Impact of Designed Oxygenation Monitoring Protocol on Critical Care Nurses' Level of Knowledge and Practice

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Abstract: **All patients in the ICUs may require oxygen during their disease course. Monitoring of the oxygenation level for patients is a basic principal during oxygen therapy administration. Adequate knowledge and skillful practice while nurses using pulse oximeter is an indication for patient safety and quality of care. Aims of the study: that study includes two aims 1st is to assess critical care nurses' practice of oxygenation monitoring using pulse oximetry in ICUs. The 2nd is to evaluate the effect of implementing a designed nursing protocol on nurses' knowledge and practice regarding oxygenation monitoring by pulse oximetry in ICUs. Research design: Quasi-experimental research design has been utilized. Settings: General, Trauma and Chest ICUs at Aswan university hospital. Tools: Two tools were used, structured knowledge questionnaire and observation checklist sheet. Results: 72.0% of the study sample was females, aged from 20 to <30 years and 76.0% were technical nurses. The hypotheses were supported as the mean and standard deviation of knowledge improved from 11.84 ± 3.22 to 18.74 ± 2.1 post implementation of the designated nursing care protocol. Practice mean and standard deviation improved from 12.94 ± 7.68 to 25.30 ± 1.51 post the implementation. There were highly statistically significant difference $P<0.01$. Conclusion: implementation of designed oxygenation monitoring protocol showed a significant improvement in nurses` knowledge and practice. Recommendations: New nurses are in need for orientation program, written protocol located in ICU, supervision, in-service training programs, workshops and conferences on oxygenation monitoring using pulse oximeter.**

Keywords: **critical care nurse, oxygenation, pulse oximeter, nurses' knowledge and practice.**

I. INTRODUCTION

The pulse oximetry is a modern innovative technology with its ability to continuously monitor the oxygen saturation of hemoglobin in arterial blood (SaO2). Pulse oximetry is so broadly prevalent in clinical and emergency care that it is often regarded as a fifth vital sign (**Nimbalkar et al., 2018**). Pulse oximetry is a noninvasive spectrophotometric device that provides an estimation of arterial oxygen saturation of hemoglobin by measuring the oxygen saturation in the mixed capillary blood to the peripheral circulation by using an external sensor it is performed intermittently. Oxygen saturation is an indicator of the percentage of hemoglobin saturated with oxygen at the time of the measurement. The readings obtained with standard Pulse oximetry uses alight sensor that contains two sources of light (red and infrared) absorbed by hemoglobin and transmitted through tissues to aphotodetector. The amount and type of light transmitted through the tissue is converted to a digital value that represents the percentage of hemoglobin saturated with oxygen (**Morton & Fontaine, 2017**).

Errors of Pulse oximetry reading is reported as 7.2% in more critically ill patients **(Seifi et al., 2018)**. Conditions or limitations that may lead to inaccurate readings of pulse oximetry include: physiologic limitations shape of oxyhemoglobin dissociation curve, intra venous dyes, nail polish, low-perfusion state, skin pigmentation, ambient light, motion artifact, poor positioning of the sensor, temperature and arrhythmias. Critical care nurses have limited understanding of pulse oximetry. Monitoring with pulse oximetry continues to be a critical component of standard of care of critically ill patients despite the paucity of data that such devices improve outcome **(De Medeiros et al., 2015)**. Critical care nurse must be able to determine factors that may interfere with accurate pulse oximetry readings such as diminished or absence circulation at sensor sites as (shock, cardiac arrest, hypothermia, hypotension), severe anemia, elevated carboxyhemoglopin (heavy smoker), excessive patient movement or tremors, incorrect placement of probe, environmental factors and technology failures **(Seifi et al., 2018)**. It is important that nurses understand how the technology device functions as well as its limitations because improper readings can lead to unnecessary monitoring **(Urman et al., 2016)**.

The procedure of pulse oximetry is essential to maintain oxygenation, ventilation and provide patients' clear airway. Nursing procedures must perform following the standards and best practices to prevent complications especially desaturation that may be developed **(Eachempati, 2016)**. In addition frequent false alarms in the intensive care unit can also distracting caregivers and lead to threaten patient safety **(Lee et al., 2016)**. Overexposure to frequent false clinical alarms in intensive care units (ICUs) leads to reduce attention to alarms which obstacles to proper patient care management, ambient noises, and also cause nurses' fatigue, decrease concentration, become careless, commit mistakes and become less sensitive to alarms that can affect patients' safety. Alarm hazard was ranked first among ten types of medical technology hazards in United States **(Cho et al., 2016)**.

Critical and emergency care nurses must be aware of the uses and limitations associated with pulse oximetry technology. Knowledgeable nurses who practice effectively during oxygenation monitoring are paramount for patient's and staff's safety.

I.1 Significance of the study

By observation newly graduated nurses working in ICUs at Aswan university hospital has insufficient knowledge and practice, don't receive training courses about oxygenation monitoring and there is no written procedure for oxygenation monitoring present in the ICUs. Therefore, the study was conducted to improve nurses' practice by increasing nurses' knowledge about oxygenation monitoring using pulse oximetry designed protocol.

I.2 Aim of the study

This study aims to:

- Assess critical care nurses' practice of oxygenation monitoring using pulse oximetry in ICUs.

- Evaluate the effect of implementing a designed nursing protocol on nurses' knowledge and practice regarding oxygenation monitoring by pulse oximetry in intensive care units.

I.3 Hypothesis

To fulfill the aims of the study, the following research hypotheses were formulated:

- A significant difference between pre and posttest of nurses' knowledge regarding pulse oximetry.

- Significant difference in nurses' practice between pre and post implementing a designed nursing protocol on nurse's regarding pulse oximetry.

II. SUBJECTS AND METHOD

Research design

Quasi-experimental research design has been utilized in this study.

Setting of the study

The study was conducted in General, Trauma and Chest ICUs at Aswan University Hospital.

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Study sample

A convenience sample of 50 newly appointed nurses.

Inclusion criteria: nurses at the first 2 years of appointment, working in selected settings, who don't receive an official training course about oxygenation monitoring and are willing to participate in the study.

Tools of data collection

Two tools to collect data were:

Tool I: Structured pre/post knowledge questionnaire which was developed in a simple clear Arabic language by the researchers based on the literature review (**Jubran, 2004; Elliott & Coventry, 2012; De Medeiros et al., 2015; Seeley et al., 2015**) the tool consisted of two parts:

Part I: contains personal characteristics of the study subjects as sex, age and educational level.

Part II: includes 12 true and false questions measures nurses' knowledge about pulse oximetry and 9 multiple choice questions measures nurses knowledge about oxygenation and physiology of respiration.

Scoring system: The total score for all items was 21. Each right answer was given one score. Those who obtained less than 50% were considered having unsatisfactory level of knowledge. While those who obtained from 50% or above were considered having satisfactory level of knowledge.

Tool II: Observation checklist sheet (pre/post-observation): adapted from **Johns Hopkins Institute for Clinical & Translational Research (2015)** to assess standards of practice for nurses providing care during oxygenation monitoring using pulse oximetry for patients. This tool was used before and immediately after the implementation of the designed nursing protocol to assess the impact of the protocol on nurses' practice.

Scoring system: Each item was observed, categorized, and scored as follow: 2 for each step that done correct (correctly, in time and with the required frequency) and 1 for each step done with assistance and zero for step that not done correct. Inapplicable means that the nurses were not able to apply the principles of the standard due to nurses not have enough knowledge about pulse oximetry. Score equal to 60% and more represent nurse's good practice while less than 60% considered poor practice.

Content validity: It was established by panel of 5 experts who reviewed the instruments for clarity, relevance, comprehensiveness, understandability, applicability and easiness for administrative minor modifications were required. The content validity of this tool was checked by expert professors in the fields of medicine and nursing and needed correction was carried out accordingly.

Reliability was established by the application of the study on 10 nurses working at intermediate care unit. Cronbachs' Alph test used reliability was 0.91. Analyses of the pilot study revealed that minimal modifications required then needed modifications were done.

Ethical considerations and human rights: An official permission to conduct the study was obtained by the researchers from the head nurses of each ICU. Nurses were informed of the purpose and nature of the study. The researchers emphasized that the participation is voluntary and confidentiality and anonymity of the subjects assured through coding all of data.

Procedure

- Study tools have previously been designed to construct the questionnaire and observation checklist sheet. After a process of review, the questionnaires developed by the researchers and address the domains of ventilation, gas exchange and oxygen transport and as well as the practice limitations of pulse oximetry. In addition to the checklist sheet of the pulse oximetry protocol includes the steps to be done before during and after the pulse oximetry procedure.

- Collection of data started from April to July 2018. At initial interview the researcher introduces herself to initiate line of communication, explain the nature and purpose of the developed nursing care standard/protocol and fill out the structured interview sheet (**tool I**) to assess nurse's knowledge pre and post implementation of nursing care protocol. Moreover the researcher fills out the observation checklist sheet (**tool II**) to assess nurse's practice pre implementation of nursing care protocol.

- The purpose of the study was explained to nurses prior to answering the questions. The study was carried out at morning, and after noon shifts.

- **The procedure of the study done by the following sequence:**

I- Practice measurement:

o   Nurses observed while performs oxygenation monitoring for patients using pulse oximetry pre implementation of designated nursing care protocol (tool II) through April 2018 as follows:

- ✓ Checking patient's records
- ✓ Patient identification
- ✓ Preparing equipment consists of paper and pen, for recording results.
- ✓ Hands washing
- ✓ Prepare the patient by explaining what you will do
- ✓ Select sensor site that is free of moisture and drainage
- ✓ Assess capillary refill and proximal pulse.
- ✓ Cleanse site (remove nail polish or artificial nails).
- ✓ Follow manufacturer's instruction for using pulse oximeter. Connect sensor to oximeter and set alarms as ordered
- ✓ Position sensor with light-emitting diode (LED) and photo sensor aligned on opposite sides of the selected site.
- ✓ Obtain reading
- ✓ Administer oxygen as required.
- ✓ Hands washing

II- Theoretical part:

o   Teaching sessions on the spot during official working hours for both theory and practice were scheduled. Nurses were divided into small groups; each group included 3-5 nurses.

o   There were a total of five sessions for each group included (definition of oxygenation, pulse oximetry, Spo2, how does it work, indication, contraindication, purpose, sites of pulse oximeter, factor affecting readings, causes of hypoxia, complication might occurs).

o   The duration of each session was 30-45 minutes, including 10 minutes for discussion and feedback. The researchers provided each nurse with the designed illustrated booklet. That part started at May 2018.

o   Each session usually started by a summary of what has been taught during the previous session and the objectives of the topics. Feedback and reinforcement of teaching was performed to ensure participants understand.

III- The final stage:

o   Theoretical and practical content were repeated according to understandability of participants.

o   Each nurse can master oxygenation monitoring skill using pulse oximetry easily. So immediately post implementation of designated nursing care protocol (after completing all sessions of the theoretical and practical parts of the study for each group) the researchers again observes the nurses practice. This done through July 2018.

III.   RESULTS

TABLE 1: Clarified that; 72.0% of the study sample were females, aged from 20 to <30 years and 76.0% were technical nurses.

TABLE 2: Demonstrates that; mean and standard deviation of the study sample knowledge pre and post implementation of designated nursing care protocol it were 11.84 ± 3.22 and 18.74 ± 2.1 respectively. For mean and standard deviation of the study sample practice pre and post implementation of designated nursing care protocol it were 12.94 ± 7.68 and 25.30 ± 1.51 respectively. There were highly statistically significant difference $P < 0.01$.

FIGURE 1: Shows that; most of the study sample had satisfactory level of knowledge and practice post implementation of designated nursing care protocol 98.0% and 100.0% respectively. There were highly statistical significant difference P<0.01.

**TABLE 1: Distribution of personal characteristics of the studied nurses (n=50).**

Personal characteristics	No	%
Sex		
Male	14	28.0
Female	36	72.0
Age		
< 20	6	12.0
20 - <30	36	72.0
30 years or more	8	16.0
Educational level		
Technical nurse	38	76.0
Bachelor degree nurse	12	24.0

TABLE 2: Total mean scores of the level of nurses` knowledge and practice as regard pre and post implementation of designated nursing care protocol (n=50).

Mean score of nurses' as regard to knowledge and practice	Score	Pre (n=50) Mean ±SD	Post (n=50) Mean ±SD	P. value
Nurses knowledge about pulse oximetry	12	7.4±2.43	10.96±1.5	<0.01**
Nurses knowledge about oxygenation and physiology of respiration	9	4.44±1.26	7.78±0.93	<0.01**
Total mean of knowledge	21	11.84±3.22	18.74±2.1	<0.01**
General guidelines for vital signs	8	3.24±3.23	8.00±0.00	<0.01**
During procedure	16	7.39±3.97	13.30±1.51	<0.01**
After procedure	4	2.31±1.31	4.00±0.00	<0.01**
Total mean of practice	28	12.94±7.68	25.30±1.51	<0.01**

**Highly Statistical significant differences (P-value)   Independent T- test
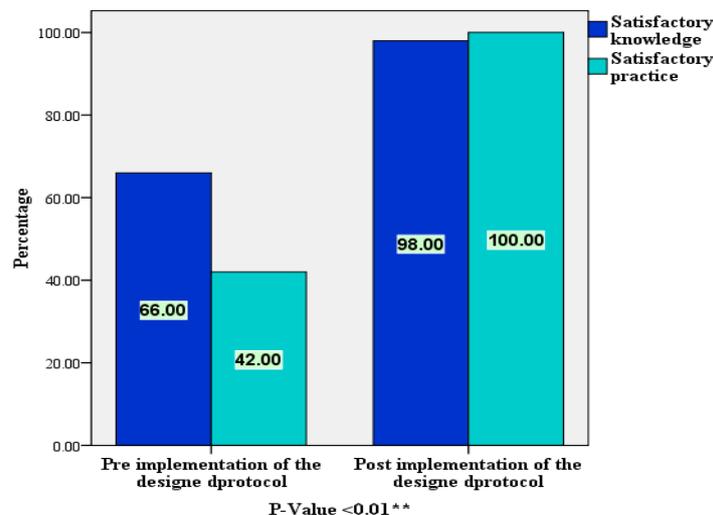
Fig. 1: Percentage distribution regarding nurses' satisfactory knowledge and practice pre and post implementation of designed nursing care protocol (n=50)

IV. DISCUSSION

Pulse oximetry is a noninvasive method of continuously monitoring of the arterial blood oxygen saturation (SpO2 or SaO2) and the pulse rate of a critical ill patient. It is widely prevalent in intensive care unit and is often regarded as the fifth vital sign after body temperature, pulse rate, respiration rate and blood pressure. By measuring light absorption at a well-perfused body part (ear lobe, finger or nasal alar) with two different wavelengths (red and infrared), it assesses the SpO2 and the pulse rate **(Ebmeier, et al., 2018)**.

Oxygen saturation is an important one of the vital signs to be monitored and measured for critically ill patients. One of the important factors could contribute to oxygen desaturation; is nursing practices. This study was conducted to determine the relationship between nursing practices and knowledge on oxygen saturation for critically ill patients.

The results of the present study showed; that the majority of nurses**,** were aged from twenty to less than thirty years. The highest proportion of them was females' technical nurses. This may be for in the recent past the nursing education was not recommended by Upper Egypt families, thus also reflected on the setting up of nursing faculties. So, nursing education was largely limited to technical education.

This was in the same line with **Ali and Seloma (2019**) who study the effect of nursing educational guidelines about pulse oximetry on critical care nurses' knowledge stated that the majority of the study sample 93.3% was females, 40 % of the nurses age ranged between 25-30 years old, with mean age of (31.3), about half of the sample (46.7%) had diploma certificate. Moreover **Aloushan et al., (2019)** who assess the knowledge, attitude and practice regarding oxygen therapy at emergency departments show that the majority 77% in the age group of 20–35 years. Additionally **Khosravi et al., (2018)** study for the evaluation and improvement of knowledge of medical staff on pulse oximetry in educational hospital nurses were 57.4% of the study sample, the highest percentage of them were females and aged less than 40 years. In the same line **Seeley et al., (2015)** measures the graduate nurses' knowledge of the functions and limitations of pulse oximetry found that 93.2% were females, 90.2% in the age category of 20–34 years and 91.2% held a Bachelor degree in nursing.

As regard nurse's knowledge, the current study findings indicate that apparent improvement in the mean of knowledge scores after implementation of the designed nursing care protocol relatively from twelve to nineteen. In the same line the current study revealed that the level of nurse's knowledge turned from lower percentage sixty six pre to higher satisfactory percentage ninety eight post implementation of the designed nursing protocol. The current results regarding nurse's knowledge are concurrent with the first hypothesis of the study. So, we can conclude from the analysis of the data collected in the present study that all studied nurses weren't properly prepared prior to their working to deal with pulse oximetry and really they got their experience while being there, working and managing the patients in the real life emergency situations.

The results of the current study was in accordance with previous study of **Khosravi et al., (2018)** who found that after educational program on pulse oximetry, the average percentage of correctly answered questions increased significantly from 74% to 93% the difference was highly significant. Educational course for pulse oximetry significantly improved the knowledge scores among participants. Continuing education and adequate training programs are mandatory to improve the lack of knowledge on pulse oximetry. Also **Attin et al., (2002)** demonstrated the average percentage of correctly answered questions increased significantly from 66% to 82% the difference was highly significant. Additionally **Seeley et al., (2015)** examine nursing graduates' knowledge of functions and limitations of pulse oximetry revealed that significant deficits relating to the theoretical factors that affect pulse oximetry application and interpretation were identified.

Continuously and in the same line in Egypt a study done by **Ali and Seloma (2019)** show that the total mean and standard deviation pre knowledge scores increased significantly after submission of the educational guidelines from 8.6 ± 2.3 to 16.6 ± 1.65, p< 0.001. That means educational guidelines improved critical care nurses' knowledge about pulse oximetry monitoring. This was in accordance with **Nimbalkar et al., (2018)** states there is marked deficiency in the knowledge of pulse oximetry in the healthcare professionals. Strategies directed at improving the competency correct interpretation of pulse oximetry are urgently needed, to improve patient care and safety. **Lee et al., (2006)** demonstrated that there was insufficient knowledge on the use of pulse oximetry among staff of the accident and emergency department. The level of understanding did not correlate with their clinical experience. Training programs targeting both the fresh and the

experienced staff are recommended. The current study results was in the same line with **Stathoulis et al., (2017)** who evaluated the pulse oximetry knowledge of Greek registered nurses showed that the implementation of educational programs contributes positively to update registered nurses' Knowledge on clinical issues, which cannot be replenished only through undergraduate education and experience.

The current study revealed a great improvement in the level of nurse's practice post implementation of nursing care protocol in all items. This has been concluded by the mean scores of practice were improved nearly from thirteen to twenty five, the practice transformed from unsatisfactory pre to satisfactory post. The previously mentioned results for nurse's practice are in the same line with the second hypothesis of the study. This finding indicated that skills can be easily improved, especially if linked with their relevant scientific base of knowledge. So critical care nurses should have basic knowledge and skills to close monitor, identify and prevent the occurrence of oxygen desaturation in critically ill patients. Thus periodical official training in the field of critical care is indicated for patients and staff safety and for staff development.

There is scarcity of research articles that describe the practice of nurses regarding oxygenation monitoring. Regarding nurses practice and in accordance with the current study **Lemma, (2015)** study to assess nurses knowledge, attitude and practice about oxygen therapy at emergency departments found that the practice on oxygen therapy was poor the percentage was 56.6%. The results showed that lack of training on oxygen therapy affected nurses' knowledge, attitude and practice. So, Lamias' study recommended that emergency department nurses must be given training on oxygen therapy and be updated. National oxygen therapy guideline or hospital protocol must be developed. In the same line **Aloushan et al., (2019)** study of knowledge, attitude and practice regarding oxygen therapy at emergency departments revealed that main factors associated with poor knowledge, attitude and practice were workload and lack of local guidelines. Developing a locally updated oxygen therapy guideline and recommendations will improve practice.

Additionally **Yazdannik et al., (2018)** study of the performance of ICU nurses in providing respiratory care shows that nurses performed poorly in respiratory care, which is indicative of the fact that the nursing staff requires training courses and educational protocols in relation to respiratory care. **Asfour, (2016)** studies the oxygen desaturation and nursing practices in critically ill patients the results of his study shows that there were significant relationships between oxygen desaturation and the procedures performed as oxygen saturation decreased during and after certain performed procedures. Guidance should be provided to critical care nurses through workshops to be more knowledgeable about oxygen saturation and factor affecting it. In-service training program should be carried out for all nursing practices to train nurses regarding best practices in procedure performance.

V. CONCLUSION

In the light of the current study it can be concluded that, Implementation of designed nursing care protocol for correct monitoring oxygen saturation for critically ill patients using pulse oximeter within ICUs shows a significant improvement in nurses` knowledge and practice.

VI. RECOMMENDATIONS

1. Orientation programs for new critical care nurses should include more knowledge about pulse oximetry, oxygenation and factors affecting it.

2. Written protocol of oxygenation monitoring should be available for nurses in ICUs to be a ready reference for them.

3. Sufficient supervision should be provided on nurses during performing their skills practice to determine areas of mal practice and needs corrective action should be done on spot during work.

4. In-service training programs on oxygenation monitoring using pulse oximetry should be well organized within ICUs that will be reflected on better outcome, safety and service for critically ill patients.

5. Nurses should be encouraged to attend workshops, conferences and scientific meetings to have current knowledge and skillful practice necessary for proper oxygenation monitoring.

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