years. Regarding training courses and performance enhancement 76.7% of them out of 7 didn't attend any training courses and six of them represented 85.7% had benefit related management of devices alarms in critical care unit.

**Table 2:** Shows that, 80% of them had unsatisfactory total knowledge regarding devices alarms. Also, 83.7% of them had unsatisfactory total knowledge regarding alarms of hemodynamic monitor. In addition to, 80.0% of them had unsatisfactory knowledge regarding alarms of mechanical ventilator. Moreover, 63.3% of them had unsatisfactory total knowledge regarding alarms of syringe / infusion pump.

**Table 3:** Reveals that, 80% of the studied nurses had unsatisfactory total practice regarding devices alarms management. Moreover, 76.7% of the studied nurses had unsatisfactory practice regarding total False Alarm Prevention.

**Table 4:** Illustrated that there were highly statistically correlation between practice and knowledge at  $r = 0.784$  at  $p > 0.001$ . As well as there was highly statistically correlation between practice and attitude at  $r = 0.678$  at  $p > 0.001$ .

**Figure 1:** Showed that 77% of the study nurses had unsatisfactory knowledge regarding ICU devices alarms.

**Figure 2:** Showed that that 80% of the study nurses had unsatisfactory practice regarding management of ICU devices alarms.

**Figure 3:** illustrated that 54.0% of the study group of nurses had positive attitude regarding ICU devices alarms. While 46% of them had negative attitude regarding ICU devices alarms.

**Table 1:** Number and percentage distribution of demographic characteristics of the study group of nurses (n =30)

Items	N	%
<b>Gender</b>		
Male	9	30
Female	21	70
<b>Age</b>		
18-30	6	20.0
>30-40	20	66.7
>40	4	13.3
<b>Mean+ _ SD</b>	32.6+	6.76
<b>Level of Education</b>		
Nursing Secondary school diploma	16	53.3
Technical nursing institute	10	33.3
Bachelor degree in nursing	3	10
Post graduated studies	1	3.3
<b>Experience years</b>		
<5	5	16.7
5-<15	5	16.7
≥15	20	66.6
<b>Mean+ _ SD</b>	16.7+	8.04
<b>Training course</b>		
Yes	7	23.3
No	23	76.7
<b>Benefit from training</b>		
Yes	6	85.7
No	1	14.3

**Table 2:** Number and percentage distribution of nurses' level of knowledge related ICU devices alarms (n=30)

Knowledge related of devices alarms	Satisfactory		Unsatisfactory	
	%	N	%	N
Total	6	20	24	80
knowledge related alarms of hemodynamic monitor	Satisfactory		Unsatisfactory	
Total	%	N	%	N
knowledge related alarms of mechanical ventilator	5	16.7	25	83.7
Total	Satisfactory		Unsatisfactory	
knowledge related alarms of syringe / infusion pump	%	N	%	N
Total	6	20	24	80
Total	Satisfactory		Unsatisfactory	
	%	N	%	N
	11	36.7	19	63.3

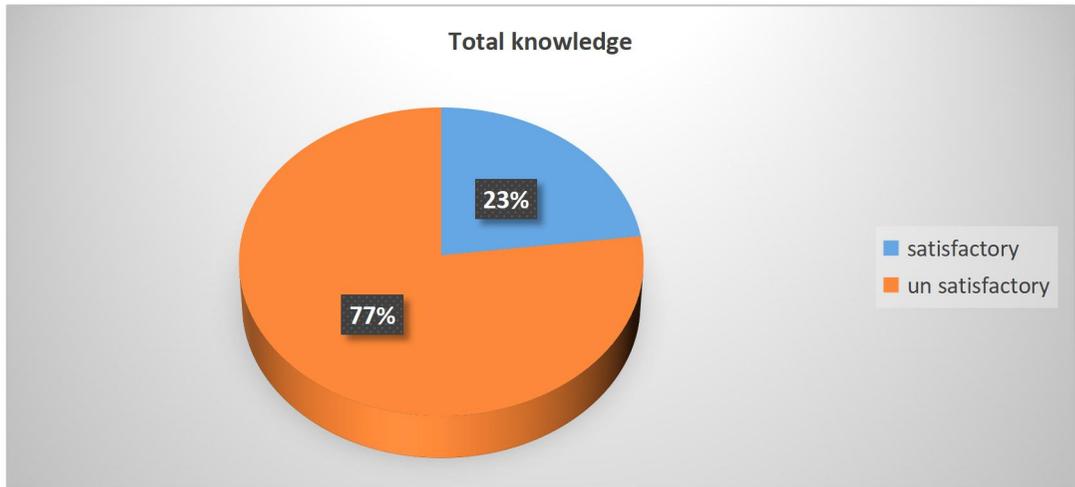


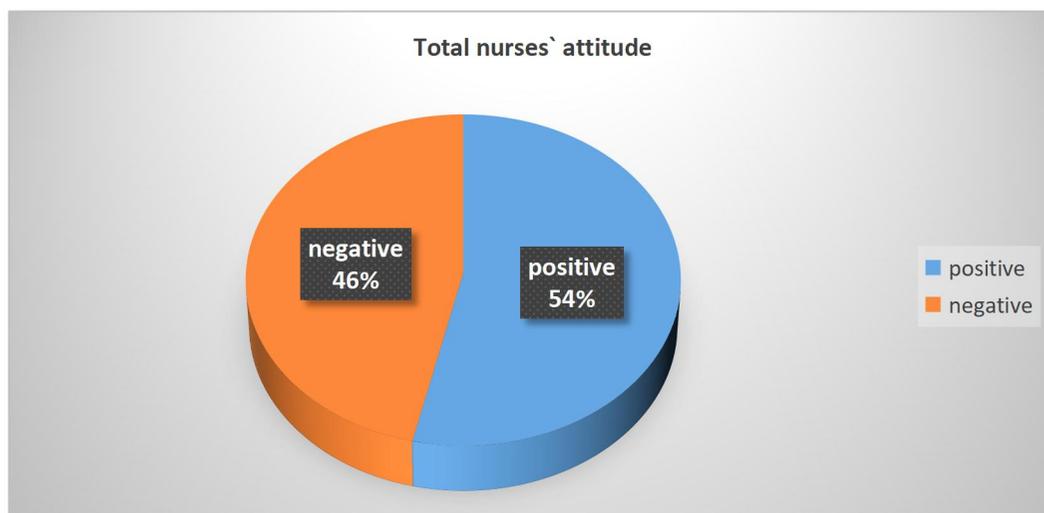
Figure 4: Percentage distribution of total studied nurses' knowledge regarding devices alarms (n=30)

Table 3: Number and percentage distribution of studied nurses' practice regarding assessment of nurses `practice in devices alarms management (n=30)

Observational checklist for assessment of nurses `practice in devices alarms management	Done		Not done	
	%	N	%	N
<b>Total</b>	6	20	24	80
<b>False Alarm Prevention Checklist</b>	%	N	%	N
<b>Total</b>	6	23.3	24	76.7



Figure 5:Percentage distribution of total studied nurses' practice regarding management of ICU devices alarms (no=30).



**Figure 6** percentage of total nurses` attitude regarding dealing with ICU devices alarms (n=30)

**Table (4):** Correlation between total level of knowledge, practice and attitude among the studied nurses (n=30)

Items		Total level of practice	Total level of attitude
total level of knowledge	Pearson Correlation coefficient	0.784	0.088
	r		
total level of practice	P	0.000**	0.645
	Pearson Correlation coefficient	----	0.678
	r	----	
	P	----	0.000**

Not significant  $P > 0.05$

\*Significant  $p < 0.05$

\*\* Highly significant  $p < 0.001$

## Discussion

Medical device alarms, which were designed to draw medical staff's attention when a patient's conditions goes beyond the proper range, are causing a new alarm hazard problem (Cho et al., 2016). The number of devices with alarms has multiplied exponentially in the vast majority of hospital units. Monitors, ventilators, infusion pumps, and many other devices beep endlessly, demanding an attention (ECRI Institute, 2014).

Intensive care units (ICUs) are complex work environments where false alarms occur more frequently than on non-critical care units. The Joint Commission National Patient Safety Goal.06.01.01 targeted improving the safety of

clinical alarm systems and required health care facilities to establish alarm systems safety as a hospital priority. An important initial step toward this requirement is identifying ICU nurses' perceptions and common clinical practices toward clinical alarms (Sowan et al., 2015)

This study was aimed to assess nurses' performance regarding devices alarms in intensive care units through the following: 1- Assessing the nurses' level of knowledge regarding devices alarms in intensive care units. 2- Assessing the nurses' level of practice regarding devices alarms in intensive care units. 3- Assessing the nurses' attitude toward devices alarms in intensive care units.

Regarding the study group of nurse's demographic characteristics, the results of the current study revealed that more than two thirds of the study group were females. This is may be due to the greater segment of the nurse in Egypt was female and also related to the studying of nursing in Egyptian university were exclusive for female only till few years ago. These finding is inconsistent with **Cho et al (2016)** who stated that the majority of the studied nurses were females in the study which titled "Clinical Alarms in Intensive Care Units: Perceived Obstacles of Alarm Management and Alarm Fatigue in Nurses"

Furthermore, **Rushdy, Youssef, & Elfeky (2015)** who stated that more than half of the studied sample was females and more than two thirds of the studied sample was young adults and had one to four years of ICU experience in the study that titled "Nurses' knowledge and practice regarding care of patients connected to intra-aortic balloon pump at Cairo university hospitals"

Moreover, **Abudahi, Fekry, & Elwahab (2012)** who stated that the majority of nurses were females in the study that titled "Relationship between Perceived Organizational Climate and Conflict Management Strategies among Nurses in Cairo University Hospital"

As regards age of the nurses in current study, two thirds of them were more than 30 to less than 40 years old. This might explain that they are adult and tolerate the nature of the work. Our findings are in agreement with **El Feky and Ali, (2013)** who stated that around three quarters of the studied sample were from 30 to less than 40 years old in the study that titled "Nurses' Practices and Perception of Delirium in the Intensive Care Units of a Selected University Hospitals in Egypt".

In relation to educational level, more than half of them were nursing diploma. This might elaborate the current condition of nursing qualification in Egypt. This result on the same line with **Farag (2008)** who revealed that nursing education and the distribution of nurses

approximately 87- 93% diploma nursing school certificate.

While **Honan, etal (2015)** believes that education has a significant impact on the knowledge and competencies of the nurses, as it does for all health care providers. Bachelor of Science in Nursing (BSN) degrees are well-prepared to meet the demands placed on today's nurse. BSN nurses are prized for their skills in critical thinking, leadership, case management, and health promotion, and for their ability to practice across a variety of inpatient and outpatient settings.

While regarding the years of experience about two thirds of them had experience more than 15 years. Because they had a certification and license to practice their field as a nurse since graduated. This finding goes in the same line with what was reported by **Phillips, Wood & Kinnersley (2013)** who found that 61% had 10–20 years of experience.

Regarding training courses and performance enhancement about three quarters of them didn't attend any training courses and six of them had benefits regarding management of devices alarms in critical care unit. This may reflect job regulation related factors that affecting nurses' performance as well as lack of motivation for attending courses related to ICU devices alarms. The training courses for nurses is very important to improve their performance that affect positively on quality of patient care.

However, this finding is coinciding with the studies by **El Feky and Ali, (2013)** and **Abudahi et al (2012)** who revealed that the great majority of their studied samples were diploma nurses. On the other hand, our result disagrees with **Rushdy et al (2015)** who revealed that more than half of the studied sample had bachelor nursing degree. Also our findings aren't coinciding with that of **Abd el-kader and Ali, (2012)** who studied critical care nurses' knowledge and practice of fever management at a university hospital and revealed that more than two thirds of the studied sample had bachelor degree. According to the researcher's point of view, these differences might be related to different types of nursing

recruitment and variation of patient acuity level in the selected ICUs.

The current study findings in demographic characteristics of the studied nurses collectively are also parallel with **Sowan et al (2015)** who studied nurses' perceptions and practices toward Clinical Alarms in a Transplant Cardiac Intensive Care Unit on 39 nurses. The majority of nurses were females, about two thirds were 40 years old, and full-time staff. The percentages of nurses who reported having "1-3" and ">5" years of overall nursing experience were about half of study sample.

Regarding total nurses' level of knowledge regarding devices alarms, the results of the current study stated that more than two-thirds of the studied nurses had unsatisfactory knowledge regarding devices alarms. This might be due to that the wide base of nurses' education was technical nursing diploma and lack of enthusiasm to learn new skills and knowledge. The authorized administrative staff of the hospital doesn't provide specialty courses for nurses and motivate them for more studying.

Also, this might be due to most of nurses working in critical care units had not enough time to attend conferences, workshops and courses to enrich and update knowledge regarding management of devices alarms especially those who were working in the intensive care units for several years and overloaded by increased critical care units work and number of patients for each nurse with shortage in the staff.

Current finding is in agreement with **Rushdy et al (2015)** who found that the great majority (88%) of the studied sample had unsatisfactory knowledge level.

The reasons for lack of knowledge may be attributed to lack of continuing educational programs or sessions about this therapeutic intervention, supervision, continuous evaluation of nurses' practice, and cooperation.

Regarding total knowledge toward alarms of hemodynamic monitors, the majority

of the studied nurses had unsatisfactory knowledge. The study result is in agreement with **McGhee and Woods (2001)** who stated that there were knowledge deficit in all content areas at all cognitive levels in the study titled "Critical care nurses' knowledge of arterial pressure monitoring".

Regarding knowledge toward alarms of ventilator, the results of the current study stated that the majority of the studied nurses had unsatisfactory knowledge. This finding is disagreement with **Mesquita Melo, et al., (2014)**

**Mesquita Melo** who studied nursing care of hospitalized patients receiving mechanical ventilation in intensive care units and they found that 82.76% of the nurses always checked mechanical ventilator alarms.

Regarding knowledge toward alarms of syringe pump / infusion pump, more than half of the studied nurses had unsatisfactory knowledge. This might be due to Lack of in service education, support and new technology.

Current study finding is in parallel with **Carayon, Hund & Wetterneck, 2010** whom thesis in study titled "Nurses' Acceptance of Smart IV Pump Technology" found post one year implementation use and experience that technical performance 51%, learnability and memorability 26%, efficiency 64%, errors 47% and satisfaction 61%.

This finding is in disagreement with **Han (2008)** conducted cross-sectional study on staff nurses to assess time to alarm for intravenous infusion pumps and the study results concluded that nurses maximal acceptable time-to-alarm was 2.0 (1.0 - 5.0) minutes. And for infusions of vasoactive drugs, nurses' maximal acceptable time-to-alarm was 0.4 (0.1 - 1.0) minutes. While most of nurses in current study did not know time to alarm for intravenous infusion pumps.

Regarding assessment of nurse's practice in devices alarms management, more than three quarters of the studied nurses had unsatisfactory practice regarding management of ICU devices alarms. This might be due to more than one

third of the studied nurses were technical nursing diploma and they were newly graduated however, the bachelor degree nurses usually worked as a head nurses not bedside when they worked in governmental hospital.

Moreover, this could be due to that the majority of nurses had not orientation program before assigning to work in ICU, shortage of staff nurses which leads to work overload in these units, guideline books were unavailable, lack of supervision and continuous evaluation, most of nurses hadn't interest and motivation in work, insufficient financial reward to the nurses, lack of in-service training, nurses complains of overlapping of the activities by non-nursing activities, poor management of their time and unknown of job description.

Also, this could be due to unavailability of supplies as, there were a large number of nurses working with temporary recruitment due to lack in nurses' number so they had different levels of performance that varied according to their level of knowledge.

Current result is coinciding with **Sowan et al (2015)** who reported that Only half of the nurses reported changing electrodes every 24 hours (51%, 20/39 nurses). Other nurses reported changing electrodes only when needed (23%, 9/39), every shift (13%, 5/39), or every 48 hours (13%, 5/39). Similarly, more than one third of the nurses indicated not changing monitors' parameters and only 5% (2/39) change parameters after disconnecting the patient from the monitor and when the setting reverted to defaults.

Regarding false alarm prevention, more than three quarters of the studied nurses had unsatisfactory practice. The current result disagrees with **Sowan et al (2015)** who reported that almost all nurses (95%-98%) believed that false alarms are frequent, disrupt care, and reduce trust in alarm systems, causing nurses to inappropriately disable them.

A majority percentage of ICU nurses that responded in the current study did not indicate that they understood the purpose of alarms and also indicated that they were not applied of the

existing policies and procedures set out by the company with regards to alarm management. Thus in this study they do not have an understanding of their role and expectations with alarm management but due to the nuisance alarm frequency there is an acknowledged delay in the response to these alarming limits.

Regarding assessment of nurse's attitude in devices alarms management, more than half of the study nurses had positive attitude. This may be due to awareness of the importance of emotional support to such group of patients.

This finding could be interpreted in light of **Meng'anyi et al (2017)** Conducted a descriptive cross sectional study on staff nurses to assess the practice of nurses in management of clinical alarms and the study results concluded that Out of 87 respondents 48(55.2%) reported that "Always" the common causes of alarms to beep in the unit are changes in patient condition, 16(18.4%) due to mechanical errors, 22(25.3%) poor setting of alarm limits and 16 (18.4%) artifacts.

This finding of the current study agreed with **Singh (2017)** stated that, nurses should have positive attitude towards patients and their care in the study titled "nursing attitudes and patient care".

This finding supported by **Salous et al., (2017)** showed that the alarm fatigue resulted in lack of response of health care providers due to excessive numbers of alarms, which lead to desensitization and sensory overload, and multiple factor such as non-actionable alarms and false alarms. Biomedical engineers make every effort for sensitivity, while healthcare providers need to understand specificity as it is important while taking care of patient in critical care units. Ongoing evaluation of nurse's attitudes related to alarm fatigue will help the hospitals to make and develop standard policies and education related to clinical alarms, which is considered as a major requirement of different accreditation systems in the study titled "Nurses' Attitudes Related to Alarm Fatigue in Critical Care Units".

This finding could be interpreted in light of **Korniewicz, Clark, & David, (2008)** who developed an online survey to evaluate the reasons health-care workers do not respond to clinical alarms. The study results concluded that they had negative attitude related devices alarms. As more than 90% agreed that audible and visual alarms need to be easily differentiated. Likewise, 81% agreed false were a problem and 77% agreed alarms disrupted patient care while 78% disable alarms.

There was highly statistically correlation between practice and knowledge of the studied nurses Furthermore, there was highly statistically correlation between practice and attitude of the studied nurses. This result means that the nurses who had satisfactory level of knowledge regarding ICU devices alarms also had satisfactory level of practice and attitude regarding ICU devices. This may be due to nurses' educational level and experience are affecting the level of nurses' practice regarding management of patient connected with ICU clinical devices.

In agreement to current study results **Karnik & Bonafide (2015)** conducted an observational study about the relationship between nurses exposed to high rate of non-actionable physiological monitor alarms and the time of responding to critical alarms. 36 nurses were observed in the intensive care unit in the Children Hospital of Philadelphia/Pennsylvania, for 210 hours with 5070 alarms. They found 87.1% of ICU and 99% of medical ward alarms were not actionable, and if non-actionable alarms increase they lead to delay in response time. The researchers concluded that the non-actionable alarms have direct effect and lead to unsafe practice, and they decrease time of nursing response, all of them lead to enhance patient safety.

### **Conclusion:**

**Based on this study finding, it can be concluded that:**

- The study revealed that more than two third of the studied nurses had unsatisfactory

knowledge as well as practice regarding management of ICU devices alarms.

- Moreover, there was highly statistically significant correlation between studied nurses' knowledge, practice and attitude.

### **Recommendations**

The result of this study projected the following recommendations:

- The importance of implementing an in service training program for nurses to improve their performance regarding ICU devices alarms.
- The management of the hospital should develop protocols and policies on alarm management which will address the issue of completion of alarm checklist to be completed at the beginning and end of each shift.
- The study should be replicated on large sample and in different hospitals settings in order to generalize the results.

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No

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