

Effects of Teaching Intervention on the Knowledge and Competency of Critical Care Nurses Regarding Bilevel Positive Airway Pressure

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Abstract

Inadequate knowledge and skills among critical care nurses in Pakistan regarding BiPAP therapy can lead to serious complications for patients. This study aims to assess the effect of an educational

intervention on the knowledge and competency of critical care nurses regarding BiPAP therapy. To determine the effect of an educational intervention on the knowledge and competency of critical care nurses regarding BiPAP therapy. This quasi-experimental study involved pre- and post-test assessments of critical care nurses' knowledge and competency regarding BiPAP therapy following an educational intervention. The study was conducted at a tertiary care hospital in Karachi, Pakistan, with a sample size of 60 participants selected using non-probability purposive sampling. Statistical analysis was performed using SPSS Statistics version 25, with the Paired T-test and Wilcoxon signed-rank test used to compare pre- and post-intervention results. The participants had a mean age of 27.98, with the majority being female (80%). Before the intervention, 100% of the participants had poor knowledge scores, and 56.7% had poor competency scores. After the intervention, 75% of participants demonstrated good knowledge, and 95% showed good competency in BiPAP therapy, with a significant improvement in scores ($p < 0.001$). The study findings indicate that an educational intervention can significantly enhance critical care nurses' knowledge and competency in BiPAP therapy, potentially reducing complications associated with mechanical ventilation in patients.

Keywords: BiPAP therapy, critical care nurses, educational intervention, non-invasive ventilation, nursing skills, BiPAP education.

1. Introduction

1.1 Background:

Lower respiratory tract problems are a leading cause of mortality worldwide, accounting for approximately 12% of deaths. The mortality rate is higher in developing countries, with around 4.412 million deaths compared to 3.58 million in developed countries. In Pakistan, approximately 14.60% of deaths are attributed to pneumonia, chronic obstructive pulmonary diseases (C.O.P.D.), asthma, tuberculosis, influenza, and acute respiratory distress syndrome.¹ The recent COVID-19 outbreaks have highlighted the importance of respiratory care, particularly the use of Bi-level Positive Airway Pressure (BiPAP) as a first-line therapy for various respiratory conditions. BiPAP helps improve breathing efforts, gas exchange, and comfort, and can prevent pneumonia, endotracheal intubation, nosocomial infections, and weaning failures^{2,4}.

Nursing plays a crucial role in providing healthcare and minimizing the side effects of BiPAP therapy¹⁷. However, nurses may face challenges such as face mask leaks, synchronization strategies, and covering the expiratory port or pressure tubes¹⁸. Despite the benefits of BiPAP, it is underused in Pakistan due to a lack of awareness and training among healthcare practitioners, particularly critical care nurses^{13, 20}. Therefore, there is a need for educational interventions to equip critical care nurses with the necessary knowledge and competencies for effective BiPAP use²³.

1.2 Rationale of the study:

This research aims to investigate the effect of teaching programs on nursing knowledge and competency regarding BiPAP in Pakistan. Organized training can enhance nurses' competency and knowledge of BiPAP, leading to improved patient care and clinical outcomes^{25, 26}.

1.3 Objective:

To determine the effect of teaching interventions on the knowledge and competency of critical care nurses regarding BiPAP.

1.4 Research question:

What is the effect of a teaching intervention on the knowledge and competency of critical care nurses regarding BiPAP?

1.5 Hypothesis:

- **Ho:** There will be no effect of an educational intervention on the level of knowledge and competency among critical care nurses regarding BiPAP.
- **Ha:** There will be an effect of an educational intervention on the level of knowledge and competency among critical care nurses regarding BiPAP.

2. Materials and Methods

2.1 Setting:

The study was conducted at the Dr. Ziauddin Group of Hospitals, North Campus in Karachi, Pakistan, encompassing critical care areas such as M.I.C.U., S.I.C.U., NICU, H.D.U., CCU, PICU, and the Emergency room.

2.2 Sample:

The sample size was n=60, and the non-probability purposive sampling technique was used.

2.3 Data Collection Tools:

In this research, two data collection tools were employed: a knowledge-based questionnaire and a competency-based checklist to ensure the tools were appropriate for the study population. Content validation and reliability testing were carried out.

2.4 Ethical Consideration:

The research was conducted after obtaining approval from the Graduate Nursing Research Committee (GNRC), Ethical Review Committee (ERC), and the Board of Advanced Study and

Research (BASR). Permission was also granted from the study setting, and written consent was obtained from the study participants. Safety precautions were taken to protect participant privacy and data integrity during the consent process.

2.5 Data Collection Procedure:

The research included three phases: pre-intervention, intervention, and post-intervention. The knowledge-based questionnaire and competency-based checklist were used to gather baseline data during the pre-intervention phase. Organized sessions covering various aspects of BiPAP were conducted during the intervention phase, accompanied by hands-on training. After a month, knowledge and competency were evaluated using the same instruments in the post-intervention phase.

2.6 Data Analysis:

The data were analyzed using Statistical Package for Social Sciences (SPSS) version 25. Descriptive analysis was conducted, involving the calculation of mean and standard deviation (S.D) for categorical demographic variables, and frequency and percentages were computed. The Kolmogorov-Smirnov test was used to confirm the normality of the data, and the obtained p-values were greater than 0.05. For inferential statistics, the Paired T-test was employed to compare the pre- and post-results. Additionally, the Wilcoxon signed-rank test was utilized to assess the difference between dependent categorical variables.

2.7 Results:

This chapter summarizes the findings of the study, including the demographic data and the inferential variables that were examined. Numerical variables included age, experience, and the number of patients who attended BiPAP, while categorical variables included education, previous training, gender, and unit distribution. Notably, the Kolmogorov-Smirnov test revealed that the data had a normal distribution. Furthermore, this chapter also compares the knowledge and competency scores of critical care nurses before and after a BiPAP education intervention. The outcomes show a strong effect of the teaching intervention on the knowledge and competency of critical care nurses following the teaching intervention.

3. Distribution of Demographic Variables among the Study Population

3.1 Demographic Variables:

Table 1, shows the demographic variables of the study population. The analysis showed that the majority of the nurses who participated in the study belonged to the age group between 21–30 years, accounting for 46 participants (76.7%), while the lowest frequency was observed in the age

group older than 50 years, with only 2 participants (3.3%). The education level of the participants revealed that the majority belonged to the BSN category, with 31 individuals (51.7%), while 29 individuals (48.3%) had an RN education. Many participants' work experience was 3–4 years (45%), and only a few had experienced 9–10 years (6.7%). It is observed that most participants had not received training on BiPAP therapy; 52 (86.7%) participants claimed they had not received training, while only 8 (13.3%) participants claimed they had received a session on BiPAP therapy.

Table 1: Distribution of Demographic Variable among Study Participants.

Demographic variable n=60)	Frequency	Percentage
Age		
< 21 years	5	8.3
21 - 30 years	46	76.7
31 - 40 years	4	6.7
41 - 50 years	3	5
>50 years	2	3.3
Education		
RN	29	48.3
BSN	31	51.7
Experience in years		
1-2	14	23.3
3-4	27	45
5-6	10	16.7
7-8	5	8.3
9-10	4	6.7
Previous Training		
Yes	8	13.3

No	52	86.7
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In **figure 1**, the gender distribution of the study population is shown. The frequency of female participants was found to be higher, 48 (80.0%), than male participants, 12 (20.0%) among the study population.

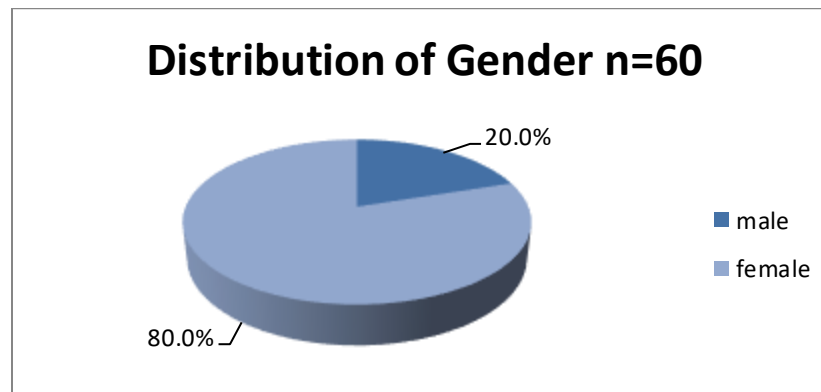


Figure 1: Distribution of gender among the study population

3.2 Participants' Frequency of BiPAP-Attended Patients:

Table 2, shows the frequency distribution and percentages of clinical characteristics. It is observed that 44 (73.3%) participants had attended patients on BiPAP with a frequency of ≤ 100 , and few nurses 7 (11.1%) had attended patients around 201–300 patients in their career, and only 1 (1.7%) participant had attended more than 300 patients in their career. There were more people from the E.R. unit 21 (35.0%) and M.I.C.U. unit 14 (23.3%), and very few from the Peads unit 4 (6.7%).

Table 2: participants' frequency of BiPAP attended to patients.

n=60	frequency	Percentage
BiPAP Patients		
≤ 100	44	73.3
101 -200	8	13.3
201-300	7	11.7
>300	1	1.7
Unit		
C.C.U	9	15.0

E.R	21	35.0
M.I.C.U	14	23.3
N.I.C.U	6	10.0
PAEDS	4	6.7
S.I.C.U	6	10.0

3.3 Distribution of Age:

Table 3, shows the descriptive statistics of the study population. It was found that participants had an average age of 27.98 ± 7.98 . On average, patients who attended BiPAP Ventilation were 101.7 ± 91.17 .

Table 3: Distribution of age

n=60	mean	±	Std
Age	27.98	±	7.98
No of patients attended on BiPAP	101.7	±	91.17

3.4 Comparison of Knowledge and Competency Scores Before and After Educational Intervention:

Table 4, shows the mean $\pm$ SD of knowledge score and competency score. A Paired t-test has been applied to compare pre- and post-results of knowledge and competency scores. It was found that there was a significant difference in scores before and after educational intervention. On average, the knowledge score increased from 4.25 ± 2.10 to 11.37 ± 1.30 , p-value < 0.001 . It was also noted that the competency score was 12.9 ± 3.447 to 21.2 ± 1.70 after the BiPAP training score increased significantly, p-value of 0.011.

Table 4: Comparison of Knowledge and Competency Score before and after the teaching intervention.

Mean$\pm$SD(n=60)	Pre	Post	P-value
Knowledge	4.25 ± 2.10	11.37 ± 1.30	< 0.001
Competency	12.9 ± 3.447	21.2 ± 1.70	0.011

Figure 2, shows visible paired differences in average knowledge and competency scores among the study population before and after training.

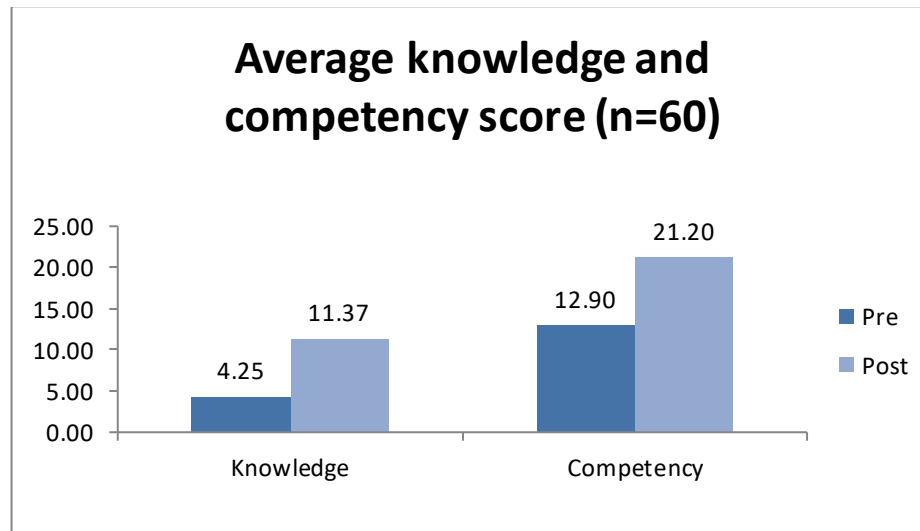


Figure 2: Comparison of Knowledge and Competency score before and after intervention

3.5 Comparison of Knowledge Score Before and After Intervention with Study Demographic and Clinical Variables:

Table 5, shows the mean $\pm$ SD of the knowledge score before and after BiPAP training concerning the demographic and clinical variables. A paired t-test has been applied to compare pre- and post-results of knowledge scores concerning demographic variables, demonstrating paired differences that were statistically significant before and after training across each variable, which were less (<0.001).

Table 5: Comparison of Knowledge score before and after intervention concerning demographic variables.

n=60	N	knowledge (mean± std)						p-value
		Pre			Post			
Previous Training								
Yes	8	2.88	±	2.36	11.13	±	1.73	<0.001
No	52	4.46	±	2	11.4	±	1.24	<0.001
Experience in years								

1-2	14	4.43	±	1.65	11.5	±	1.02	<0.001
3-4	27	4.44	±	2.19	11.41	±	1.31	<0.001
5-6	10	3.1	±	2.08	10.7	±	1.77	<0.001
7-8	5	5.4	±	2.7	12	±	1.22	0.001
9-10	4	3.75	±	1.89	11.5	±	0.58	0.003
Education								
RN	29	4.66	±	2.07	11.48	±	1.3	<0.001
BSN	31	3.87	±	2.09	11.26	±	1.32	<0.001
Gender								
male	12	4.5	±	1.73	11.75	±	1.14	<0.001
female	48	4.19	±	2.2	11.27	±	1.33	<0.001
Unit								
C.C.U	9	3.44	±	1.740	11.00	±	1.000	<0.001
E.R	21	3.71	±	2.171	11.24	±	1.480	<0.001
M.I.C.U	14	5.00	±	2.481	11.64	±	1.151	<0.001
N.I.C.U	6	4.67	±	1.751	11.33	±	1.506	<0.001
PAEDS	4	4.75 ^a	±	1.708	10.75 ^a	±	1.708	0.014
S.I.C.U	6	4.83	±	1.722	12.17	±	.753	<0.001

A paired T-test has been applied

P-value <0.05 taken as significant.

3.6 Comparison of Competency Scores Before and After Teaching Intervention Concerning Clinical and Demographic Variables:

Table 6, shows the mean ± SD of competency scores before and after the teaching intervention concerning demographic and clinical variables. A paired t-test has been applied to compare pre- and post-results of competency scores concerning demographic variables, demonstrating paired differences that were statistically significant before and after training across each variable, which were less (<0.001).

Table 6: Comparison of Competency scores before and after teaching intervention.

Competency n=60	n	mean± std						p-value
		Pre			Post			
Previous Training								
Yes	8	12.5	±	2.27	20.25	±	2.12	<0.001
No	52	12.96	±	3.61	21.35	±	1.6	<0.001
Experience								
1-2	14	12.21	±	3.02	21.79	±	1.42	<0.001
3-4	27	12.7	±	3.73	21.15	±	1.54	<0.001
5-6	10	12.7	±	3.56	20.1	±	1.52	<0.001
7-8	5	14.6	±	2.79	21.2	±	3.03	<0.001
9-10	4	15	±	3.46	22.25	±	0.96	0.02
Education								
RN	29	13.45	±	3.51	21.14	±	1.79	<0.001
BSN	31	12.39	±	3.36	21.26	±	1.63	<0.001
Gender								
Male	12	14	±	2.66	21	±	1.41	<0.001
Female	48	12.63	±	3.59	21.25	±	1.77	<0.001
Unit								
C.C.U	9	12.1	±	3.1	20.4	±	2.0	<0.001
E.R	21	12.3	±	4.0	21.1	±	1.4	<0.001
M.I.C.U	14	13.7	±	4.0	21.6	±	1.7	<0.001

N.I.C.U	6	13.0	±	2.8	21.2	±	1.7	<0.001
PAEDS	4	14.3	±	1.7	20.0	±	2.4	0.014
S.I.C.U	6	13.3	±	2.4	22.5	±	0.8	<0.001

A paired T-test was applied

P-value<0.05 taken as significant.

3.7 Comparison of Knowledge Before and After Training:

Table 7 and Figure 3, Show the frequency and percentage of poor, fair, and good knowledge before and after training. Wilcoxon signed-rank test has been applied to compare pre- and post-results of knowledge level. It had been noted that before training, everyone had poor knowledge (60%). On the contrary, after training, there were 14 (23.3%) participants had fair knowledge, 45 (75% of the population) had good knowledge, and only one had poor knowledge regarding bi-level positive airway pressure.

Table 7: Comparison of Knowledge before and after Training.

n=60 (100%)	Knowledge frequency (%)		
	Pre	Post	P-value
Poor	60(100%)	1(1.7%)	<0.001
Fair	0(0%)	14(23.3%)	
Good	0(0%)	45(75%)	

Wilcoxon signed-rank test has been applied

P-value <0.05 taken as significant.

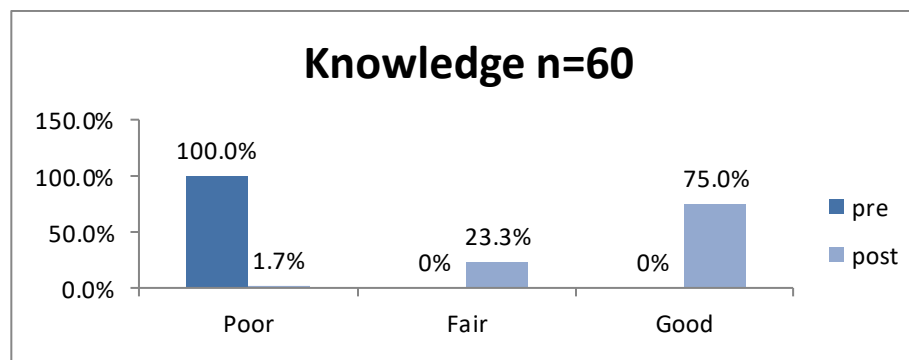


Figure 3: Comparison of Knowledge before and after Training.

3.8 Comparison of Competency Levels Before and After Training:

Table 8 and Figure 4, Reveal the distribution of competency levels before and after the training intervention. A Wilcoxon signed-rank test was conducted to compare the pre- and post-results of competency levels. Before the training, a majority of participants (56.7%) had poor competency levels, while smaller proportions had fair (38.3%) and good (5%) competency levels. However, following the intervention, there was a remarkable shift in the distribution of competency levels. The percentage of participants with poor competency decreased to zero. Only 5% of participants had a fair level of competency; additionally, the percentage of individuals with good competency levels substantially increased to 95%. These findings provide clear evidence leading to a significant improvement in overall competency levels regarding bi-level positive airway pressure.

Table 8: Comparison of Competency Level before and after Training

n=60 (100%)	Competency frequency (%)		
	Pre	Post	P-value
Poor	34(56.7%)	0(0%)	<0.001
Fair	23(38.3%)	3(5%)	
Good	3(5%)	57(95%)	

Wilcoxon signed-rank test had been applied

P-value<0.05 is taken as significant.

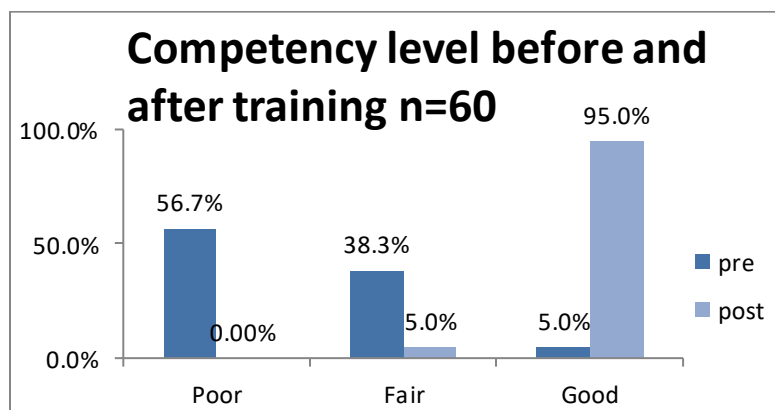


Figure 4: Comparison of competency level before and after training

4. Discussion

The discussion section elaborates on the study findings and compares them with literature support and arguments addressing the limitations, and establishing a conceptual framework for the study. The primary aim is to determine and describe the objective of the study and the effect of BiPAP teaching and hands-on practice intervention on critical care nurses' knowledge and competency before and after the program. The literature review provided evidence that such interventions can increase nurses' knowledge and competency regarding BiPAP therapy. Numerous studies show the significance of continuing nursing education in ensuring the ongoing development of nurses' knowledge and competency, as well as better patient outcomes.

In this study, findings revealed that the mean age of the participants was 28 years. A study conducted in Egypt reported similar findings, while a study done in Pakistan indicated a mean age of 39 years^{26,17}. The current study result regarding the gender distribution was 80% female and 20% male, which was similar to a study conducted in Egypt²⁷. However, research done in Iraq indicated that males were 57% of the participants, while females were 43%. According to the results of the current study, the majority of participants (45%) had 3–4 years of experience, which is consistent with a study carried out in Pakistan¹⁹. Additionally, a study done in South Korea included participants with a similar year of experience range²³. The results of research done in the Republic of Haiti, where the average age was recorded as 39.94, were quite different³⁵. The present study revealed that the majority of the nurses had a bachelor's degree in nursing (51.7%), which is consistent with findings from New York City and Iraq^{29,27}.

According to the current study's findings, the majority of participants in training workshops on BiPAP therapy had never attended them previously, with 86.7% of the participants reporting this. Comparable research done in New York City findings were revealed that the majority of participants had not attended any sessions before the intervention²⁹. Contradictory findings were found in a study conducted in Egypt³⁰. Other contrasting findings in South Korea reported in the study results were that 80% got education sessions prior and 20% never took sessions before the educational intervention²³. In this present study, all the participants were selected from critical care areas, mostly emergency (35%), and medical intensive care units (23%). Similar findings relating to critical care settings were reported in a study done in New York. However²⁹. In contrast to the research findings, the study conducted in Pakistan reported different findings in their study, which mostly focused on critical care nurses chosen from medical and surgical ICUs¹⁹.

The results of the current study indicate that participants' knowledge was evaluated 100% of the population had knowledge score less than <50% considered as poor level before education. Similar study findings were observed in Egypt, before the educational intervention, nurses were found to have significantly poor levels of knowledge and practice, with a recorded knowledge deficiency of 100%²⁷. Contradictory studies found different findings in the research mentioned that knowledge levels among nurses were found to be 63.3% poor and 36.7% fair before the

teaching intervention³¹. The findings of the present study showed that there had been a significant improvement in knowledge after the teaching intervention. In particular, 75% of nurses revealed a good level of knowledge, 23.3% showed a fair level of knowledge, and only 1.7% showed a poor level of knowledge. In the study done in Egypt, an educational intervention was carried out to evaluate nurses' knowledge and practice. The study's findings showed that after the intervention, there was a significant increase in knowledge levels. In particular, 67.3% showed a good level of knowledge, 30.0% showed a fair level of knowledge, and 2.7% had a poor level of knowledge, and these remarkable results are consistent with current findings³².

Contrasting results were found about the knowledge levels of nurses were evaluated both before and after a teaching intervention in a study done in Pakistan. The results showed that none of the participants had good knowledge before the intervention and that 50% of participants had a poor level of knowledge, while the other 50% had a fair level of knowledge. After the educational intervention, significant improvements were observed in the nurse's knowledge, particularly, 5.7% showed poor knowledge, 48.6% showed fair knowledge, and 45.7% showed a good level of knowledge³³.

Based on the results of the recent study, before the intervention, 56% of participants had poor competency, 38.3% had fair competency, and only 5% had good competency. After the teaching and hands-on intervention, participants' scores were evaluated. A good level of competency was seen in 95% of nurses, a fair level of competency in 5% of nurses, and no one with a poor level of competency was observed. Related outcomes were reported both before and after the educational intervention, the study conducted in Egypt. When competencies were observed before the educational intervention, 80% scored poor, 20% scored fair, and none had a good level of competencies. Similar outcomes were obtained after the intervention, with 96.7% revealing good competency, 3.3% demonstrating fair competency, and none falling into the poor group. These findings quite reflect the present study findings, and the p-value is likewise identical at 0.0001³.

To the best of our knowledge, this study was the first to be carried out in Pakistan regarding BiPAP teaching and hands-on intervention on critical care nurses' knowledge and competency. Earlier studies carried out in our region regarding BiPAP predictor outcomes in COPD patients were evaluated, as well as the clinical outcome of COPD patients on BiPAP and mechanical ventilation and the knowledge and practice of critical care nurses regarding ventilator-associated pneumonia^{19,34}. However, nurses play a crucial part in administering and overseeing BiPAP therapy for patients. It's important to determine their degree of knowledge and competency, as well as the impact of educational interventions³.

4.1 Limitations of the study:

However, the study has a few limitations. Firstly, the sample size was relatively small, which may affect the generalizability of the findings. Secondly, the study did not assess the long-term

retention of knowledge, making it difficult to ascertain the intervention's sustained impact over time. Third, multi-center studies are necessary to deepen and strengthen these findings on a larger scale. The most prominent limitation of the study was the small sample size and one center.

4.2 Study the implications of clinical practice and future recommendations:

The positive findings of this study suggested that BiPAP education and hands-on training be included in a nursing orientation program, as nurses can confidently initiate and monitor BiPAP therapy, reducing the need for critical care beds and improving patient care.

Develop comprehensive and ongoing training programs focusing on BiPAP and essential respiratory skills for critical care nurses, including theoretical knowledge, hands-on practice, and skill assessments for continuous improvement.

Encourage continuing education, simulation training, clinical mentorship, and interdisciplinary communication. Prioritize quality improvement initiatives, ensure access to resources, support policy advocacy, promote research, and foster a culture of learning to enhance critical care practices and patient outcomes.

BiPAP therapy training programs for critical care nurses should be provided and available in written form in all emergency units and critical units.

This study made the recommendation that additional research be done on patient-centered outcomes and that nurses receive BiPAP training.

Future research might benefit from including patient and family views, as well as examining the perspectives of nurses and those receiving their care.

5. Conclusion

The current research supports our alternative hypothesis that BiPAP teaching interventions improve critical care nurses' knowledge and competence regarding BiPAP therapy. After implementing the teaching program, the majority of nurses had a good level of knowledge and competency about BiPAP therapy, according to the study's findings, with highly statistically significant differences from before. Thus, it can be concluded that teaching and hands-on practice can improve nurse knowledge and competency, before attending to BiPAP patients, every critical care nurse should be trained in nursing education services.

References

- [1] Abramo, T., Williams, A., Mushtaq, S., Meredith, M., Sepaule, R., Crossman, K., et al. (2017). Paediatric ED BiPAP continuous quality improvement programme with patient analysis: 2005–2013. *BMJ Open*, 7(1), e011845.
- [2] Ali, S., Khatri, A., Ghouri, N., Mukhtar, S., Zawawi, S., & Saleem, S. G. (2021). Combining noninvasive ventilation with timed position change in the emergency department to improve oxygenation and outcomes in patients with COVID-19: A prospective analysis from a low resource setup. *Pakistan Journal of Medical Sciences*, 38(ICON-2022).
- [3] Amra, B., Samadi, B., & Soltaninejad, F. (2019). Effect of bi-level positive airway pressure (BIPAP) ventilation on gas exchange, body mass index, and body composition in patients with obesity hypoventilation syndrome. *Tanaffos*, 18(4), 315.
- [4] Bahgat, R. S., & Nada, M. A. (2017). Effect of educational intervention program on nurses' knowledge and practice about immunosuppression drugs of pediatric age groups with actual post liver transplantation. 4(2).
- [5] Bambi, S., Mati, E., De Felippis, C., & Lucchini, A. (2017). Noninvasive ventilation: Open issues for nursing research. *Acta Bio Medica: Atenei Parmensis*, 88(Suppl 1), 32.
- [6] Cherian, S., Kathamuthu, R., Karkada, S., & Alkhatib, A. J. (2019). Improving care of patients on noninvasive ventilation in general wards. 1(2).
- [7] Clay, P., Cruz, C., Ayotte, K., Jones, J., & Fowler, S. B. (2018). Device related pressure ulcers pre and post identification and intervention. *Journal of Pediatric Nursing*, 41, 77–79.
- [8] Delaney, M. M., Friedman, M. I., Dolansky, M. A., & Fitzpatrick, J. J. (2015). Impact of a sepsis educational program on nurse competence. *The Journal of Continuing Education in Nursing*, 46(4), 179–186.
- [9] Devi, P., Raja, R., Kumar, R., Shah, A., Ansari, S. I., & Kumar, B. (2019). Invasive versus non-invasive positive pressure ventilation in chronic obstructive pulmonary disease complicated by acute respiratory failure. *Cureus*.
- [10] Dobler, C. C., Murad, M. H., & Wilson, M. E. (2020). Noninvasive positive pressure ventilation in patients with COVID-19. *Mayo Clinic Proceedings*, 95(12), 2594–2601.
- [11] El-Aal, B. G., & El-Mawgoud Ahmed, N. (2018). Effectiveness of educational intervention about prevention and control of health-care associated infection on knowledge of nurses in outpatient clinics. 4.
- [12] Harb, N. A., & Jasim, A. K. (2023). Evaluation of performance quality of workers in medical laboratories within the health sector under the Corona pandemic in Al-Muthana Governorate/Iraq. *University of Thi-Qar Journal of Science*, 10(1 SI).
- [13] Ishfaq, N., Gul, N., & Zaka, N. (2019). Outcome of early use of non-invasive positive pressure ventilation in patients with acute exacerbation of chronic obstructive pulmonary

- disease: NIPPV in chronic obstructive pulmonary disease exacerbation. *Pakistan Journal of Medical Sciences*, 35(6).
- [14] Jackson, P., Siddharthan, T., Cordoba Torres, I. T., Green, B. A., Policard, C. J.-P., Degraff, J., Padalkar, R., Logothetis, K. B., Gold, J. A., & Fort, A. C. (2022). Developing and implementing noninvasive ventilator training in Haiti during the COVID-19 pandemic. *ATS Scholar*, 3(1), 112–124.
- [15] Karagiannidis, C., Hentschker, C., Westhoff, M., Weber-Carstens, S., Janssens, U., Kluge, S., et al. (2022). Observational study of changes in utilization and outcomes in mechanical ventilation in COVID-19. *PLoS ONE*, 17(1), e0262315.
- [16] Karim, H., Burns, K., Ciobanu, L., El-Khatib, M., Nicolini, A., Vargas, N., et al. (2019). Noninvasive ventilation: Education and training. A narrative analysis and an international consensus document. *Advances in Respiratory Medicine*, 87(1), 36–45.
- [17] Khan, M. A., Shahbaz, H., Noorali, A. A., Ehsan, A. N., Zaki, M., Asghar, F., et al. (2022). Disparities in adult critical care resources across Pakistan: Findings from a national survey and assessment using a novel scoring system. *Critical Care*, 26(1), 209.
- [18] Khan, Z. H., Aldulaimi, A. M., Varpaei, H. A., & Mohammadi, M. (2022). Various aspects of non-invasive ventilation in COVID-19 patients: A narrative review. *Iranian Journal of Medical Sciences*, 47(3), 194.
- [19] Kim, J., Park, J. H., & Shin, S. (2016). Effectiveness of simulation-based nursing education depending on fidelity: A meta-analysis. *BMC Medical Education*, 16(1), 152.
- [20] Kim, M. S., Seo, M. H., Jung, J. Y., & Kim, J. (2021). The effect of a non-invasive positive pressure ventilation simulation program on general ward nurses' knowledge and self-efficacy. *International Journal of Environmental Research and Public Health*, 18(6), 2877.
- [21] King, O., West, E., Lee, S., Glenister, K., Quilliam, C., Wong Shee, A., et al. (2022). Research education and training for nurses and allied health professionals: A systematic scoping review. *BMC Medical Education*, 22(1), 385.
- [22] Mohamed, W. K., Fahmy, H. I., & Aly, S. E. (2019). Effect of teaching program on nurses' knowledge and practice regarding measuring end-carbon dioxide by capnography at critical care units. *Assiut Scientific Nursing Journal*, 7(18), 145–153.
- [23] Morsy, A. A., & Ahmed, F. R. (2020). Effect of SBAR situational awareness technique as educational intervention on critical care nurse students' skills of patient safety. *Journal of Nursing Education and Practice*, 10(5), 47.
- [24] Mushtaq, M. Z., Mahmood, S. B. Z., Almas, A., Ather Wasti, S., & Ahsan Ali, S. (2022). Tocilizumab in critically ill COVID-19 patients: An observational study. *International Immunopharmacology*, 102, 108384.
- [25] Onturk, Z. K., Ugur, E., Kocatepe, V., Ates, E., Ocaktan, N., Unver, V., et al. (2019). Use of simulation from high fidelity to low fidelity in teaching of safe-medication practices. *Journal of the Pakistan Medical Association*, 69(2).

- [26] Osadnik, C. R., Tee, V. S., Carson-Chahhoud, K. V., Picot, J., Wedzicha, J. A., & Smith, B. J. (2017). Noninvasive ventilation for the management of acute hypercapnic respiratory failure due to exacerbation of chronic obstructive pulmonary disease. *Cochrane Database of Systematic Reviews*, 2017(7).
- [27] Osman, F. K., El Banna, H. M., Sharaf, A. Y., & Mohammed, Y. F. (2021). The effects of educational interventions on nurses' knowledge and practices in hemodialysis unit regarding infection control practices. *The Egyptian Journal of Hospital Medicine*, 84(1), 1739–1748.
- [28] Raurell-Torredà, M., Argilaga-Molero, E., Colomer-Plana, M., Ródenas-Francisco, A., & Garcia-Olm, M. (2019). Nurses' and physicians' knowledge and skills in non-invasive ventilation: Equipment and contextual influences. *Enfermería Intensiva (English ed.)*, 30(1), 21–32.
- [29] Rochwerg, B., Brochard, L., Elliott, M. W., Hess, D., Hill, N. S., Nava, S., et al. (2017). Official ERS/ATS clinical practice guidelines: Noninvasive ventilation for acute respiratory failure. *European Respiratory Journal*, 50(2), 1602426.
- [30] Salahuddin, N., Irfan, M., Khan, S., Naeem, M., Haque, A. S., Husain, S. J., et al. (2010). Variables predictive of outcome in patients with acute hypercapnic respiratory failure treated with noninvasive ventilation. 60(1).
- [31] Shah, H. B. U., Atif, I., Rashid, F., Zulfqar, H., Mian, K., Sarfraz, M., et al. (2017). Knowledge and practices of critical care health professionals related to ventilator associated pneumonia in tertiary care hospitals of Islamabad and Rawalpindi. *Journal of the Pakistan Medical Association*, 67(11).
- [32] Sultana, T., Afzal, A., Sultana, S., Al-Ghanim, K., Shahid, T., Jabeen, Z., et al. (2017). Epidemiological estimates of respiratory diseases in the hospital population, Faisalabad, Pakistan. *Brazilian Archives of Biology and Technology*, 60(0).
- [33] Valley, T. S., Walkey, A. J., Lindenauer, P. K., Wiener, R. S., & Cooke, C. R. (2017). Association between noninvasive ventilation and mortality among older patients with pneumonia. *Critical Care Medicine*, 45(3), e246–e254.
- [34] Vaschetto, R., Pecere, A., Perkins, G. D., Mistry, D., Cammarota, G., Longhini, F., et al. (2021). Effects of early extubation followed by noninvasive ventilation versus standard extubation on the duration of invasive mechanical ventilation in hypoxemic non-hypercapnic patients: A systematic review and individual patient data meta-analysis of randomized controlled trials. *Critical Care*, 25(1), 189.
- [35] Yousef, N., Ozigi, A. K., Hussain, M., Perveen, K., & Afzal, M. (2021). Impact of educational pedagogy on registered nurses' knowledge in neurological assessment of traumatic brain injury patients. *Pakistan Journal of Physiology*, 17(3), 50–53.