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Original Research Article

A study to assess the effectiveness of educational training for nurses regarding non-invasive positive pressure ventilation

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ABSTRACT

Background: The use of non-invasive positive pressure ventilation (NIPPV) has significantly increased in the last three decades, becoming an essential, cost-effective tool for managing respiratory failure. The study aimed to evaluate the impact of an educational training program in improving nurses' knowledge and attitude towards non-invasive positive pressure ventilation (NIPPV) therapy.
Methods: A quasi-experimental study with single group pre and post intervention conducted from 01 May 2023 to 30 June 2023 with 42 nurses, working at respiratory unit selected through enumerative sampling technique. The educational program followed the recommendation proposed by NIPPV guidelines and included six hours of theoretical and hands on training sessions. Nurses' knowledge and attitude were assessed using a questionnaire developed by the researcher. Administrative approval was obtained from the authority and informed consent taken from all the participants.
Results: Study findings reveals that there was substantial improvement in the pre and post training overall knowledge scores of nurses regarding different aspects of NIPPV therapy (15.31±3.28-26.93±1.69, with mean difference 11.62±3.56, 95% CI- 10.51-12.73, t- 21.15 $p<0.001$ respectively). In terms of attitude, the proportion of participants with positive attitudes increased from 0% pre-training to 100% ($p<0.001$) post-training.
Conclusions: The educational program has proven to be a valuable asset to the nursing team in the respiratory unit. It has enhanced evidence-based practices and the quality of care, resulting in improved effectiveness, timeliness, and safety. The study findings confirm that the program effectively enriches nurses' knowledge and attitudes.

Keywords: Attitude, Educational training, Knowledge, Non-invasive positive pressure ventilation, Nurses

INTRODUCTION

Non-invasive positive pressure ventilation (NIPPV) involves the delivery of oxygen into the lungs via positive pressure through an external facemask, generally used to avoid endotracheal intubation in patients with respiratory distress.[1] Non-invasive positive pressure ventilation (NIPPV) has emerged as a preferred therapeutic intervention for respiratory disorders due to its safety, efficiency, and cost-effectiveness compared to traditional methods which offers multiple benefits, including reducing risks, infections, and length of hospital stay, as well as diminishing the need for sedation.[3-5]

Over the past three decades, there has been an evident increase in the use of non-invasive ventilation for the management of both acute and chronic respiratory failure, initial treatment of exacerbations of chronic obstructive pulmonary disease (COPD) with hypercapnia and acute pulmonary edema from congestive heart failure.[6,7]

Non-invasive ventilation (NIV) is widely utilized in European and other developed nations. The European

Respiratory Society delivers comprehensive training in NIV, covering both fundamental and advanced aspects.[8] Notably, the European Respiratory Society's "harmonized education in respiratory medicine for European specialists" project stands as a significant endeavour. In contrast, while the utilization of NIV in clinical practice is commonplace in India, structured educational programs for NIV in developing nations, such as India, remain scarce.[9]

British Thoracic Society guidelines (2017) recommended that all personnel involved in the NIV service receive training which incorporate a mix of knowledge-based learning supported by hands-on training. Acute NIV patient care is only successful if the treatment is adequately provided through a multidisciplinary team approach. To provide a good standard of care it is essential that all staff are trained in both knowledge and practical skills corresponding to their role.[10]

Achieving patient-ventilator interaction is the most important step to obtain successful results in NIV. In addition to choosing an appropriate mask, the location of NIV application according to the patient's need, the characteristics of the mask to be used, the mode and settings of the selected mechanical ventilator, experienced and well-equipped team members are also important to the management of the ventilation process.[11]

As nurses continuously provide close patient care, they play a pivotal role in the identification of deteriorating patients, requiring either optimization of NIV related factors or direct for escalation of care through endotracheal intubation and invasive mechanical ventilation.[11,12] Nursing care can improve patient compliance and monitor improvements, but success of NIV is drastically reduced if insufficient associated knowledge and experience exist.[13]

Specifically, literature emphasized that nurses must possess strong knowledge of NIV due to its increasing use in various clinical settings and needed to stay up to date on current standards, build trusting relationships with patients through their presence and positive attitude; and provide competent, continuous nursing care to improve the feeling of safety among NIV patients. The absence of this understanding can significantly impact the care quality and safety for individuals undergoing NIV.[14]

Education and training in NIPPV have the potential to increase knowledge and skills of the staff. In this regard, an educational program is paramount.[15] The nurses acknowledged that continuous education is necessary and that they were unaware of their own training needs. In-service training and formal education programs should address nurses' perceived lack of knowledge and abilities in weaning patients off from ventilation.[16]

Training is key to the successful implementation of NIV, along with formal competency assessments and available simulations for clinical staff to utilize. Due to the need for close monitoring, these patients should be in units with a low nurse-to-patient ratio, such as ICUs. Nursing staff should also receive regular education regarding caring for NIV patients, and providers should be provided with best practice guidelines.[17]

A study conducted by Jackson et al in 2022, a three-day educational intervention was implemented, involving 36 healthcare professionals, of which eight were nurses.[18] This intervention utilized team-based learning exercises and simulation scenarios. The professionals evaluated their confidence levels in administering care to individuals requiring non-invasive ventilation (NIV) before and after the intervention. The evaluation encompassed diverse typologies/modes, general and exceptional indications, and practical applications. The authors observed a statistically significant increase in overall scores between the pre- and post-intervention periods (24.6% versus 64.22%; $p<0.001$).

Terhan conducted a study on 147 nurses employed at a training and research hospital in Istanbul has indicated that the successful administration of non-invasive ventilation (NIV) necessitates the expertise of well-trained nurses. Furthermore, the study recommends the implementation of a comprehensive training program encompassing both theoretical knowledge and practical clinical experience for these nurses.[11]

Finding from literature serve as a supporting reason for recognizing the importance of educating nurses on NIV therapy. The best approach to improve knowledge and attitudes towards the NIV therapy is through educational interventions. Providing accurate knowledge, imparting proper skills, cultivating positive attitude, and rectifying irregularities in providing NIV therapy are all necessary steps to improve patient care.[19] In a systematic literature review, authors reported that the main barriers to evidence-based practice among nurses in NIV related to insufficient training, impaired communication within the team, and a lack of knowledge and adherence to guidelines.[20]

Literature source shows that knowledge of nurses regarding NIV therapy is not satisfactory. Several previous studies measured the knowledge of nursing staff towards NIV therapy. However, there are very few studies conducted from low middle income group countries like India on the effectiveness of educational program on improving the knowledge and attitude of nurses towards NIPPV therapy.

In consideration of the challenge at hand, we have developed and implemented an educational training program for the nursing team of respiratory unit by utilizing a theoretical and hands-on sessions approach which aligns with the latest international recommendations in this field.[21]

Hence the present study was conducted to assess the effectiveness of educational program in improving the

knowledge and attitude regarding NIV therapy among nurses working in Respiratory unit.

Objectives

To assess the level of knowledge and attitude concerning the care of patients undergoing NIPPV therapy among nursing personnel both before and after the implementation of a training program. To determine the association between the pre and post-test knowledge and attitude scores with the selected demographic variables of nursing personnel before and after the training program. To analyze the correlation between the pre and post-test knowledge and attitude scores of nursing personnels before and after the training program

Hypothesis

H_1: There will be significant difference between the pre-test and post-test level of knowledge and attitude scores among nursing personnel before and after the training program.

H_2: There will be significant association between the level of knowledge and attitude regarding care of patients receiving NIV therapy among nursing personnels with their selected demographic variables.

METHODS

Research design, setting and participants

The study employs a single-group quasi-experimental research design, incorporating pre- and post-intervention assessments conducted from May 1, 2023, to July 30, 2023, at a tertiary-level hospital in New Delhi, India. Using an enumerative sampling method, 42 nurses were recruited from the department of pulmonary, critical care, and sleep medicine at VMMC and Safdarjung Hospital, New Delhi. The inclusion criteria for participants required that nurse's consent to participate, provide direct patient care, and be available at the time of data collection. In contrast, the exclusion criteria encompassed nurses who were unwilling to participate, were not involved in direct patient care, or were on leave during the data collection period.

Research tool

We developed the tool based on the literature review from the original articles, review articles, guidelines from several data base (Pub-med, Cochrane Library, EMBASE, Google Scholar, CINAHL, published research), discussion with the practicing nurses in the respiratory care units. The information from the database was retrieved by using keywords. The tool comprised of four sections.

Section 1: demographic variables of 7 items: age, gender, designation, professional nursing qualification, total years of experience in nursing, total years of experience in respiratory care unit, and any type of training attended on NIV therapy.

Section 2: structured knowledge multiple-choice questionnaire (30 items). Participants provided responses to these items by selecting the correct option, with a correct response being assigned 1 point and an incorrect response receiving 0 points. The total score ranged from 0 to 30.

Section 3: consists of 10 attitude statements measured on a 5-point Likert scale which encompass both positive and negative statements, with responses ranging from strongly agree (score 5) to strongly disagree (score 1). Reverse scoring was applied to the negative statements. The maximum total attitude score ranged from 10 to 50.

Interpretation of knowledge scores were categorized according to Bloom scoring criteria: adequate knowledge: 80-100%; moderately adequate: 60-79%; inadequate knowledge: <59%.

Interpretation of attitude scores were categorised as: positive attitude: 80-100%; neutral attitude: 60-79%; negative attitude: <59%

Section 4: the structured teaching program was meticulously developed by the researcher incorporating recommendation from experts, collaborative discussions with colleague, personal clinical experience, and comprehensive review of literature. The program covers the basics of non-invasive ventilation therapy including indications, contraindications, selection criteria, application methods, advantages, disadvantages, ventilatory parameters, ventilatory modes, necessary equipment, interface selection, nursing care, monitoring, maintenance, complications (e.g., interface, pressure, and flow), success factors and troubleshooting management in NIV.

The content validity of the tools was ensured by submitting the tool to five nursing experts, three medical expert and one statistician and had more than 95% agreement of the contents. The content validity index score was found 0.97.

Reliability of the tool was calculated by using Cronbach alpha at α=0.82; indicated towards a good internal consistency.

After obtaining administrative approval from the hospital authority, data was collected. The researchers individually engaged with the participants, explained the purpose of the study and obtained written informed consent from them. All the nurses who consented to participate were recruited in the study. Knowledge and attitude of the participants were assessed using structured knowledge questionnaire and five-point Likert scale on day-1 prior to commencement of educational training. The structured teaching program on NIV was conducted on 01 June 2023, with comprehensive two hours sessions by using PowerPoint presentation followed by two hours hands on

training sessions. We employed variety of teaching methods including lectures complemented by discussion, case scenario, followed by hands on training sessions covering filter selection and placement, interface selection, ventilator interface setup, proper interface sizing by using sizing gauze chart, personalized interface fitting, skin assessment in pressure areas, and strategies for pressure sores prevention. Subsequently a post-test was conducted on day-7 by administering same set of structured knowledge and attitude questionnaire.

Data analysis

The collected data were analysed using the SPSS for Windows, Release ver. 27.0, and Microsoft Office Excel 365. Descriptive and inferential statistics were employed for the analysis. The normality of data distribution was assessed through the Normal Q-Q Plot and the Shapiro-Wilk test, confirming that the data followed a normal distribution. Fisher Exact Test, paired t-test, McNemar test, and Wilcoxon sign rank test were employed to assess the effectiveness of the intervention. Additionally, the independent t-test was used to examine associations between groups concerning selected demographic variables. Furthermore, Pearson Correlation coefficient was computed to determine the corelation among participants knowledge and attitude regarding NIV therapy before the Training. The results were in the 95% CI, and significance was evaluated as $p<0.05$.

RESULTS

Of the 42 participants, majority were females (54.8%) aged 25-35 years (64.3%), with a mean age of 34.90±8.78. Nursing Officers comprised the largest group (73.8%), and 76.2% had a graduate degree. Their total nursing experience was 10.55±7.43 years, with 61.9% possessing up to 10 years. On average participants had 6.00±2.89 years of experience in the respiratory care unit. Notably, none had received any training on non-invasive ventilation therapy.

Table 1: Distribution of participants according to their demographic characteristics (n=42).

Demographic characteristics	f	%
Age (in years) (mean±SD = 34.90±8.78; Range =25-54)		
25-35	27	64.3
More than 35	15	35.7
Gender		
Male	19	45.2
Female	23	54.8
Designation		
Nursing officer	31	73.8
Sr. nursing officer	11	26.2
Professional nursing qualification		
Diploma	10	23.8
Graduate and postgraduate	32	76.2
Total nursing experience (in years) (mean±SD = 10.55±7.43; range =02-30)		
Up to 10	26	61.9
More than 10	16	38.1
Experience in respiratory care unit (in years) [mean ±SD = 6.00 ± 2.89; Range = 01 – 12]		
Up to 5	24	57.1
More than 5	18	42.9
Training attended regarding NIV therapy		
Yes	00	0.0
No	42	100.0

Table 2 depicts that pre training, majority of nurses (85.7%) had inadequate knowledge, following the training this figure decreased significantly to 0% reflecting substantial improvement. Furthermore, none of the participants exhibited adequate knowledge prior to training, whereas post-training, 92.9% attained this level. In terms of attitude, 92.9% of participants held negative attitudes before the training, a percentage that decreased to 0% post-training. Conversely, the percentage of participants with positive attitudes increased from 0% before the training to 100% after the training.

Table 3 shows substantial improvement in the pre and post training overall knowledge scores of nurses (15.31±3.28, 26.93±1.69, with a mean difference 11.62±3.56, 95% CI-10.51-12.73, t- 21.15 p=0.001 respectively).

Table 4 depicts notable improvement in knowledge post-training, as reflected by the statistically significant p-

values for several items. For instance, participants exhibited a significant increase in their understanding of NIV basics, primary nursing responsibilities before obtaining an arterial blood gas (ABG) sample, early onset hypoxemia identification, the most appropriate interface for acute respiratory failure, and various aspects related to mask fitting and care. Table 5 illustrates that prior to training, majority of participants (92.9%) exhibited a negative attitude towards NIV therapy as indicated by a mean score of 29.12±2.67, with none holding a positive attitude. After the training, a marked shift occurred, with all participants (100%) now expressing a positive attitude, reflected with mean score of 43.71±1.19, and none had negative or neutral stance. The Attitude score displayed a substantial mean difference of 14.59 (95% CI: 13.77-15.42, p value <0.001).

Table 2: Effectiveness of training program on level of knowledge and attitude towards NIV therapy analysis using Fisher exact test (n=42).

	Before the training	After the training	Fisher exact test	
	f (%)	f (%)	Value	P value
Level of knowledge†				
Inadequate	36 (85.7)	00 (00.0)	96.782	<0.001*
Moderately adequate	06 (14.3)	03 (07.1)		
Adequate	00 (00.0)	39 (92.9)		
Attitude$^{\Psi}$				
Negative	39 (92.9)	00 (00.0)	106.58	<0.001*
Neutral	03 (07.1)	00 (00.0)		
Positive	00 (00.0)	42 (100.0)		

†- Scores were categorized using Bloom's cut-off points as 80-100% (adequate), 60-79% (moderately adequate), and ≤59% (inadequate). Ψ- Scores were categorized using Bloom's cut-off points as 80-100% (positive), 60-79% (neutral), and ≤59% (negative).
*- Significant at p≤0.005.

Table 3: Effectiveness of training program on non-invasive ventilation: pre- and post-training level of knowledge in different aspects of NIV (n=42).

Aspects of NIV therapy	Max score	Before the training	After the training	Mean difference		Paired t-test statistics	
		Mean±SD	Mean±SD	Mean±SD	95% CI (LL-UL)	t-score (df=41)	P value
Basics of non-invasive ventilation	8	4.17±1.64	7.1±1.05	2.93±1.93	2.33-3.53	9.83	<0.001*
Interface selection and application strategies	7	4.07±1.20	6.38±0.66	2.31±1.33	1.89-2.73	11.22	<0.001*
Patient monitoring and identification of critical events	5	1.69±0.90	4.43±0.67	2.74±1.19	2.37-3.11	14.90	<0.001*
Assessment and prioritized nursing care for patients undergoing NIV	10	5.38±1.53	9.02±1.05	3.64±1.85	3.07-4.22	12.79	<0.001*
Over all knowledge score	30	15.31±3.28	26.93±1.69	11.62±3.56	10.51-12.73	21.15	<0.001*

*-Significant at p≤0.005

Table 4: Item-wise distribution of participants' responses to knowledge questions regarding NIV therapy (n=42).

Question (abbreviated)**	Before training	After training	P value$^{\Psi}$
	N (%)	N (%)	
Non-invasive positive pressure ventilation basics	06 (14.3)	42 (100.0)	<0.001*
Primary nursing responsibilities before obtaining ABG sample	28 (66.7)	40 (95.2)	0.004*
Identification of respiratory acidosis	32 (76.2)	39 (92.9)	0.092
Early onset hypoxemia identification	26 (61.9)	38 (90.5)	0.004*
Most appropriate interface for acute respiratory failure	07 (16.7)	34 (81.0)	<0.001*
Understanding the functioning of CPAP	16 (38.1)	32 (76.2)	0.001*
Familiarity with the term EPAP	35 (83.3)	38 (90.5)	0.549
Function of EPAP	22 (52.4)	39 (92.9)	<0.001*

Continued.

Question (abbreviated)**	Before training N (%)	After training N (%)	P value$^{\Psi}$
Understanding the function of inspiratory pressure	24 (57.1)	39 (92.9)	<0.001*
Ensuring mask fitness with the two-finger rule	14 (33.3)	39 (92.9)	<0.001*
Identifying snug fitting of nasal mask	14 (33.3)	37 (88.1)	<0.001*
Chemical disinfection of NIV mask and circuit	24 (57.1)	38 (90.5)	0.001*
Methods to preserve skin integrity in patients with NIV mask	16 (38.1)	37 (88.1)	<0.001*
Potential risks of overtightening mask straps	35 (83.3)	40 (95.2)	0.180
Reasons for low-pressure alarm	11 (26.2)	35 (83.3)	<0.001*
Best nursing strategies for nasal congestion with nasal mask use	19 (45.2)	35 (83.3)	<0.001*
Landmarks for oronasal mask fitting	32 (76.2)	39 (92.9)	0.065
Best nursing practices to help patients adjust to NIV	28 (66.7)	42 (100.0)	<0.001*
Identifying factors leading to niv success	30 (71.4)	41 (97.6)	0.003*
Reasons for high-pressure alarm	16 (38.1)	40 (95.2)	<0.001*
Maintaining patient position during NIV therapy	34 (81.0)	40 (95.2)	0.109
Identifying immediate reportable conditions in patients receiving NIV therapy	11 (26.2)	38 (90.5)	<0.001*
Frequency of maintaining oral hygiene for NIV patients	15 (35.7)	37 (88.1)	<0.001*
Frequency of providing eye care for NIV patients	04 (09.5)	33 (78.6)	<0.001*
Absolute contraindications of NIV	03 (07.1)	32 (76.2)	<0.001*
Physiologic effects of peep	12 (28.6)	37 (88.1)	<0.001*
Oxygen therapy requirements with CPAP/BPAP	25 (59.5)	31 (73.8)	0.238
Function of foam bridges attached to the end of NIV mask	37 (88.1)	40 (95.2)	0.453
Function of exhalation port in NIV mask	32 (76.2)	39 (92.9)	0.065
Pressure delivery levels with BPAP and CPAP	35 (83.3)	40 (95.2)	0.125

*-Significant at p≤0.005; $^{\Psi}$ - McNemar test; and ** - Each question contains one correct expression.

Table 5: Effectiveness of training program on non-invasive ventilation: pre- and post-training attitude score towards NIV therapy (n=42).

Group	Attitude score	Mean difference		Paired t-test statistics	
	Mean±SD	Mean±SD	95% CI (LL-UL)	Value	P value
Before the training	29.12±2.67	14.59±2.65	13.77-15.42	35.681	<0.001*
After the training	43.71±1.19				

*-Significant at p≤0.005

Table 6: Distribution of item wise participants responses towards attitude regarding NIV therapy (n=42).

Attitude statements**	Before the training Mean±SD	After the training Mean±SD	P value$^{\Psi}$
Nurses play a pivotal role in providing care to patients undergoing NIV therapy	2.90±1.19	4.86 ± 0.35	<0.001*
I recognize the psychological and physical discomfort experienced by patients undergoing NIV therapy	2.69±0.75	4.52±0.51	<0.001*
The selection and sizing of the interface are critical determinants of the success of NIV therapy	2.31±0.72	4.36±0.49	<0.001*
Prior to initiating NIV, providing a clear explanation to the patient contributes to improved adherence and compliance with the therapy	2.88±0.67	4.74±0.45	<0.001*
Performing chemical disinfection of NIV equipment after use is essential to prevent cross-contamination	3.00±0.88	4.64±0.49	<0.001*
I routinely assess device-related pressure injuries in all patients undergoing NIV therapy	2.88±0.63	4.64±0.49	<0.001*
The presence of written nursing care protocols/guidelines in the unit would enhance nursing care practices related to NIV therapy	3.50±0.67	4.79±0.42	<0.001*
I offer education to patients/caregivers regarding compliance with BIPAP/CPAP therapy before discharging the patient from the hospital	2.86±0.72	4.52±0.51	<0.001*

Continued.

Attitude statements**	Before the training Mean±SD	After the training Mean±SD	P value[Ψ]
I am motivated to enhance my skills and knowledge when managing a patient undergoing NIV therapy	3.43±0.70	1.67±0.48	<0.001*
I acknowledge that NIV training has the potential to improve nurses' knowledge and attitudes, thereby advancing nursing care practices and improving patient outcomes	2.67±0.87	4.98±0.15	<0.001*

[Ψ]- Wilcoxon sign rank test. *-Significant at p≤0.05. **- Each statement contains min=1 and max=5 points.

Table 7: Correlation among participants knowledge and attitude regarding NIV therapy before the training (n=42).

Variables	Mean±SD	Pearson correlation coefficient	P value
Knowledge	15.31±3.28	0.182	0.248
Attitude	29.12±2.67		

Table 8: The association of sociodemographic variables with pre training knowledge and attitude scores in non-invasive ventilation (n=42).

Sociodemographic variables	Knowledge score				Attitude score			
	Mean±SD	t-score[$]	P value	95% CI (LL-UL)	Mean±SD	t-score[$]	P value	95% CI (LL-UL)
Age (in years)								
≤35	16.26±3.24	2.705	0.010*	0.67-4.65	29.33±2.90	0.693	0.492	-1.15-2.35
>35	13.60±2.67				28.73±2.25			
Gender								
Male	15.95±3.55	1.150	0.257	-0.88-3.21	29.79±2.84	1.501	0.141	-0.42-2.87
Female	14.78±3.01				28.57±2.45			
Professional qualification								
Diploma	13.10±4.28	-2.608	0.013*	-5.15--0.65	28.70±3.06	-0.564	0.576	-2.52-1.42
Graduate and postgraduate	16.00±2.62				29.25±2.58			
Designation								
Nursing officer	15.81±3.52	1.685	0.100	-0.38-4.17	29.42±2.78	1.231	0.225	-0.74-3.03
Sr. Nursing officer	13.91±2.02				28.27±2.24			
Total nursing experience (in years)								
Up to 10	16.19±3.29	2.342	0.024*	0.32-4.32	29.35±2.95	0.698	0.489	-1.13-2.32
More than 10	13.88±2.80				28.75±2.18			
Experience in respiratory care unit (in years)								
Up to 5	15.79±3.85	1.103	0.277	-0.94-3.19	29.71±2.66	1.688	0.099	-0.27-3.02
More than 5	14.67±2.28				28.33±2.54			

*-Significant at p≤0.05; [$]- independent samples t-test

Table 6 reflects item wise participants' responses towards attitude regarding non-invasive ventilation (NIV) therapy before and after training. The results reveal a substantial positive shift in participants' attitudes after the training intervention, as evidenced by significant p values (<0.001) obtained from Wilcoxon sign rank tests.

In Table 7 the Pearson correlation coefficient of 0.182 indicates a notably feeble positive correlation, signifying a marginal incline in participants' attitudes as their knowledge increases. Notably, the accompanied p value of 0.248 denotes a lack of statistical significance for the observed correlation.

In Table 8, data indicates a significant association of knowledge with age, professional qualifications, and total nursing experience (p<0.010, p=0.013, p=0.024) respectively. However, there were no statistically significant differences observed in attitude scores concerning sociodemographic variables.

DISCUSSION

The efficacy of non-invasive ventilation (NIV) is contingent upon various factors, including the nature and severity of the underlying clinical condition, appropriate ventilator settings, the utilization of a user-friendly

interface, and diligent and continual monitoring of hemodynamic response during its application. Accordingly, the provision of high-quality care for individuals requiring NIV represents a significant challenge, necessitating healthcare professionals to integrate current scientific evidence and embrace a patient-centric approach.[10]

It is widely recognized that educational programs designed to enhance nurses' knowledge and attitudes have a positive impact on mitigating complications associated with non-invasive ventilation (NIV). Our study evaluated the influence of NIV training on the knowledge and attitudes of nurses, revealing a substantial improvement in both their knowledge and positive attitudes following the training.

In our study, majority of participants (64.3%) were in the age group of 25-35 years, females constituted (54.8%), nursing officer comprise the largest group (73.8%) These findings align with the research of Aziz et al, Annarani et al, Lomnyack et al, Chaudhary et al and Goktas et al.[12,22-25]

In the present study, majority of nurses have a graduate degree (76.2%) and up to five years of experience (57.1%) in the respiratory care unit. These findings are consistent with Mohamed et al, who reported that 36% of nurses hold bachelor degree.[13] The limited years of experience in respiratory care unit may be attributed to nurses' rotation across different unit within the hospital. These results contrast with findings of Shrofi and Arbon, who noted that most nurses in their study in ICU held nursing diploma, with more than half having over five years of experience.[26] Additionally, Eastwood et al found that most ICU nurses generally had a bachelor's degree in nursing.[27]

The pre-intervention phase of our study revealed that none of the nurses had received specific training in non-invasive ventilation (NIV), the findings is consistent with Gírio and Sousa, where 78.9% of nurses had never undergone specific training in NIV, a percentage higher than that reported by Palma.[28,29] This disparity exists in terms of both frequency and the maximum duration of training sessions (14 hours versus 16 hours). Similar findings were also supported by Chaudhary et al; Annarani et al; Wilson Paulo Lomnyack et al; Merve Trehan et al.[11,12,23,24]

Multiple studies have emphasized previous endeavours to enhance the proficiency of healthcare professionals in NIV Karim et al; Raurell-Torredà et al; Chen et al prompted by the exigencies imposed by the COVID-19 pandemic.[18,21,30-32] The present findings were substantiated by Mohamed et al findings who advocated for supplementary education for nurses in the intensive care unit to ensure optimal care for patients.[13]

In the present study, we found that the care provided to patients in need of NIV in the clinical setting was not standardized among the nursing team members, which could compromise the expected level of quality and care experience. Additionally, participating nurses expressed a lack of updated knowledge in the field of NIV as reflected in pre training scores. This lack of updated knowledge is more significant compared to findings by Palma et al and Fragoso et al.[29,33]

Following the inferential statistical analysis in our study, it is evident that there has been a substantial improvement in the overall NIV knowledge level and attitude among the nursing team following the educational intervention (Fisher Exact 96.78, $p<0.001$, 106.58, $p<0.001$). these findings align with Kim et al indicating a noteworthy difference in NIV related knowledge ($p=0.029$) and self-efficacy ($p=0.026$) between the intervention and control group.[34] Furthermore, our findings were corroborated with Jackson et al in which they report significant increase in overall score from 24.6% to 64.22%; $p<0.001$.[18]

Notable advancements were noted between the pre and post-intervention periods, particularly in the nurses' comprehension of NIV basics (9.83, $p<0.001$), primary nursing responsibilities before obtaining ABG sampling ($p<0.004$), identification of hypoxemia ($p<0.004$), as well as understanding the functioning of BIPAP/CPAP ($p<0.001$), and IPAP ($p<0.001$). These results further supported by Gírio et al who reported an improvement in nurses' understanding of BIPAP mode ($Z=-2.081$, $p=0.037$) and ventilator parameters ($Z=-2.440$, $p=0.015$) in their study.[28]

The findings of our study present more positive outcomes in comparison to a study conducted by Raurell-Torredà et al.[30] This study focused on the understanding of non-invasive ventilation (NIV) among 48 doctors and 181 nurses in four Spanish hospitals. Their results indicated that only 25.1% of nurses answered the questionnaire correctly, with no significant variations across different work settings such as intensive care, emergency department, and post-surgical units. Additionally, only 50.2% of participants responded accurately to queries regarding the appropriate mask size selection, and a smaller percentage answered correctly about the type and characteristics of the mask to choose (17.1%) and mask application (7.7%). This contrasted with the results of our study, where there was a significant improvement in nurses' responses to questions about the interfaces used in NIV, with a rise from 33.3% to 88.1% of nurses answering all questions correctly ($Z=-2.271$, $p=0.023$). Nonetheless, in a systematic literature review by Pierucci et al highlighted that even highly trained NIV teams may encounter challenges due to a scarcity of suitable material resources, potentially compromising the selection of an interface that suits the individual effectively.[35]

In the post-intervention phase of our study, the nurses demonstrated a significantly enhanced understanding pertaining to the indications for NIV, with an increase from 31.6% to 73.7%. These findings were corroborated by Jackson et al, who identified the "general indications"

domain as exhibiting the most notable improvement among participants, reflecting a 41.66% surge in scores during the post-intervention period.[18]

In the present study, a statistically significant improvement in nurses' response was noted in relation to interface selection and application strategies (CI: 1.89-2.73, t=11.22, p<0.001). These findings are consistent with those of Gírio and Sousa, who similarly documented improvements in nurses' responses pertaining to the application of the mask and harness (Z=-1.990, p=0.047).[28]

Regarding the patient monitoring and identification of critical events, we found a significant improvement in pre and post training nurses response patterns for all questions (mean difference =2.31, 95% CI -1.89-2.73, p<0.001). Our results were in congruent with Gírio and Sousa, who also reported statistically significant differences in monitoring of patients on NIV (Z=-2.652, p=0.008).[28]

The post-training surge in knowledge levels observed in our study suggests that a comprehensive and meticulously planned NIV training program significantly enhances the knowledge levels of nurses. These findings align with those of Salturk.[36]

Following the training, there was a significant increase in the nurses' knowledge levels regarding the proper usage of masks and management of air flow during non-invasive mechanical ventilation (NIMV). A study conducted by Torredà et al across various intensive care units indicated a low level of knowledge among nurses on this subject.[30] Conversely, a study by Tarhan et al revealed that most nurses advocated for the placement of face masks on the patient's face without any gaps to prevent leakages, along with the proper taping to avoid pressure on the nasal bridge.[11] Our findings are in alignment with Tarhan's study indicating an increased ratio following the training.[11]

Regarding attitude: in our study, the overall mean scores for all the statement has substantially improved post training with Fisher exact value =106.58, p<0.001.

However, it is essential to persist in providing support to the nursing team in this specific domain, acknowledging their indispensable role in addressing the individual's requirements, particularly in terms of physical, environmental, and sociocultural alleviation of discomfort caused by traumatic stimuli.[33] It is imperative to empower the nursing team to recognize, intervene, and evaluate the outcomes of their efforts in this area, given that physical and psychological discomfort rank among the principal complications experienced by individuals necessitating non-invasive ventilation (NIV) within the clinical milieu.[32,34] Additionally, the discomfort encountered by NIV patients represents a primary predictor of inconsistent usage within clinical settings.[37]

There are some limitations also. This study was conducted at a single centre, with a sample size limited to nurses employed at the respiratory unit. The assessment conducted during the pre- and post-training periods exclusively targeted knowledge and attitude only. Consequently, as a recommendation, it is imperative to address and evaluate the nursing team's performance in other essential competency domains associated with NIV, namely practice, communication, ethics, social/behavioral aptitude, and leadership.

CONCLUSION

Non-invasive positive pressure ventilation (NIPPV) constitutes a respiratory support therapy necessitating the active involvement of nurses. Consequently, it is imperative for nurses to possess substantial knowledge, attitude and skills in both patient preparation preceding NIPPV application and the implementation of requisite nursing interventions before, during and post-ventilation. Research findings in the present study underscore the positive impact of nurse training in NIPPV application on their knowledge and attitude levels. Moreover, it is advised that extensive nursing studies on NIPPV in the country be conducted to delineate pertinent nursing care strategies. The establishment of a well-structured education and training program in NIV is imperative at present. This is necessary for improving patient outcomes, reducing instances of failure, and mitigating complications associated with the use of NIV.

Our research has revealed a significant increase in nurses' knowledge following non-invasive applications training. These training programs are designed to enhance nurses' affective, cognitive, and psychomotor skills. We anticipate that the rigorous research efforts will yield successful outcomes, thus contributing to the enhanced effectiveness of NIV applications.

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