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# Improving Care of Patients on Non-invasive Ventilation in General Wards

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## ARTICLE INFORMATION

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## ABSTRACT

Limited intensive care beds have caused an increasing incidence of non-invasively ventilated patients in general wards, which require trainings on care of non-invasively ventilated patients. The objectives of study were to assess the nurses' competence in caring for non-invasively ventilated patients before and after intervention, to identify the patient outcomes before and after intervention related to care of NIV patients and to identify the effect of intervention related to care of non-invasively ventilated patients on nurses' knowledge, skills and attitude. A pretest, posttest design tested the effect of onsite trainings related to care of non-invasively ventilated patients on nurses' competence (i.e., nurses' knowledge, skills and attitude) and the patient outcomes, incidence of Hospital Associated Infection (HAI). Following onsite trainings on care of non-invasively ventilated patients for 65 nurses from general wards, their knowledge, skills and attitude were assessed using questionnaires and Competency assessment tool. The hospital-associated infections in these patients were compared before and after training. The McNemar's Test was used to find the association between the Pretest and Posttest in areas of knowledge, skill and attitude. Chi Square method was used for analysis. The p value remained statistically significant ( $p=0.00$  to  $0.014$ ), indicating a significant improvement in the nurses' competency post intervention. There was an overall decreasing trend in the hospital associated infection rates over the posttests period. Regular trainings for general ward nurses may help them to become more competent in caring for the non-invasively ventilated patients, improving patient outcomes.

**Keywords:** Onsite trainings, competence, patient outcomes, non-invasive ventilation, general wards

## INTRODUCTION

Non-Invasive Ventilation (NIV) was an effective treatment for acute hypercapnic respiratory failure<sup>1</sup>. It is now increasingly used in the treatment of acute hypoxemic respiratory failure. A study done in a tertiary care centre, from Jan 2009 to Sept 2010, on medical ward patients (for whom the Rapid Response Team was activated for an oxygen saturation  $\leq 90\%$  and an respiratory rate  $\geq 28$ ), compared the patients on Bipap (Bilevel positive airway pressure) with those not on Bipap. Only 3% of the Bipap

patients were intubated compared to the 18% of the non-Bipap patients. They concluded that the acute use of Bipap in medical wards will prevent intubation and does not adversely affect mortality<sup>2</sup>. Bipap is a beneficial therapy for children presenting with severe asthma exacerbation<sup>3</sup>.

NIV is a therapeutic procedure for acute and chronic respiratory failure. There was a need to provide set standards and practical advice to nurses for caring for patients on non-invasive ventilation in the general wards. Facilities for NIV should be available 24 h per day in hospitals admitting such patients. A designated ward area with supervision by the respiratory team, trained staff and on-going teaching for medical and nursing staff was needed<sup>4</sup>. The unavailability of acute NIV services is an important issue, as this prevents the availability of facilities for invasive ventilation of deteriorating patients leading to increased mortality in ward settings especially when there were less intensive care beds<sup>5</sup>.

Another benefit with noninvasive ventilation may be a reduction in nosocomial infections associated with its application. This was because averting endotracheal intubation also avoids a major risk factor for ventilator-associated pneumonia (i.e., the endotracheal tube). Experience in a case-control study suggested a reduction in nosocomial pneumonia from 22 to 8%, with fewer days in the ICU (Intensive Care Unit) and lower mortality (26% down to >4%) in those treated with noninvasive ventilation as opposed to those who received endotracheal intubation<sup>6</sup>. NIV has been shown to decrease the rate of Intubation/Intrathoracic unit admission by 66%, decrease mortality from 29 to 9%, decrease in Intrathoracic unit length of stay from 32 to 13 days and decrease in hospital length of stay from 35 to 23 days. Efficacy was also seen in patients with stable, although deteriorating, chronic hypercapnic respiratory failure secondary to respiratory pump dysfunction<sup>7</sup>. The concept that critical care is a service rather than a location has been increasingly highlighted in the same study.

All over the world, the nurses lead intervention protocols that are evaluated through their impacts on patient outcomes. However, the studies have ignored the related nurses' perceptions and views<sup>7</sup>. NIV facilities should be available 24 h per day in all hospitals to admit such patients. The unavailability of acute NIV services would mean less or no facilities available to invasively ventilate patients leading to the sure death of some patients especially during a shortage of intensive care beds<sup>4</sup>. Provision of ward based acute respiratory care improves patient outcomes and reduces hospital length of stay.

A recent study in 2017 stressed that in order to enhance the feeling of safety among 'home mechanically ventilated' patients, nurses needed to work towards developing a trusting relationship with patients with their presence and attentiveness (in form of attitude); stay updated on current standards (knowledge) and provide competent, continuous nursing care (skill)<sup>8</sup>.

Despite numerous benefits of NIV, it is important that the nurses should be made aware that patients might start to deteriorate while on NIV. Progressive respiratory decompensation, cardio respiratory arrest and hypotension related to positive intrathoracic pressure (support with fluids) are few of the risks that may go unnoticed by the ward nurses, thinking that they were being safely managed by NIV<sup>6</sup>.

A study that explored the factors that influenced the experience of competent nurses that cared for critical patients located in general wards, found that nurses felt panicky and nervous. The nurses admitted their lack of awareness of own training needs and that education needs to be ongoing. Nurses may feel they lack the skills and knowledge required to wean patients from ventilation and this needs to be addressed in formal education programs and in-service training<sup>9</sup>.

NIV, within both the ICU and the ward environment, has been shown in RCTs and systematic reviews to reduce intubation rate and mortality in COPD (Chronic Obstructive Pulmonary Disorder) patients with decompensated respiratory acidosis ( $\text{pH} < 7.35$  and  $\text{PaCO}_2 > 6$  kPa) following immediate medical therapy. Ward studies have also shown a reduction in the need for ICU and reduced hospital costs compared to standard medical therapy. Mortality rates were reduced by approximately 50% (Mortality Relative Risk 0.52; 95% CI 0.35 to 0.76) 34, equating in usual clinical practice for a need to treat approximately 10 patients to save one life<sup>10</sup>.

Besides, the high cost and limited resource environment such as ICU has resulted in the higher need for NIV interventions outside the intensive care. Wards with trained nurses and resources that provide NIV are an effective alternative to ICU admission. The lack of sufficiently trained nurses to provide 24 h cover, the seasonal disuse that causes down-skilling, particularly during the summer months when lesser patients were admitted and inevitable staff turnover are other issues that prevent competent care of NIV patients. The principles behind the practice of NIV are relatively simple and can be mastered quickly. The real problems relate to service delivery. The service needs to be available 24 h per day. Nursing work practices, however, are based around shift work and therefore a sufficient cohort of interested staff needs to be trained in order to have a constant skill mix available<sup>7</sup>.

**Study variables:** This includes Dependent and Independent variables:

**Dependent variable**

- Nurses’ competence (This includes nurses’ knowledge, skill and attitude)
- Patient outcomes (Measured by monthly incidence of HAI, Hospital Acquired Infections)

**Independent variable**

- Onsite trainings related to care of non-invasive ventilation (NIV) patients

**Study hypotheses**

- The nurses’ knowledge, skills and attitude after intervention related to care of NIV patients would be higher than their knowledge, skills and attitude before intervention
- The NIV patient outcomes related to care of NIV patients will improve after intervention

Therefore the objective of study was:

- To assess the nurses’ competence in caring for NIV patients before and after intervention
- To identify the patient outcomes before and after intervention related to care of NIV patients
- To identify the effect of intervention related to care of NIV patients on nurses’ knowledge, skills and attitude

**MATERIALS AND METHODS**

The study was carried out in general wards of Dubai Hospital.

**Existing gaps in general wards of Dubai Hospital:** The researchers assessed the existing gaps by observation, open-ended interview with the Nursing supervisors, Charge nurses (of concerned wards), intensivists (who cover the NIV patients in wards) and biomedical technicians. The gaps identified were:

- Nurses’ knowledge on clinical signs of deterioration in the patients on NIV needs to be improved in general wards
- Nurses in general wards needed to become competent in caring for NIV patients
- Nurses did not understand the basic troubleshooting of the ventilating machine

- Nurses in general wards were unable to do the basic blood gas analysis
- Nurses lacked confidence in preparing for inter departmental patient transfer or power shutdown in general wards
- Improper infection control practices related to care of NIV patients, machine and its accessories were followed in the general wards
- Improper documentation in the nursing care plans

**Existing supports in Dubai Hospital**

- The ventilator accessories and the consumable equipments are stored in the general wards and a portable ventilator placed in the hospital’s “Equipment Library”, which was easily accessible
- Other available portable ventilators kept standby in MICU (Medical Intensive Care unit), SICU (Surgical intensive Care Unit) and Emergency Department
- Ongoing training sessions on ‘Care of patients on BIPAP’ for the nurses in general wards that included the principles of respiratory failure, the evolution and role of NIV and arterial blood gas analysis
- An existing nursing policy on “Ventilated Patient Care” in the hospital intra-site

Locally, the researcher monitored the frequency of NIV use in all the general wards of Dubai hospital from November 2013 until March 2014 (Table 1).

Data presented in Table 1 depicts that the wards with the highest frequency of NIV use include the male and female medical, nephrology and oncology wards. These wards were selected for the study. It is a common practice in this hospital, that patients are quickly put on the NIV and transferred from the Accident and Emergency department to the general wards. At other times, patients who deteriorate in the wards are referred to the intensivist who decides to connect them to

Table 1: Frequency of NIV use in general wards

	Nov’13	Dec’13	Jan’14	Feb’14	March’14
Total NIV days	138	99	138	161	186
Male surgical ward	0	0	0	0	0
Female surgical ward	0	0	0	0	0
Male medical ward	29	15	47	40	30
Female medical ward	102	70	79	93	117
Nephrology/Urology ward	1	3	12	7	21
Oncology ward	4	11	5	9	13
Hematology ward	0	0	1	3	0
VIP suites	1	2	7	9	3
Male cardiology ward	1	0	0	0	2
Female cardiology ward	0	0	0	0	0

the NIV. Such and increasing incidence of NIV patients in general wards required trainings for nurses on the care of NIV patients, basic blood gas analysis and troubleshooting of ventilators.

The design of this study was pre-experimental. A pretest, posttest design tested the effect of intervention related to care of NIV patients on nurses' competence (i.e., nurses' knowledge, skills and attitude) and the patient outcomes i.e., incidence of Hospital Associated Infection (HAI). The study was conducted in the general wards (medical, nephrology and oncology) in Dubai Hospital. The sample included 65 nurses selected using purposive sampling technique. The tools used for the data collection were List of Expectations, Questionnaire A and Questionnaire B, Highlights of Onsite Trainings, Policy on care of patients on non-invasive ventilation and NIV Competency Assessment Form. The researcher used the existing hospital policy and the competency forms that were available in the hospital intrasite for the study. List of expectations included the areas that the nurses need to prepare on, before being tested for their competencies. Important areas on nursing competence and documentation in nursing care plan were stressed on<sup>11</sup>.

During the month of March 2014, the researcher inspected the routines in the selected general wards (during her rounds) and identified the existing gaps in care of NIV patients. A random discussion with the supervisors, charge nurses and nurses of the selected general wards helped the researcher to understand the needs of the nurses. In addition, suggestions were taken from the intensivists, physiotherapists and biomedical staffs. Then the researcher started the study with pretests on the existing nurses' knowledge, skills and attitude and the patient outcomes (HAI rate). This was completed on March 28, 2014. Based on the pretests, onsite training was planned during the period between 1 to 30th May, 2014. A

critical care nurse with an extensive critical care background provided the nurses working in general ward with first-hand onsite training; expert also assessed their competencies. This teaching included topics on knowledge aspects, skill related topics (like the basic troubleshooting of the machine, recognizing signs of deterioration and preparing for power shutdown) and attitude areas like patient/family teaching. The monthly HAI incidence rates were procured. Post-tests were done on day 7 (from 8<sup>th</sup> June to 5<sup>th</sup> August 2014) and the HAI incidence was monitored for the following 4 months.

**Statistical analysis:** The McNemar's Test was used to find the association between the Pretest and Posttest in all the above areas of knowledge, skill and attitude. The effect of intervention on nurses' knowledge, skill and attitude was analyzed by Chi Square method. The p value remained statistically significant (p=0.00 to 0.014).

**RESULTS**

A total of 65 nurses received first hand training by an expert with a critical background experience. Practice related to care of NIV patients improved. All the 65 nurses were certified competent and among these, 25 nurses (i.e., 38% of nurses) who had scored well in the posttest were selected as Super trainers. These trainers will guide and train their colleagues in future. Ongoing support for the team leaders was continued.

- To assess the nurses' competence in caring for NIV patients before and after intervention

According to Table 2, nurses' knowledge on NIV modes and its differences improved from 20% in the pretest to 73.8% in the posttest. Only 23% of the staffs had knowledge on 'indications, contraindications, benefits of NIV, adverse mask effects and

Table 2: The results of McNemar's test on nurses' competence

McNemar's test				Chi-Square
Pretest posttest cross tabulation		Pretest (%)	Posttest (%)	Exact Sig. (2-sided)
Nurses' knowledge	NIV modes and its differences	20.0	73.8	0.000
	NIV indications, contraindications, benefits, adverse mask effects and complications of NIV	23.1	80.0	0.000
	Basic blood gas interpretation	23.1	47.7	0.004
	Battery location and battery life	35.4	78.5	0.000
Nurses' skill	Monitoring patient tolerance on NIV	21.5	70.8	0.000
	Nursing interventions	29.2	75.4	0.000
	Technical skills in nurses	30.8	55.4	0.014
	Identifying signs of patient deteriorating on NIV and immediate nursing actions	29.2	58.5	0.003
	Preparing for power shutdowns/Interdepartmental patient transfers	27.7	49.2	0.007
	Nurses documentation in care plan, notes and PFE forms	32.3	72.3	0.000
Nurses' attitude	Patient/Family communications and teachings	35.4	69.2	0.002

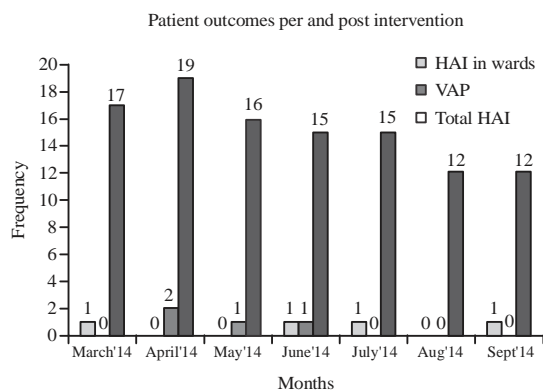


Fig. 1: The patient outcomes pre and post intervention related to care of NIV patients

complications of NIV in the pretest, which later improved to 80% in the Posttest. More nurses (47.7%) were able to correctly interpret the blood gases post intervention than before intervention (23%). The posttests revealed that 70.8% of nurses had acquired the skill of monitoring patient tolerance on NIV in contrast to the 21.5% in the pretest. Special skills like identifying deteriorating signs in an NIV patient increased from 29.2 to 58.5% and preparation for Power shutdowns/Inter-hospital patient transfers from 27.7 to 49.2%. The 72.3% of the nurses became efficient in nursing documentation posttest compared to the 32.3% in the pretests. Nurses' communications with patient/family and teachings also rose to 69.2% from 35.4%.

The McNemar's Test was used to find the association between the Pretest and Posttest in all the above areas of knowledge, skill and attitude. Here found that the p value remained statistically significant (p=0.00 to 0.014). This indicates there is significant change in the Posttests of nurse competency while compared with the pretest.

- To identify the patient outcomes before and after intervention related to care of NIV patients

The Hospital Acquired Infections (HAI), the patient outcome in the study, remained 0 to 1 throughout the months after the trainings. The Fig. 1 depicts the frequency of HAI, VAP (Ventilator Associated Pneumonia) in wards and the total HAI on y axis with respect to the months from March to September 2014 on x axis. The findings show that there was an overall decreasing trend of HAI rate over the posttest period indicating that the onsite trainings had a positive influence on the incidence of HAI in the selected general wards.

Table 3: Pre and post-test knowledge crosstabulation

McNemar's test-pre test * post test crosstabulation			
Post test			
Pre test	No knowledge	Knowledgeble	Total
<b>No knowledge</b>			
Count	54	140	194
Percentage within pre test	27.8%	72.2%	100.0%
Percentage within post test	69.2%	76.9%	74.6%
<b>Knowledgeble</b>			
Count	24	42	66
Percentage within pre test	36.4%	63.6%	100.0%
Percentage within post test	30.8%	23.1%	<b>25.4%</b>
<b>Total</b>			
Count	78	182	260
Percentage within pre test	30.0%	<b>70.0%</b>	100.0%
Percentage within post test	100.0%	100.0%	100.0%

Table 4: Pre and posttest skill crosstabulation

McNemar's test-pre test * post test crosstabulation			
Post test			
Pre test	No skill	Skillful	Total
<b>No skill</b>			
Count	92	187	279
Percentage within pre test	33.0%	67.0%	100.0%
Percentage within post test	64.8%	75.4%	71.5%
<b>Skillful</b>			
Count	50	61	111
Percentage within pre test	45.0%	55.0%	100.0%
Percentage within post test	35.2%	24.6%	<b>28.5%</b>
<b>Total</b>			
Count	142	248	390
Percentage within pre test	36.4%	<b>63.6%</b>	100.0%
Percentage within post test	100.0%	100.0%	100.0%

- To identify the effect of intervention related to care of NIV patients on nurses' knowledge, skills and attitude

**Nurses' knowledge:** Table 3 shows that the knowledge of nurses caring for patients on NIV improved from 25.4% in the pretest, to 70% in the posttest. The McNemar's test showed there was a statistically significant improvement in the knowledge of nurses' posttest with p value of 0.000 (i.e., p<0.05).

**Nurses' skill:** According to Table 4, the nurses' skills in caring for patients on NIV showed an improvement from 28.5% in the pre-test, to 63.6% in the post-test. The McNemar's Test was used to find the association between the pre-test and post-test nurses' skill after intervention on Patient/family communication and teachings. It was found that p=0.000 (i.e., p<0.05) indicating that the change in proportion of nurses' skills following intervention was statistically significant.

Table 5: Pre and post-test attitude crosstabulation

McNemar's test-pre test * post test crosstabulation			
Post test			
Pre test	Poor attitude	Good attitude	Total
<b>Poor attitude</b>			
Count	7	35	42
Percentage within pre test	16.7%	83.3%	100.0%
Percentage within post test	35.0%	77.8%	64.6%
<b>Good attitude</b>			
Count	13	10	23
Percentage within pre test	56.5%	43.5%	100.0%
Percentage within post test	65.0%	22.2%	<b>35.4%</b>
<b>Total</b>			
Count	20	45	65
Percentage within pre test	30.8%	<b>69.2%</b>	100.0%
Percentage within post test	100.0%	100.0%	100.0%

**Nurses' attitude:** As per Table 5, the nurses' attitude, which was 35.4% in the pretests, improved to 69.2% in the post-test. The McNemar's Test was used to find the association between the pre-test and post-test attitude after intervention on Patient/family communication and teachings. The p-value was 0.002 (i.e.,  $p < 0.05$ ), which was statistically significant. This indicates that the change in the proportion of nurses' attitude (from poor to good) following intervention, was statistically significant.

## DISCUSSION

The educated nurses and selected super trainers in all the selected general wards for future management and guidance as per VAP Prevention strategies 2014 were updated. Study findings as shown in Table 3, 4 and 5 infer that teaching was effective in improving the nurses' knowledge, practice and attitude. There was an overall decreasing trend of HAI rate over the post-test period (Fig. 1) indicating that the onsite trainings had a positive influence on the incidence of HAI in the concerned general wards.

A very recent cross-sectional, descriptive study in 4 intensive care units, 1 postsurgical recovery room, 2 emergency departments and 3 general wards, performed in four hospitals with 407 professionals found the lack of knowledge among nurses and physicians regarding NIV therapy depended on training received and material available. The study suggested the use of a single type of NIV supply and provision of an appropriate training for nurses to reduce confusion<sup>12</sup>.

A study done on 147 nurses who were working at a Training and Research Hospital in Istanbul said that NIV practices required trained nurses and that these nurses should receive

a training program which included clinical experience as well as theoretical information<sup>13</sup>.

Meta-analyses suggest that oral care with chlorhexidine can decrease the microbial burden of the aerodigestive tract and reduce pneumonia rates in this population by 10 to 30%<sup>14</sup>.

A 2013 article supported the above findings by stressing that simulation based trainings can prove effective in improving clinical skills acquisition and these skills can in turn improve patient care and clinical outcomes. It said such a tool can be used for NIV training of clinicians to develop their knowledge and skills related to NIV<sup>15</sup>.

Similar findings were noted in a 2012 study, in which a structured questionnaire probed doctors' understanding, confidence and practical skills in administering NIV. The questionnaires were answered after a teaching session. A 43% of interns did not know what "BiPAP" stands for; 33% described their knowledge of NIV indications as inadequate; 87% of nurses claimed they had no formal education or training on the use of NIV; same number of nurses admitted they had inadequate practical knowledge of NIV and 70% felt their confidence was inadequate with regard to managing patients on NIV. An overwhelming majority of nurse respondents (90%) felt they required formal training on how to use NIV to ensure patient safety. The study concluded by stressing on the importance of formal teachings<sup>16</sup>.

Standardized protocols that guide nurses to perform weaning in a uniform style ensure safe practice and quality care for the critically ill<sup>17</sup>.

Another study in 2000 used a quantitative questionnaire and audit to assess pre and post medical and nursing staff knowledge, confidence and current NIV practice after an education program and algorithm protocol were initiated on small group sessions (in both theoretical and practical aspects). It found that such a focused education and algorithm guidance can improve the management of patients requiring acute NIV<sup>18</sup>.

Future studies would benefit from including patient and family perspectives and exploring the congruence between nurses' perspectives and those receiving their care.

## CONCLUSION

NIV is now considered as a safe and effective therapy to treat patients with respiratory failure from COPD or congestive heart failure on the general medical floor outside intensive care units. Ongoing trainings on changing trends will not only make the nurses knowledgeable, skillful and confident in

caring for the NIV patients, but also reduce the incidence of hospital-acquired infections in these NIV patients. Standardized protocols on weaning not only describes a uniform style of weaning but also can prove to be especially beneficial safe and quality care for patients. Nurses should have initial training in setting up and looking after patients on NIV before the service is introduced in the general wards. A regular continuing training program for all new nurses involved in setting up and looking after patients on NIV should be in place.

### **Study implications on clinical practice and future recommendations:**

The study findings remind the need for regular trainings for nurses. This can help increase the confidence of nurses in general wards and further help reduce the need for critical care beds and nurses. Nurse administrators must ensure availability of trained staff and adequate skill mix as well as adequate ventilator, accessories and oral care supplies. The study implies the importance of initial orientation with hands on practice and trainings for the novice nurses.

The researcher recommends further studies on Patient/Family views and perceptions on the use of NIV, Seasonal trends in use of NIV and performing similar study on pediatric patients on NIV. After completion of this study, the researcher made a few recommendations to Nurse Supervisors in the selected general wards. These included 'placing NIV patients in high dependency beds where the patients could be closely monitored', 'to maintain the nurse patient ratio as 1:2 as much as possible' and 'to strictly follow the listed Infection Control Standards'. Besides, the unit in charges was encouraged to ensure provision of adequate supplies and infrastructure and conduct follow up inspections and positive reinforcements to keep up the good work.

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