



Effectiveness of Structured Training on Knowledge and Attitude of Nurses About Oxygen Therapy in Orotta National Referral Hospital

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Abstract: *Background:* Oxygen is one of the most essential elements for life, so nurse must be familiar for its administration and its potential hazards. Oxygen therapy is useful when it is performed with appropriate dosage, but when it is used on the other way side, it has substantial adverse side effects secondary to its beneficial characteristics. The purpose of the study is to explore the outcome of structured training about oxygen therapy on the nurses' knowledge and attitude. *Method:* Quantitative one group pre-post study design was applied using self-administered questionnaire. Data collection was conducted at pre-training, immediate after training & three months late. Repeated measures ANOVA was used to analyze the data by Statistical Package for Social Sciences (SPSS, Version 26) software. *Result:* The overall average score of knowledge of the nurses during the pre-intervention period was 45%. The level of knowledge of nurses at immediate post intervention increased in all the knowledge items with an overall score of 77% and declined slightly after three months to 62%. The average attitude score of the nurses during the pre-intervention period was 71.6%, and at the immediate post intervention time was increased to 80.2% then after three months it reached to 80.5 %. The result displayed that knowledge scores were higher at immediate post intervention than pre-intervention ($p < 0.001$), after 3-months, than pre-intervention ($p < 0.001$), and immediate post intervention than 3 months later ($p < 0.001$). The tendency of knowledge scores about oxygen therapy was perceived to be quadratic across the three time periods ($p < 0.001$). *Conclusion:* Based on the outcomes of this study, most of the nurses had an acceptable knowledge and attitude toward oxygen administration after applying teaching intervention.

Keywords: Training Program, Oxygen Therapy, Knowledge, Attitude and Nurses

1. Introduction

Nurses those who are responsible for oxygen administration must be aware of oxygen indications and possible hazards as oxygen is so vital to life [1]. Another study about oxygen therapy reported that, OT was started to be used for the treatment of various diseases at the end of the 18th century and nowadays used very frequently for medical treatments. From that point, indications of oxygen therapy are hypoxia, hypoxemia, cardiac and respiratory arrest, hypertension, stroke, low cardiac output, metabolic acidosis

and respiratory distress [2]. As oxygen is administered via different methods and amount, but the optimal amount and method of oxygen delivery varies depending on a patient's underlying medical condition. The selection of the best oxygen delivery device and flow rate of oxygen depends on many factors some of which are the patient's age, the therapeutic goals and patient tolerance [3]. Even though OT is one of the most widely used resuscitation methods, it may harm or cause a patient's status to deteriorate if used inappropriately or unwisely. Pulmonary oxygen toxicity and oxygen induced hypercapnia are considered as two of the

major side effects of OT [4]. A favorable effect that improves survival rates has been reported at OT saturations between 94% and 98% for acutely ill patients; however, lower saturation, 88%–92% should be considered for patients with suspected risk of hypercapnic respiratory failure [5]. The inappropriate administration also leads to increased hospital lengths of stay, higher rates of admission to high dependency units, and an increased risk of death [6]. Similarly in fibrosing alveolitis, there is no retention of CO₂, so high concentration can be given as in these conditions, there is no danger of induction of hypoventilation. Maintaining PaO₂ above 60 mmHg gives O₂ saturation of 90%. Oxygen is also administered in conditions such as cardiac and respiratory arrest, systemic hypotension, low cardiac output, metabolic acidosis and respiratory distress [7].

Based on the above concept adequate knowledge and good attitude is mandatory among the health persons, more the nurses as they are participated bedside patient care over 24 hours.

The concept of knowledge explains oxygen administration to the critical ill patients and related myths. Kavitha and Patil, in their study concluded that, there is a need to update the knowledge of staff nurses, and regular trainings should be integrated into their work schedule [8]. A study in Ethiopia by Girma reported that, attitudes will be illustrated to the extent of accord and outcome expectancies nurses have towards oxygen administration to the critical ill patients, their level of motivation and perceived self-efficacy [9]. According to Bell, nurses need high-quality training to develop and maintain the knowledge and skills needed to provide the level of care that those critical ill patients need, which can be difficult to integrate in to the nurse's daily activities coupled with material resources management, time, responsibility and patient care while maintaining the patients' health care complications of monitoring [10]. Similarly knowledge can be considered as the familiarity of the person with anyone or anything, including information, facts, descriptions, and/or qualifications that a person has acquired through experience or training. However, there is no consensus on the definition of knowledge, and there are many theories about it [11]. On the other hand a pre and post study design by Mostafa, A. H., et al and Wang, T., et al, results showed that, there is a highly significance differences in nurses knowledge and practice mean score between pre and post implementation of teaching program about oxygen therapy [12, 13].

In Eritrea, the study done by Fanuel et al, results concluded that, there was knowledge, attitude and practice gap among nurses who were working in ED and ICU, and at the same time results reported that, lack of oxygen therapy training and guidelines as well as increased workload contributed much to the challenges on oxygen therapy [14]. Additionally from the researchers' previous clinical experience and their observation on the clinical area, there is a poor practice of nurses on oxygen administration for the critically ill patients. In addition to this nurses didn't follow the guideline of oxygenation that incorporates to the

condition of the patient or disease process and use their prior knowledge of oxygen therapy for all cases of critically ill patients. To conclude that supplemental oxygen is a lifesaving treatment in emergency conditions and is commonly used as a therapeutic agent in emergency, ICU and Recovery units at ONRH. So it is important to assess the knowledge, and attitude of nurses on OT in the acute settings of the hospital by intervene structured training based on the standard guideline in order to know the nurses' basic knowledge and to intervene accordingly.

2. Methodology

2.1. Study Design

A type of quasi experimental, namely one group pre-post study design was applied to determine the effect of teaching intervention on knowledge, and attitude about oxygen administration on critically ill patients. Quantitative approach was used to carry out the study from September 2021 to May 2022.

2.2. Study Site

The study was done in Orotta national referral and teaching hospital, at the emergency, ICU and recovery units. The hospital is one of the Eritrea's tertiary hospital that gives health services for referred and self-referred patients from almost all the country. It is with 200 bedded hospital and have with different professional levels. This hospital is the only hospital that have ICU and highly equipped emergency department. In addition to that it has operating room with different specialty and a recovery room that gives care to the post-operative patients. The three units are staffed with nurses that give care for different cases with oxygen and other important nursing care.

2.3. Study Population

All nurses at the study site during the specified period of time constituted the study population. The total number of nurses in three units was 61.

All nurses who involved in the care of critically ill patients in the emergency, ICU and recovery units were included in the study. However, nurses who were not available (n=11) during data collection/training were excluded and those who were willing to participate and attend the training were (n=50) were included.

2.4. Data Collection Tool and Method

The data was collected using a self-administered questionnaire, which is adopted by the researchers from related studies [9, 14] and the guideline for training was adopted from, British Thoracic Surgery [7] additionally it was revised for its application by the field experts. The questionnaire was prepared using close ended questions. The questionnaire was written in English and it included 8 items and 6 institution related supportive items of socio-

demographic characteristics, 20 items regarding the knowledge prepared as multiple choice with only one correct answer and 7 attitude items of participants towards oxygen therapy.

For descriptive purpose, the five Point Likert Scaled questions were re-categorized into three, as disagree/strongly disagree, neutral, agree/strongly agree. Then, nurses who agreed/strongly agreed to the positively coined statements are considered to have a positive attitude and the rest of the category (neutral and disagree/strongly disagree) were considered as having a negative attitude.

2.5. The Intervention of Training Program

Training manual British Thoracic Surgery (BTS) about oxygen administration was adopted from the guideline published by O'Driscoll, B. R. et al, [7] and the lecture materials was prepared by the experts in the field and training was given to study participants. Then the participants were divided into two groups according to the work shifts, each containing 25 nurses. The two educational sessions implemented were:

Session 1

During this two hour preliminary session, the researchers explained the objectives, the content, ways of assessment of the training and the anatomy and physiology of respiratory system to the participants.

Session 2

This two hour session included introducing the definition of oxygen, essentials for oxygen administration, methods of the delivery, oxygen humidification, oxygen complication, Oxygen toxicity signs, oxygen monitoring, nurses role in oxygenation and oxygen toxicity management.

Evaluation phase

The assessment was done by the three times using tools' knowledge & attitude questionnaires before (pretest) and immediately after (posttest) implementation of educational program after three months retention test.

2.6. Data Processing and Statistical Analysis

Data was coded, edited and entered, cleaned for discrepancies, and analyzed using Statistical Package for Social Sciences (SPSS, Version 26) software. Frequency (percentage) was used to label categorical variables, while mean (SD), and median (IQR) was used to summarize the continuous ones, as appropriate. After confirmation of normality, the effect of intervention through time on knowledge and attitude on oxygen therapy was assessed using repeated measures ANOVA. Pair wise comparisons across the different time points was performed and *p*-values less than 0.05 was considered as significant in all analyses.

3. Results

3.1. Demographic Characteristics

From the total population 50 (81.9%) were attended the

training. From that, the average age of the participants was 31.10 (SD=9.53) years with the majority lying in the age group 30 or less (64.0%). Almost half (52%) of the participants were females and most of them were nurse diploma (62%). Majority which is 62.0% were single and the median years of experience was 6.0 (IQR=9). Most of the nurses had five or less years of experience (44.0%) followed by >5 and ≤10 (30%). Almost half of the nurses have an experience in ICU (48.0%), followed by emergency (46.0%), and 16.0% in recovery.

Table 1. Percentage Distribution of the Nurses' Demographic Characteristics.

Variable	Frequency	Percentage
Age (M=31.10, SD=9.53, Min.=20.0, Max.=58.0)		
30 or less	32	64
31 or above	18	36
Sex		
Male	24	48
Female	26	52
Educational level		
Associate nurse	19	38
Nurse diploma	31	62
Marital Status		
Never married	32	64
Ever married	18	36
Total experience Md=6.0, IQR=9, Min.=1.00, Max.=33.00)		
Less or equal 5	22	44
>5 and ≤10	15	30
Greater than 10	13	26
Experience in ICU		
No	26	52
Yes	24	48
Experience in Emergency		
No	27	54
Yes	23	46
Experience in Recovery		
No	42	84
Yes	8	16

M=Mean, Md=Median, SD=Standard deviation, IQR=Interquartile range, Min. =Minimum, Max. =maximum

3.2. Institution Related and Other Relevant Factors

The majority (88.0%) of the nurses were not trained on oxygen therapy and 68% of the nurses reported that there was no guideline of oxygen therapy in the hospital. Only 28% of the participants correctly answered to the question that using too little oxygen in emergency room/ICU may contribute to carbon dioxide retention and the remaining 72% replied incorrectly. Around thirty percent (32.05%) of the nurses reported that there was adequate supply of oxygen in the hospital. Almost sixty percent (62.0%) of the nurses thought that work load has an effect on oxygen therapy in emergency/ICU department and 44% said that there was a payment on oxygen therapy.

Table 2. Percentage Distribution of the Institution Related and Other Relevant Factor Affecting Knowledge.

Variable		Frequency	Percentage
Ever being trained	No	44	88
	Yes	6	12
Presence of guideline	No	34	68
	Yes	7	14
	Don't know	9	18
Contribution of CO ₂ while using oxygen	Correct	14	28
	Incorrect	36	72
Adequacy of oxygen supply	No	27	54
	Yes	16	32
	Don't know	7	14
Work load effect on oxygen therapy	Correct	31	62
	Incorrect	19	38
Payment on oxygen therapy	No	19	38
	Yes	22	44
	Don't know	9	18

3.3. Knowledge of the Participants on Oxygen Therapy

The participants' knowledge regarding oxygen therapy was assessed using 20 questions. The average score on knowledge of the nurses during the pre-intervention period was 45%. The level of knowledge of the nurses at immediate post intervention increased to overall score of 77% and then it declined slightly after three months to 62%.

Administration of oxygen to prevent and treat hypoxia was correctly responded by 76% of the nurses before intervention and increased to 94% at immediate post and 3 months. Similarly, normal oxygen saturation at rest for adults was correctly responded by 54% of the nurses at pre-intervention and increased to 92% and 84% at immediate post intervention and after 3 months, respectively. Factors affecting pulse oximetry monitoring was correctly responded by 56% at pre-intervention and inclined to 92% at immediate post and 80% after 3-months. The percentage distribution of correct responses for all the knowledge questions at the three time points are summarized in Table 3.

Table 3. Percentage Distribution of the Nurses' Knowledge on Oxygen Therapy.

No.	Knowledge	PI n (%)	IP n (%)	3-Mn (%)
1	Administration of oxygen to prevent and treat hypoxia	38 (76.0)	47 (94.0)	47 (94.0)
2	Administration of oxygen to CO poisoning, cardiopulmonary arrest and critical illness	21 (42.0)	38 (76.0)	27 (54.0)
3	Normal oxygen saturation at rest for adults	27 (54.0)	46 (92.0)	42 (84.0)
4	Oxygen therapy is not indicated	29 (58.0)	38 (76.0)	36 (72.0)
5	Definition of ventilation	25 (50.0)	42 (84.0)	38 (76.0)
6	Passive process in respiratory physiology – respiration	12 (24.0)	41 (82.0)	27 (54.0)
7	Low flow method of oxygen administration	29 (58.0)	43 (86.0)	34 (68.0)
8	Method of oxygen administration in acute airway problems like Asthma	10 (20.0)	22 (44.0)	23 (46.0)
9	Method of oxygen administration in acute respiratory distress syndrome	8 (16.0)	24 (48.0)	6 (12.0)
10	The indication for mechanical ventilation	9 (18.0)	28 (56.0)	18 (36.0)
11	Presentation of patient with oxygen toxicity	33 (66.0)	41 (82.0)	34 (68.0)
12	Criteria for discontinuing oxygen for a patient on oxygen therapy	38 (76.0)	45 (90.0)	39 (78.0)
13	Factors affecting pulse oximetry monitoring	28 (56.0)	46 (92.0)	40 (80.0)
14	Reduction of risk of side effects associated with dry gas administration and promote patient comfort	34 (68.0)	45 (90.0)	37 (74.0)
15	Effect of collection of water in the tubing during oxygen administration	27 (54.0)	37 (74.0)	30 (60.0)
16	Optimization of oxygen travel through wet secretions	31 (62.0)	38 (76.0)	35 (70.0)
17	Nasal cannula in adult patient	17 (34.0)	40 (80.0)	20 (40.0)
18	Not appropriate nursing care during oxygen therapy	21 (42.0)	29 (58.0)	22 (44.0)
19	Potential adverse effect of oxygen therapy	28 (56.0)	42 (84.0)	34 (68.0)
20	Advantage and appropriate use of oxygen mask compared with nasal catheter	24 (48.0)	40 (80.0)	34 (68.0)

PI: pre-intervention, IP: Immediate post intervention, 3-Mn: After three month

3.4. Participants Attitude Towards Oxygen Therapy

The average attitude score of the nurses during the pre-intervention period was 71.6%. The average score at the immediate post intervention time increased to 80.2% and after three months to 80.5%. At pre-intervention, 66% of the nurses had a positive attitude towards the statement 'oxygen is a drug that should be given only when ordered', however

the percentage increased to 86% at immediate post-intervention and 94% after 3 months. Similarly, positive attitude was observed among 68% of the nurses at pre-intervention on 'oral and nasal hygiene and normal saline drops should be done when giving oxygen therapy' and increased to 82% at immediate post intervention and 92% after three months. The result of the remaining five attitude items is displayed in Table 4.

Table 4. Percentage Distribution of Nurses' Attitude towards Oxygen Therapy.

No.	Attitude questions	PI n (%)	IP n (%)	3-M n (%)
1	Oxygen is a drug that should be given only when ordered	33 (66.0)	43 (86.0)	47 (94.0)
2	Oral and nasal hygiene and normal saline drops should be done when giving oxygen therapy	34 (68.0)	41 (82.0)	46 (92.0)
3	Continuous oxygen administration is more beneficial than intermittent oxygen therapy	22 (44.0)	22 (44.0)	24 (48.0)
4	Humidification is the best practice to prevent dryness of mucus membrane or upper respiratory tract	41 (82.0)	47 (94.0)	43 (86.0)
5	Persons with severe lung disease need to be maintained at the prescribed oxygen saturation	39 (78.0)	44 (88.0)	48 (96.0)
6	Oxygen is a medicine with safe administration and also very dangerous if not used appropriately	34 (68.0)	46 (92.0)	42 (84.0)
7	A patient on oxygen therapy signposts that the patient is at the end stage of life	31 (62.0)	29 (58.0)	23 (46.0)

PI: pre-intervention, IP: Immediate post intervention, 3-M: After three month

3.5. Effect of Intervention Through Time on Knowledge About Oxygen Therapy

Table 5. Level of Knowledge about Oxygen Therapy and the Effect of Teaching Intervention through Time.

Time Period	N	Mean (SD)	Effect with time
Time 1 (Pre-intervention)	50	9.02 (2.94)	Wilk's $\lambda=0.149$,
Time 2 (Immediate Post)	50	15.44 (2.37)	$F(2,48)=137.37$,
Time 3 (3-month follow-up)	50	12.46 (2.50)	$p<0.001$

SD: Standard deviation

The mean (SD) scores of knowledge on oxygen therapy at time 1 (pre-intervention), Time 2 (immediate post intervention) and Time 3 (3-months retention test) were 9.02 (2.94), 15.44 (2.37), and 12.46 (2.50) out of 20 respectively (Table 5). Mauchly's test indicated that there was an evidence of non-sphericity (Mauchly's $W=0.920$, $p=0.134$). Hence, significant effect for time (Wilks' Lambda=0.149, $F(2, 48) = 137.37$, $p<0.001$), was observed using multivariate ANOVA.

Pairwise comparisons of the knowledge scores at the three time periods were also done using Bonferroni post-hoc test (Table 6). The result displayed that knowledge scores were significantly higher at immediate post intervention than pre-intervention ($p<0.001$), after 3-months, than pre-intervention ($p<0.001$), and immediate post intervention than 3 months later ($p<0.001$). The trend of knowledge scores regarding oxygen therapy was observed to be quadratic across the three time periods ($p<0.001$).

Table 6. Pair-Wise Comparison of Knowledge Scores Vis-à-vis Oxygen Therapy at Pre-Intervention, Immediate Post, And After 3 Months.

Post-hoc Comparison	MD (95% CI)	p-value	p-value (trend)
Immediate Post and pre-intervention	6.42 (5.45, 7.39)	<0.001	<0.001
3-months follow-up and pre-intervention	3.44 (2.26, 4.62)	<0.001	Quadratic
Immediate Post and 3-months follow-up	2.98 (2.02, 3.94)	<0.001	

MD: Mean difference, CI: Confidence interval

3.6. Outcome of Intervention Through Time on Attitude Towards Oxygen Therapy

The mean (SD) scores of attitude towards oxygen therapy at time 1 (pre-intervention), Time 2 (immediate post) and Time 3 (after three month) were 25.08 (3.79), 28.08 (2.71),

and 28.20 (3.31) out of 35 respectively (Table 7). Mauchly's test indicated that there was an evidence of non-sphericity (Mauchly's $W=0.953$, $p=0.319$). Multivariate ANOVA showed significant effect for time (Wilks' Lambda=0.602, $F(2, 48) = 15.87$, $p<0.001$).

Table 7. Level of Attitude about Oxygen Therapy and the Effect of Teaching Intervention through Time.

Time Period	N	Mean (SD)	Effect with time
Time 1 (Pre-intervention)	50	25.08 (3.79)	Wilk's $\lambda=0.602$,
Time 2 (Immediate Post)	50	28.08 (2.71)	$F(2,48)=15.87$,
Time 3 (3-month follow-up)	50	28.20 (3.31)	$p<0.001$

SD: Standard deviation

Table 8 displays the pairwise comparison of attitude scores about oxygen therapy. Bonferroni post-hoc test showed that attitude scores was significantly higher at immediate post intervention than pre-intervention ($p<0.001$), after 3 months than pre-intervention ($p<0.001$). However, no significant

difference in attitude scores was found between 3 months and immediate post intervention ($p=1.000$). The trend of attitude towards oxygen therapy was seen to be quadratic through the three time periods ($p<0.001$).

Table 8. Pair-Wise Comparison of Attitude Scores Regarding Oxygen Therapy at Pre-Intervention, Immediate Post, After 3- Months.

Post-hoc Comparison	MD (95% CI)	p-value	p-value (trend)
Immediate Post and pre-intervention	3.00 (1.59, 4.41)	<0.001	<0.001
3-months follow-up and pre-intervention	3.12 (1.57, 4.67)	<0.001	Quadratic
Immediate Post and 3-months follow-up	-0.12 (-1.40, 1.16)	1.000	

MD: Mean difference, CI: Confidence interval

3.7. Effectiveness of Teaching Intervention on Knowledge About Oxygen Therapy

Analysis of variance was done using mixed between-within participants to assess the effect of teaching intervention on the scores of knowledge about oxygen therapy across the three time periods by age, sex, educational level, marital status, total years of experience, and training

(Table 9). The result revealed no significant interaction between age group and time (Wilk's Lambda=0.983, $p=0.675$), educational level (Wilk's Lambda=0.889, $p=0.063$), marital status (Wilk's Lambda=0.968, $p=0.460$), total years of experience (Wilk's Lambda=0.942, $p=0.597$) and training (Wilk's Lambda=0.933, $p=0.195$). Nevertheless, there was significant interaction between sex and time (Wilk's Lambda=0.950, $p=0.012$).

Table 9. Effectiveness of Teaching Intervention on Knowledge of Oxygen Therapy by Background Characteristic.

Characteristics		PI M (SD)	IP M (SD)	3-M M (SD)	Box M	Wilk's Lambda	p-value
Age	30 or less	9.25 (2.75)	15.63 (15.11)	12.91 (2.15)	0.353	0.983	0.675
	31 and above	8.61 (3.29)	15.11 (2.14)	11.67 (2.93)			
Sex	Male	10.92 (2.10)	16.25 (1.78)	13.08 (2.10)	0.141	0.95	0.012*
	Female	7.27 (2.49)	14.69 (2.63)	11.88 (2.73)			
Educational level	Associate nurse	7.05 (2.91)	14.58 (3.13)	11.68 (2.47)	0.04	0.889	0.063
	Diploma nurse	10.23 (2.25)	15.97 (1.60)	12.94 (2.43)			
Marital Status	Never married	9.16 (2.68)	15.72 (2.34)	13.03 (2.07)	0.191	0.968	0.46
	Ever married	8.78 (3.42)	14.94 (2.41)	11.44 (2.91)			
Years of experience	Less or equal 5	9.05 (2.42)	15.68 (2.38)	12.77 (1.95)	0.146	0.942	0.597
	>5 and ≤10	9.73 (3.03)	15.40 (2.53)	13.00 (2.51)			
	Greater than 10	8.15 (3.58)	15.08 (2.33)	12.46 (2.50)			
Training	Yes	8.50 (3.02)	15.83 (1.33)	11.00 (2.10)	0.199	0.933	0.195
	No	9.09 (2.96)	15.39 (2.49)	12.66 (2.51)			

PI: pre-intervention, IP: Immediate post intervention, 3-M: After three month

3.8. Effectiveness of Teaching Intervention on Attitude

Analysis of variance was done using mixed between-within participants to assess the effect of teaching intervention on the scores of attitude about oxygen therapy across the three time periods by age, sex, educational level, marital status, total years of experience, and training (Table

10). The result shown no significant interaction between age group and time (Wilk's Lambda=0.972, $p=0.511$), sex (Wilk's Lambda=0.973, $p=0.524$), educational level (Wilk's Lambda=0.960, $p=0.388$), marital status (Wilk's Lambda=0.971, $p=0.507$), total years of experience (Wilk's Lambda=0.966, $p=0.803$) and training (Wilk's Lambda=0.995, $p=0.887$).

Table 10. Effectiveness of Teaching Intervention on Attitude of Oxygen Therapy by Background Characteristics.

Characteristics		PI M (SD)	IP M (SD)	3-M M (SD)	Box M	Wilk's Lambda	p-value
Age	30 or less	25.16 (3.82)	28.38 (2.60)	28.81 (3.41)	0.72	0.972	0.511
	31 or above	24.94 (3.84)	27.56 (2.89)	27.11 (2.91)			
Sex	Male	25.96 (3.18)	28.29 (2.29)	28.75 (2.88)	0.14	0.973	0.524
	Female	24.27 (4.17)	27.88 (3.08)	27.69 (3.65)			
Educational level	Associate nurse	24.00 (4.20)	27.47 (2.82)	28.21 (3.65)	0.416	0.96	0.388
	Diploma nurse	25.74 (3.42)	28.45 (2.62)	28.19 (3.16)			
Marital Status							

Characteristics	PI	IP	3-M	Box M	Wilk's Lambda	p-value
	M (SD)	M (SD)	M (SD)			
Years of experience	Never married	24.91 (3.64)	28.31 (2.79)	0.891	0.971	0.507
	Ever married	25.39 (4.13)	27.67 (2.59)			
Years of experience	Less or equal 5	24.91 (3.93)	28.00 (2.76)	0.869	0.966	0.803
	>5 and ≤10	25.67 (3.35)	28.93 (2.40)			
	Greater than 10	24.69 (4.23)	27.23 (2.86)			
Training	Yes	25.17 (2.48)	27.50 (3.27)	0.914	0.995	0.887
	No	25.07 (3.96)	28.16 (2.66)			

PI: pre-intervention, IP: Immediate post intervention, 3-M: After three month

4. Discussion

4.1. Discussion on Demographic Characters

In the current study results revealed that, the study participants were almost equal in number of females and males, and majority of the nurses were diploma holders. This because in Orotta National Referral Hospital most nurses who are assigned are diploma holders and regarding sex, in the training college the sex preference to the nursing profession is almost equal. When we come to the study participants' age group majority of them are 30 years or less. This might be, in those units naturally requires labored work to comply with the units' workload, and also the more experienced aged nurses are assigned to light work. However, in the study done by Mostafa, A. H. et al, the average age was 40 years [12]. In the current study the results revealed that, Most were single and had five or less years of work experience in the study sites. This might be most of the experienced nurses were sent for higher education and it might had high turnover nurses. On the other hand most of the participants experience was in Emergency and ICU units than the recovery. This because the nurses working in the recovery room is less in number than the other as the nature work is less demanding and the room is too small.

From the current study results, regarding previous training program, participants did not attend any previous training, the main reason for this may be due to hospital or the units have not regular staff development program related to O₂ administration. Concurrent with this current study, a study done by Chen, Y. et al, reported that, none of its participants attended training courses on oxygen therapy [15].

On the other way in this study, most of the nurses reported that there was no guideline of oxygen therapy in the units. This might be either they are true there is no guideline or the departments may not display it to be accessible by the nurses. Using too little oxygen in emergency room/ICU or recovery may contribute to carbon dioxide retention was correctly answered by only less number of the nurses, this is might be because there was lack of training or unavailability of guideline. In the current study most of the nurses thought that increased work load hinders proper oxygen therapy in emergency/ICU and recovery units. So this load could contribute to the lack of proper follow-up of the patients who are already attached to oxygen. This is similar the study done

in 2019 by Fanuel et al, [14] in the same study site, results showed that, there was lack of oxygen therapy training and guidelines as well as increased workload contributed to the challenges on oxygen therapy.

4.2. Effect of Teaching on the Nurses' Knowledge

In the current study the result revealed that knowledge scores were significantly higher at immediate post intervention than pre-intervention, after 3-months than pre-intervention, and immediate post intervention than 3 months later. The trend of knowledge scores about oxygen therapy was observed to increase at immediate post, but later on it declined after 3 months. The current study is supported by previous study done in Eritrea by Fanuel et al, results concluded that, there was knowledge gap among nurses [14], but that study was crosssectional that cannot identify the cause and effect, so it only assessed the pre-intervention knowledge level of the nurses. This is also in line with study done by Mostafa, A. H. et al, and Wang, T., the study result shown that, there were significant improvement in the knowledge of the participants with intervention of teaching program [12, 13]. Results from Kavitha, K., & Ninaganagouda, G. P. and Considine, J., & Botti, M. reported that, educational program has positive effect, per se which reflect their need for educational program related to O₂ therapy [8, 16]. Low level of nurses' knowledge before implementation of teaching program might be attributed to the fact that this part not included in nursing curricula. These results were in line with Markocic, S. et al who mentioned the nurses must be educated about management and specific needs of patients receiving oxygen to improve their skill and prevent expected complications (oxygen toxicity) [17]. In addition to Aloushan, A. concluded that, nurses need further education about the risk of administering O₂ therapy to patients [18]. Similarly Urden, D. et al mentioned that nurses' knowledge toward oxygen therapy was moderate and they recommended the need for in-service educational programs to develop nurses' knowledge and practice [19]. Likewise Hagos, K. et al revealed that, there was a high level of awareness towards O₂ therapy among medical students, but there was a poor level of general knowledge about O₂ therapy and toxicity [20].

On the other hand in the current study the effect of the teaching intervention on the scores of knowledge about oxygen therapy across three time periods by age, sex, educational level, marital status, total years of experience,

and training result revealed that, no significant interaction between all the backgrounds. This is different as compared to the study done by Mostafa, A. H. et al that illustrates there was significant relation between total nurses' knowledge mean score and level of education after implementation of teaching program but similarly there was no significant relation between nurses' knowledge, years of experience, sex and age at pre and post implementation of educational program [12]. However, in the current study a significant interaction was found between sex and time of training. This may be as the females are more engaged in household activities and family responsibility. So they may not get time to read and concentrate on the training. Generally in the current study the knowledge performance towards oxygen administration was significantly improved from the pre-intervention to the immediate post-intervention.

4.3. Effect of Teaching on the Nurses' Attitude

In the current study the attitude scores was significantly higher at immediate post intervention than pre-intervention and after 3 months of intervention than pre-intervention. Result indicate that there was an evidence of significant effect through time. Similar to this, a study done by Theresa Dede Tisei reported that, about half of the nurses were with poor attitude towards oxygen therapy [21], but that study was cross-sectional study that cannot tell us the cause and effect.

In the current study educational intervention on the scores of attitude on oxygen therapy across three time periods by age, sex, educational level, marital status, total years of experience, and training revealed that, no significant interaction between age group, time, sex, educational level, marital status, total years of experience and training. The current study is supported by the study done in Eritrea in Orotta ICU and emergency by Fanuel et al, results concluded that, there was attitude gap among nurses who were working in ED and ICU [14]. This is also congruent to the study done by Grim, C. et al, results concluded that self-reported attitudes has changed considerably in the period after a stepwise implementation of conservative oxygenation targets in critically ill patients [22]. Finally in the current study there was significant change in attitude from pre-intervention to immediate post-intervention and retention. As knowledge change over training time same is true with attitude. This may be if the nurses knowledge is improved after intervention then it is expected the behavior of the nurses to be enhanced.

5. Conclusion

Grounded on the results of the current study, it can be concluded that: most of the participants had a reasonable knowledge and attitude toward oxygen administration after applying teaching program. There was statistical significant difference between total nurses' knowledge and attitude towards oxygen therapy in different three time period after educational training was applied. But no significant interaction was found between the time of education and

knowledge and attitude of the back ground of the nurses. So from this the researchers recommend that, there must be a regular and non-interrupted training schedule for nurses, in order to give time based patient care.

Acronyms

BTS: British Thoracic Society
 ECCN: Emergency and Critical Care Nursing
 ED: Emergency Department
 ICU: Intensive Care Unit
 MOH: Ministry Of Health
 ONRH: Orotta National Referral Hospital

Availability of Data and Materials

Data and materials are available by the principal authors on sensible request.

Contributions

All authors had substantial roles in scheming, conceiving, and conducting the study and preparing the manuscript. HK, AB, and YT contributed to designing the study. AB, WT and YT collected the data, and analyzed by EH were the supervisor of the whole research and checked the data, SA also participated on the preparing the manuscript. The final report and research paper were written by HK and EH. All authors read and approved the final manuscript.

Ethical Approval and Consent to Participate

Permission for conducting the study was initially obtained from the ethical committee of Orotta College of Medicine and Health Sciences, and Ministry of Health at the department of research and human resource development. Further permission was obtained from the study sites prior to carrying out the study. Verbal and written informed consent was also obtained from the participants before conducting the study.

Consent for Publication

The article does not contain any individual's details and consent for publication is not applicable.

Competing Interests

The authors declare that they have no competing interests.

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