IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 6, Issue 6 Ver. VII. (Nov.- Dec .2017), PP 27-31
www.iosrjournals.org

Effectiveness of Structure Teaching Programme on Paediatric Nurses Knowledge on Pulse Oximetry And Interpretation of The Oximetry Data

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Abstract: *Pulse oximetry is a non-invasive, painless and reliable method of measuring arterial oxygen saturation. It reflects the percentage of hemoglobin that is capable of transporting oxygen in the blood. Measurement of oxygen saturation is now considered to be a component of routine vital signs. This study was an interventional study in nature and assessed the knowledge level of pediatric nurses in a tertiary care setting, regarding the use of pulse oximeter and the interpretation of the available data. Around 61 nurses in both the groups who work in the pediatric care set up participated in the study. The study revealed that there was no significant difference in the pre test scores between the control and the experimental groups (p=0.14), but there was a significant difference in the posttest score between the groups (p<0.001). Based on the study findings a comprehensive teaching module was prepared on the use of pulse oximetry.*

Date of Submission: 06-12-2017 Date of acceptance: 18-12-2017

I. Introduction And Literature Review

Principles Of Pulse Oximetry

Pulse oximeter measures the O2 saturation and the pulse. A pulse oximeter consists of a peripheral probe and a microprocessor unit, displaying a waveform, the O2 saturation and the pulse rate (Hill & Stoneham, 2000). Most oximeters have an audible pulse tone, the pitch of which is proportional to the O2 saturation – useful when one cannot see the oximeter display. The probe is placed on a peripheral part of the body such as a digit or the ear lobe. Within the probe are two light emitting diodes (LED's), one in the visible red spectrum and the other in the infrared spectrum. The beams of light pass through the tissues to a photo detector. During the passage through the tissues some light is absorbed by blood and soft tissues depending on the concentration of hemoglobin. The microprocessor unit selects the absorption from the arteries and displays it as the saturation (SpO2). The unit of measurement of saturation (SpO2) is %. The uniform waveform on the monitor is an important indicator of the reliability of the SpO2 reading.

Oxyhemoglobin Curve

Oxygen is mainly transported bound to hemoglobin. Some amount of oxygen is dissolved in the plasma, which is used when the hemoglobin levels are very low. One molecule of hemoglobin can carry 4 molecules of oxygen, which is then 100% saturated with oxygen. The average percentage saturation of a population of hemoglobin molecules in a blood sample is the oxygen saturation of the blood, which is measured by the pulse oximeter.

The haemoglobin- oxygen dissociation curve describes the relationship between the arterial partial pressure of oxygen (PaO2) and the oxygen saturation. Unfortunately the curve is not linear rather it is sigmoid shaped (Fig.1). A PaO2 of 95mmHg corresponds to a SpO2 of 97%. A SpO2 of 100% could reflect a PaO2 of 100-140 mmHg. But, a saturation of 90% corresponds to a partial pressure of 60mmHg. If the nurses are not aware of this non-linear relationship between the SpO2 and the PaO2, they may erroneously interpret the PaO2 as 90mmHg when it actually would be 60mm Hg. They would not be concerned until the PaO2 is dangerously low. A nurse who understands this non-linear relationship would be able to detect hypoxemia early.

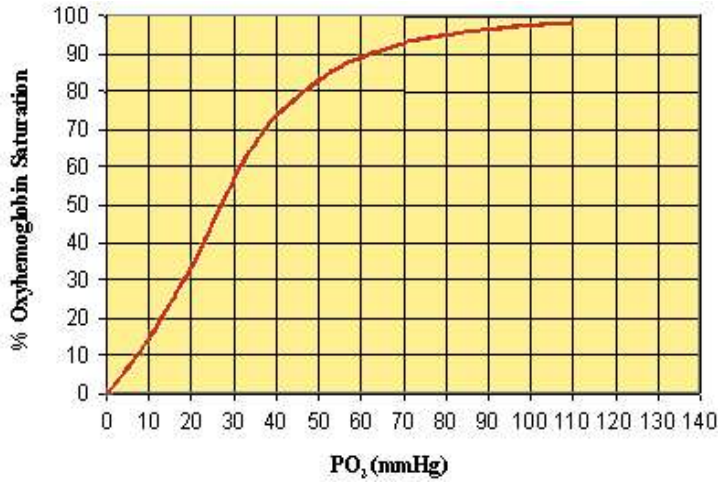

Figure1. Oxyhemoglobin dissociation curve

Factors can affect the accuracy of pulse oximeter readings

- Probe placement
- Nail polish, bright overhead light or sun light
- Peripheral vasoconstriction due to cold ambient temperature
- Poor peripheral perfusion due to decreased cardiac output, arrhythmias &shock
- Carbon monoxide poisoning. The colour of the skin or hyperbilirubinemia does not affect the accuracy of the readings.

A study done by Rodriguez (1994) on pediatric house staff's knowledge of pulse oximeter revealed that the mean test scores and standard deviation was 64.3% $\pm$ 1.9 with a range of 10% - 100%. Only 17% of the nurses answered all questions correctly with regard to the oxyhemoglobin deviation curve. With regard to accuracy of pulse oximeter, only 36% answered all questions correctly. Another study by Kruger (1997) on hospital staff's knowledge of pulse oxymeter revealed that only 68.5% of the respondents correctly stated what pulse oximeter measures, but there was limited understanding about principles of pulse oximeter, potential errors, normal range or physiology of oxygen hemoglobin dissociation.

II. Objectives

- To assess the knowledge level of Paediatric nurses on pulse oximetry and interpretation of the clinical data before and after the structure teaching programme in the experimental and the control group.
- To compare the change in level of knowledge among Paediatric nurses regarding the pulse oximetry between the experimental and the control group.
- To find the association between the level of knowledge among paediatric nurses with their selected demographic variables.

Hypothesis

There will be a significant difference in the level of knowledge among paediatric nurses regarding pulse oximetry and interpretation of the oximetry data in the interventional group compared to the nurses in the control group.

Projected Outcome

- The structured teaching module will be used as a reference by the staff and students in the wards.
- The findings will pave way for pulse oximetry to be taught in detail with other vital signs in the nursing curriculum.
- Increased knowledge of the nurses will improve the quality of care to children in the wards.

III. Limitation

The control group samples may receive information from other sources during the period of study.

Methods

The research approach used in this study was quantitative. A quasi-experimental study design was selected. The study was conducted in paediatric wards in Christian Medical College, Vellore which is a tertiary care centre. The sample was selected by simple random technique lot method.

Data collection instrument:

The data collection instrument was partly constructed by the investigator after an extensive literature review. It was a self administered questionnaire with sections.

Section I: Demographic variables of the participants that included age, education, qualification, years of experience in paediatric department and classes attended on pulse oximetry.

Section II: Questionnaire on knowledge of pulse oximetry consisted of 25 multiple Choice Questions with a single appropriate answer. The questions were regarding knowledge of the instrument, physiology related to pulse oximetry and clinical application of hypothetical scenario. The right answer was given a score of 1 and wrong answer was given 0 score. The results were converted to percentages and interpreted as follows

- < 50% - Inadequate knowledge
- 51 – 75% - Moderately adequate knowledge
- 76 – 100% - Adequate knowledge

Content validity of the tool was obtained from experts in the field. 4 pilot study samples enabled the investigator to test the reliability of the instrument.

Data collection procedure:

The data was collected for 3 weeks. All the participants were present in a conference room. The investigator explained the purpose of the study, after obtaining verbal and written consent, the staff nurses were issued knowledge questionnaire. The pretest lasted for 30-40 minutes. After a week's duration the experimental group staffs were called and instructional teaching was given for 1 hour using powerpoint and pulse oximeter. After a week posttest was conducted for both the groups.

Ethical consideration:

Approval to conduct the study was obtained from the college of nursing research committee and the institutional review board. Written consent was obtained from all the participants.

IV. Data Analysis

Statistical test such as student't' test was used to compare the effectiveness of structured teaching programme between control and experimental groups. Paired't' test was used to assess the increase in level of knowledge in control and experimental group after the structured programme teaching. Chi square was used to assess the association between the knowledge scores in both the groups with their selected demographic data. Knowledge scores were converted to percentage.

V. Results

eeeee comparison of pretest scores with posttest scores of the experimental and control groups using paired t test

Group	Pre test		Post test		Mean diff.	SD diff.	Paired 't' value	p value
	n	Mean (SD)	n	Mean (SD)				
Experimental	61	11.7 (2.5)	61	23.5 (1.5)	-11.81	2.59	-35.61	<0.001*
Control	61	12.1 (2.5)	61	14.0 (3.6)	-1.95	3.77	-4.04	0.0002

The difference between the control and experimental group in relation to the knowledge of staff nurses regarding pulse oximetry was statistically significant (P=<0.001).

Table 2: Comparison of knowledge scores between the experimental and control group by independent t tests.

Assessment	Experimental group		Control group		t value	p value
	n	Mean (SD)	n	Mean (SD)		
Pre test	61	11.7 (2.5)	61	12.1 (2.5)	-0.77	0.44
Post test	61	23.5 (1.5)	61	14.0 (3.6)	19.02	<0.001 *

The comparison of pretest post rest scores also showed a significant difference (P <0.001) in terms of knowledge of nurses regarding pulse oximetry evidencing the significance of the teaching programme.

Table 3: Association of pre-test knowledge with selected demographic variables in the experimental and control group

Demographic variables	Experimental group			Control group		
	Inadequate (n=42)	Moderately adequate (n=19)	P value	Inadequate (n=34)	Moderately adequate (n=27)	P value
Qualification						
Bsc/PcBsc	4 (9.5)	4 (21.1)		6 (17.7)	4 (14.8)	
Diploma	38 (90.5)	15 (78.9)	0.21	28 (82.3)	23 (85.2)	0.77
Experience in Paediatric wards						
≤3 years	21 (50.0)	7 (36.8)		21 (61.8)	16 (59.3)	
4-6 years	10 (23.8)	5 (26.3)	0.60	6 (17.7)	6 (22.2)	0.90
>7 years	11 (26.2)	7 (36.8)		7 (20.6)	5 (18.5)	
Attended any class on Pulse Oximetry						
No	36 (85.7)	17 (89.5)	0.69	23 (67.6)	15 (55.6)	
Yes	6 (14.3)	2 (10.5)		11 (32.4)	12 (44.4)	0.33

Demographic variables like education, experience, and attendance of classes on Pulse oximetry were associated with the knowledge of nurses and it was identified that there was no relationship between them.

Table 4: comparison of domain scores (pre, post) between the experimental and control group using independent t test

Domains	Experimental group		Control group		t value	p value
	n	Mean (SD)	n	Mean (SD)		
pre-test						
Pulse oximetry	61	3.8 (1.1)	61	3.8 (1.2)	0.24	0.81
Physiology related to Oximetry	61	4.0 (1.0)	61	3.8 (1.2)	0.92	0.36
Clinical Application	61	3.9 (1.6)	61	4.5 (1.4)	-2.28	0.03
post-test						
Pulse oximetry	61	6.3 (0.6)	61	4.4 (1.1)	11.7	<0.001*
Physiology related to-Oximetry	61	8.7 (1.5)	61	4.9 (1.6)	13.5	<0.001*
Clinical Application	61	8.7 (0.6)	61	4.8 (1.9)	15.3	<0.001*

It is shown in table 4 the domain wise distribution of the scores at pre and post test. In all the domains of knowledge listed such as pulse oximetry, physiology and clinical showed a highly significant difference between experimental and control groups. (P <0.001)

VI. Discussion

The present study revealed that majority (68.9 and 55.7%) of the paediatric nurses have adequate knowledge regarding pulse oximetry and interpretation of pulse oximetry data in both experimental and control groups during the pretest. This is similar to the findings of Rudriges, 2017 who concluded that only 36% of the respondents had adequate knowledge about pulse oximetry whereas Kruger, 1997 found that 78% of the respondents had adequate knowledge about pulse oximetry. But posttest revealed that 98.4% of the nurses has adequate knowledge and 52.5% of the nurse had moderately adequate knowledge in the experimental and control groups respectively. The present revealed a significant association (p<0.001) among the pretest and posttest scores between the experimental and control groups. There is no literature to support or contradict the present study since the other studies conducted was only survey in nature.

Interestingly among the knowledge domains of experimental groups there is a significant difference in knowledge regarding pulse oximetry (P<0.001), physiology related to pulse oximetry (P<0.001), and clinical application (p<0.001). Although the knowledge was low or equal in control group the knowledge in the experimental group was significantly high.

VII. Conclusion

Measuring O2 saturation using Pulse /oximeter has become a common phenomenon in acute care settings. Appropriate measurement, accuracy and timely interpretation are mandatory for the effective use of pulse oximetry.

Paeditric nurses need to be knowledgeable about the functioning of pulse oximetry and the relevance of the data displayed to give comprehensive care to the children.

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Lilly Prasad "Effectiveness of Structure Teaching Programme on Paediatric Nurses Knowledge on Pulse Oximetry And Interpretation of The Oximetry Data." IOSR Journal of Nursing and Health Science (IOSR-JNHS) , vol. 06, no. 06, 2017, pp. 27–31.