Original Article

Noninvasive Ventilation with Nursing Perspective: Impacts on Patient Tolerance, Short-Term Adverse Effects, and Nursing Workload

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Abstract

Background: The success of noninvasive ventilation (NIV) treatment is closely related to high levels of clinical support. **Aims:** In this study, we sought to analyze patient mask compliance and minor side effects and to evaluate additional nursing workload needed for the NIV care. **Materials and Methods:** The study was designed as a prospective and observational. The data were collected from an intensive care unit. Clinical and physiological data, patient tolerance and adverse effects, subjects' complaints about their experience, and additional nursing workload associated with NIV treatment were assessed. **Results:** Statistically significant improvements were obtained in arterial blood gas analysis, respiratory rate, and heart rate during treatment. In the first 2 h, 65% of subjects had poor mask compliance, patients' comfort scores were poor, and incompliance was associated with discomfort. The ratio of skin problems was 15% in the first 24 h and reached 60% at 48 h. The pain rate due to mask ties was 80% and then increased to 90% at 48 h. There was a significant relationship between the problems detected by the nurses and problems described by the subjects. Additional nursing workload was found as 110 min for 0–6 h. **Conclusions:** We observed that the mask compliance and comfort levels of the subjects were poor. Skin breakdowns increased depending on the duration of treatment. Treatment would require continuous nursing support in seven areas. NIV treatment generated a significant amount of workload for nurses. Additional nursing workforce planning is required for NIV units for successful NIV treatment.

Keywords: *Mask compliance, minor adverse effects, noninvasive ventilation, nursing care, nursing workload*

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Introduction

Noninvasive ventilation (NIV) is defined as ventilatory support treatment that provides mechanically positive pressure respiration, by using a mask or similar device, without the requirement of an invasive artificial airway.[1] The success of NIV treatment depends on several factors such as type and severity of underlying disease, careful patient selection, appropriate ventilator settings, choice of appropriate location, use of the suitable interface to patient, close monitoring, and trained and experienced clinical team.[2,3]

All patients should be monitored for clinical, physiological, ventilatory parameters, NIV complications, and signs of NIV failure, until they are stabilized. Clinical parameters, which should be followed, can be summarized as comfort, mask compliance, respiratory rate (RR), dyspnea, use of accessory muscles, consciousness, effective cough, and minor side-effects (e.g., skin breakdowns, nasal-oral congestion/dryness, eye irritation, gastric distention). Physiological parameters include SpO_2, arterial blood gas (ABG) analysis, and end-tidal CO_2. In addition,

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real-time ventilator setting parameters and the cardiac parameters such as heart rate (HR) and blood pressure must be monitored.[2,4,5] Other areas that should be taken care off by the nursing team are observation of patient daytime wakefulness and function increase; head strap tightness, management of patients' pain and anxiety; protection of patient upright position; controlling of respiratory secretions and protect airway; monitoring of patient's sleep time and quality; and preparation of equipment for invasive procedures (e.g., blood gases sample).[4,6,7] As the close monitoring requirement and the fact that most of the parameters to be monitored are involved in nursing activities, nurses must take an active role as key personnel in this treatment process.

Aim of study

Naturally, a significant majority of the studies about NIV is related with the indications-contraindications, technical aspects, and the effect of this treatment on the prognosis. However, the studies, focused on challenges which patients face during treatment process, nursing care requirements, and the reflection of this treatment on nursing care, are limited in the literature. The aims of this study are to analyze mask compliance and the short-term adverse effects that are in the NIV nursing responsibility areas, and to evaluate the effect of NIV on nursing workload.

Materials and Method

Study design and setting

The study was designed as a prospective and observational study. Data were collected from May 2014 to July 2014 from a single ICU. The study's population consisted of 65 patients who received NIV treatment within 1 year in ICU, and the number of samples was calculated as 20 adult patients who are suffering from acute respiratory failure (ARF). This study was approved by Ethical Committee for Non-Interventional Clinical Research (decision no: 44140529 / 2014-34) and written consent was obtained from the subjects.

NIV treatment was administered with a standardized predefined protocol. The patients were ventilated with intensive care ventilators (bi-level positive airway pressure-BiPAP Vision) in the pressure support mode. NIV was applied via total face mask (TFM). Data were recorded before NIV administration and during the 48-h treatment period.

Data Collection Tools: In the study, data were collected in four categories. The details of the data collected in the study are shown in Table 1:

1. Demographic, clinical, and physiological outcomes of subjects.
2. Nursing Observations: This observations consists of four sections: a. Patient tolerance: Patient tolerance was assessed in two separate parameters: mask compliance and patient discomfort. To evaluate mask compliance "the patient compliance scale" was used which was developed by Achmet *et al*.[8] Patient discomfort was assessed by using a visual analog scale (VAS); b. Visual skin assessment; c. Oral assessment; e. Other problems.
3. Patients' feedback about NIV treatment: The problems that patients experienced during NIV treatment were assessed with a survey containing 13 questions.
4. Nurse workload: The pathway followed to determine the nurse workload is like this:
    1. NIV-related nursing care practices were divided into seven groups [Table 1].
    2. For the purpose of calculating nurse workload, the frequency of entrance to the patient's room and time spent by the nursing staff for each practice in the first 2 and 2–6 h of treatment were recorded using a checklist and a stopwatch.
    3. Additional nursing workload was calculated by multiplication of the mean frequency and the mean time spent on each procedure.

Statistical analysis

Statistical analyses were performed using SPSS (SPSS for windows release 17. 0). Descriptive statistics (count, means, standard deviation, and ranges) were calculated for continuous variables. Categorical variables were expressed as frequency and percentage. Continuous variables were compared by the Student's t-test and categorical variables by the Chi-square test (χ^2). Spearman correlation analysis was used in determining the relationship between variables. Findings were evaluated at 95% confidence interval and at $P < 0.05$ (5%) significance level.

Results

During the study period, 20 patients, who were admitted to ICU due to ARF and for who NIV treatment was decided, were included in the study. The mean age was 65.60 ± 15.5 years (range: 33–83 years); 14 (70.0%) were male. As seen in Table 2, statistically significant improvements were obtained when the results for the PaO_2, SpO_2, RR, and HR at the 2 and 48 h of NIV, compared with the values before NIV treatment ($P < 0.05$).

At the 2 h, the poor mask compliance was found in 13 subjects (65%) and the mean mask compliance score was 2.1 (±1.02). These values changed as, respectively, 11 (55%) and 2.4 (±1.88) at 24 h. At the 48 h, poor mask

Table 1: Data collection tool

		Variables			Variables
1. Demographic, Clinical, and Physiological Outcomes		Demographic	Age, gender, education, marital status	3. Patients' feedbacks about NIV treatment	Mask compliance,
Clinical			Diagnose, hypercapnic/hypoxemic ARF, APACHEE II scores		Skin, mouth, nose, and eyes problems,
Physiological			RR and HR, SpO2, ABG values of the initial/2/48 h of the treatment		Gastric distension,
Complications			Ventilator-associated pneumonia, orotracheal intubation, aspiration pneumonia		Sleeping,
					Feeding,
					Maintain the determined position,
2. Nursing Observations	a. Patient tolerance	Mask compliance	Patient compliance scale: 1=Worse, patient is removing the mask; 2=Mild, mask ventilation continues with suggestions and support made to the patient; 3=Good, patient does not feel very uncomfortable and does not want to remove the mask; 4=Perfect, fully compatible).		Pain due to mask ties,
					Speech and communication,
					Loneliness and restriction,
					Feeling of fear
		Patient discomfort	Visual analog scale: from very severe discomfort=10 to very comfortable=0		
	b. Other problems	Visual skin assessment	1=No finding; 2=Prolonged erythema or maceration; 3=Acneiform rash or superficial abrasion; 4=Skin ulceration		
		Oral assessment	Oral Mucous Membrane Monitoring Form (OMM): adding 7 points for NIV oral care was applied to the patients (>17=12×1, 16-9=6 × 1, 8-0=3 × 1 times/day).		
		Eye problems	Redness, dryness, itching		
		Nasal problems	Irritation, dryness/congestion		
		Gastric distention	Bloating in the stomach		
		Sleep problems			
		Difficulties of maintaining the position (the semifowler position in bed)			
		Mask ties-related problems			
4. Nurse workloads	a. Providing of the mask safety (to ensure the mask sit on the face, to support the patient about breathing with a mask)				
	b. Response to monitor and ventilator alarms				
	c. Detection and preventing of unintentional air leaks from mask (control of air leak or facial moisture, adjust the tightness of the mask ties)				
	d. Assessment respiratory status (chest wall movements, use of accessory respiratory muscles, lung sounds, monitoring peripheral or central cyanosis)				
	e. Helping to maintain a fixed position				
	f. Taking the blood gases sample				
	g. Preparation of equipment for invasive procedures (e.g., central venous/arterial/nasogastric catheter).				

Notes: Demographic, clinical, and physiological outcomes were assessed initial/2/48 h of the treatment. Patient tolerance: Mask compliance and discomfort were assessed at the 2, 24, and 48 h of treatment. We evaluated in the direction of 1-2 point=mask incompliance, 3-4 point=mask compliance. Skin was assessed by inspection of the face at 24 and 48 h/Other observations were assessed at the 2, 24, and 48 h of treatment as "No finding/There is a finding." Patients' feedbacks about NIV treatment were assessed at the 48 h as "I haven't had any problem," "I experienced moderate problems," and "I had a lot of problems"

compliance decreased to 6 (30%) and the mean "mask compliance score" increased to 2.8 (± 1.81). The increase between the compliance scores shows a significantly positive correlation (for 2–24 h r = 0.672; P = 0.001; for 2–48 h r = 0.567; P = 0.009). At the first 2 h, mean patient discomfort score that evaluated with VAS was poor (mean: 7.00 ± 1.33). Patients' comfort increased progressively during the study (at the 24 h mean: 4.45 and at 48 h mean: 3.40) [Table 3]. As seen in Table 3, a significant negative correlation was detected between

Table 2: Clinical and physiological outcomes of patients during NIV

Variables	Before		2 h		48 h		Compare with	Compare with
	Mean	±SD (min-max)	Mean	±SD (min-max)	Mean	±SD (min-max)	Before/2 ht/*P*	Before/48 ht/*P*
pH	7.37	0.1 (7.13-7.5)	7.37	0.08 (7.19-7.49)	7.40	0.07 (7.18-7.50)	t: 1.221 P: 0.237	t: 1.849 p: 0.080
PaO_2	78.5	19.3 (52.8-141.0)	96.8	18.6 (74.4-136.0)	96.6	23.1 (41.7-151.0)	t: 3.407 ***P*: 0.003**	t: 2.824 ***P*: 0.011**
$PaCO_2$	44.1	25.4 (23.7-130.0)	41.6	19.7 (25.6-98.4)	38.9	10.5 (23.8-68.0)	t: 1.206 P: 0.243	t: 1.189 P: 0.249
RR	33.1	6.4 (20.0-45.0)	25,3	4.8 (18.0-35.0)	24.2	6.1 16.0-40.0)	t: 5.904 ***P*: 0.000**	t: 5.022 ***P*: 0.000**
SpO_2	92.5	5.2 (82.0-99.0)	96.1	2.9 (91.0-100.0)	95.3	3.2 86.0-100.0)	t: 3.382 ***P*: 0.003**	t: 2.282 ***P*: 0.034**
HR	109.6	24.8 (70.0-165.0)	94.8	17.9 (65.0-133.0)	92.1	18.9 (40.0-120.0)	t: 3.679 ***P*: 0.002**	t: 3.692 ***P*: 0.002**
IPAP	19.2	3.6 (12.0-27.0)	19.2	3.6 (12.0-27.0)	19.1	3.4 (13.0-27.0)	t: 0195 P: 0.847	t: 0.071 P: 0.945
EPAP	8.6	2.7 (5.0-16.0)	8.2	2.1 (5.0-13.0)	9.1	2.2 (5.0-14.0)	t: 0.878 P: 0.391	t: 0.679 P: 0.505

Abbreviations: NIV=noninvasive ventilation; SD=Standard deviation; PaO_2=partial pressure of oxygen; $PaCO_2$=partial pressure of carbon dioxide; SpO_2=peripheral oxygen saturation by pulse oximeter; RR=Respiratory rate; HR=Heart rate; IPAP=Inspiratory positive airway pressure; EPAP=Expiratory positive airway pressure. Statistical analysis: Paired group *t*-test (Italicized numbers indicate *P* values were less than 0.05)

Table 3: The patients' mask compliance and discomfort scores, and comparisons between variables

	Rating	Female (*n*: 6)	Male (*n*: 14)	Total	χ^2/*P**
		n (%)	*n* (%)	*n* (%)	
Comparison of mask compliance at 2 h between female and male	Incompliance (1-2 Point)	3 (50.0)	10 (71.4)	13 (65.0)	χ^2=3.855 *P*=0.278
	Compliance (3-4 Point)	3 (50.0)	4 (28.6)	7 (35.0)	
Comparison of discomfort scores at 2 h between female and male	Rating Discomfort (10) Comfort (1)	Female (*n*: 6) Mean/SD 6.00 (± 1.095)	Male (*n*: 14) Mean/SD 7.42 (± 1.222)	Total mean; SD; range 7.00 (± 1.33; 4-10)	*t*/*P*† t=2.463 *P*=0.024

	Mask compliance Mean (±SD; range)	Discomfort Mean (±SD; range)	*r*/*P*‡
Comparison between mask compliance with discomfort scores at 2 h	2.1 (±1.02;1-4)	7.00 (±1.33; 4-10)	r=−0.603 *P*=0.005
Comparison between mask compliance with discomfort scores at 24 h	2.4 (±1.88; 1-4)	4.45 (±1.57; 2-8)	r = -0.783 *P*=0.000
Comparison between mask compliance with discomfort scores at 48 h	2.8 (±1.81; 1-4)	3.40 (±1.72; 0-7)	r = -0.574 *P*=0.008
Comparisons of mask compliance scores for 2-24 h ‡:			r=0.672, *P*=0.001‡;
Comparisons of mask compliance scores for 2-48 h ‡:			r=0.567, *P*=0.009‡
Comparisons of subject discomfort scores for 2-48 h‡:			r=0.413, *P*=0.070‡;
Comparisons of subject discomfort scores for 24-48 h‡:			r=0.508, *P*=0.022‡

SD: Standard deviation, * Chi-square test, † Student t-test, ‡Spearman correlation analysis (Italicized numbers indicate *P* values were less than 0.05)

Table 4: Patient experiences after the NIV treatment and comparisons between nurse observations with patient experiences

Problems	Nursing Assessment	Patient Experiences			Total	Comparisons
		Not *n* (%)	Partially *n* (%)	Much *n* (%)		χ^2/*P*
Mask compliance score (3-4=Well, 1-2=Poor)	Well	2 (100.0)	6 (85.7)	1 (9.1)	9	χ^2=15.269
	Poor	0 (0.0)	1 (14.3)	10 (90.9)	11	*P*=0.018
	Total	2 (100.0)	7 (100.0)	11 (100.0)	20	
OMM Score>17=Yes, <16=No	Yes	1 (50.0)	3 (75.0)	11 (78.6)	15	χ^2=0.762
	No	1 (50.0)	1 (25.0)	3 (21.4)	5	*P*=0.683
	Total	2 (100.0)	4 (100.0)	14 (100.0)	20	
Eye (redness, itching, tears)	Yes	1 (9.1)	7 (100.0)	2 (100.0)	10	χ^2=16.364
	No	10 (90.9)	0 (0.0)	0 (0.0)	10	*P*=0.000
	Total	11 (100.0)	7 (100.0)	2 (100.0)	20	
Nose problems (dryness, itching, congestion)	Yes	2 (25.0)	6 (85.7)	5 (100.0)	13	χ^2=9.639
	No	6 (75.0)	1 (14.3)	0 (0.0)	7	*P*=0.008
	Total	8 (100.0)	7 (100.0)	5 (100.0)	20	
Gastric Distension	Yes	1 (8.3)	5 (83.3)	2 (100.0)	8	χ^2=12.708
	No	11 (91.7)	1 (16.7)	0 (0.0)	12	*P*=0.002
	Total	12 (100.0)	6 (100.0)	2 (100.0)	20	
Difficulty in maintaining position	Yes	0 (0.0)	1 (50.0)	8 (100.0)	9	χ^2=17.980
	No	10 (100.0)	1 (50.0)	0 (0.0)	11	*P*=0.000
	Total	10 (100.0)	2 (100.0)	8 (100.0)	20	
Pain (due to mask ties)	Yes	0 (0.0)	3 (42.9)	13 (100.0)	16	χ^2=9.286
	No	0 (0.0)	4 (57.1)	0 (0.0)	4	*P*=0.007
	Total	0 (0.0)	7 (100.0)	13 (100.0)	20	
Facial Skin Problems		13 (65.0)	3 (15.0)	4 (20.0)	20	
Feeding Problems (depending on not leaving the mask)		0 (0.0)	9 (45.0)	11 (55.0)	20	
Sleeping Problems		6 (30.0)	11 (55.0)	3 (15.0)	20	
Speech and communication		2 (10)	9 (45)	9 (45)	20	
Loneliness and restriction		3 (15)	6 (30)	11 (55)	20	
Fear		4 (20)	7 (35)	9 (45)	20	

OMM=Oral mucous membrane. Statistical analysis: Chi-square test (Italicized numbers indicate *P* values were less than 0.05)

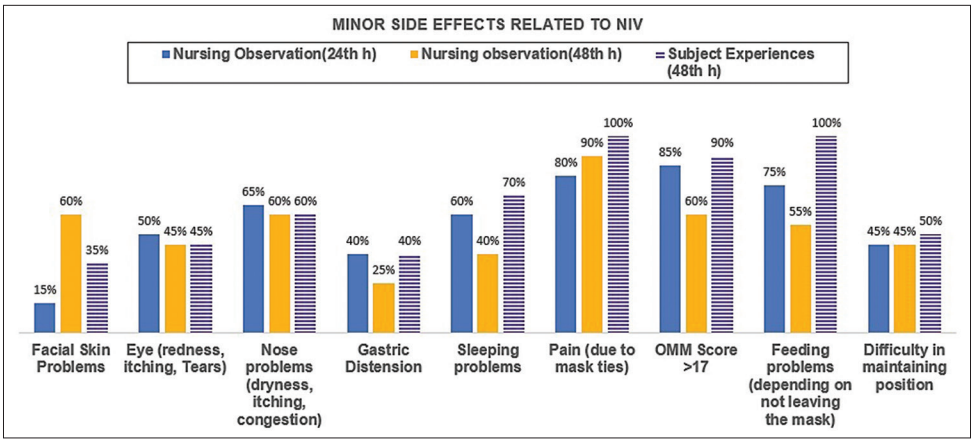

Figure 1: Rates of minor side effects according to nursing observations and patients' feedback

mask compliance and discomfort scores of the patients (at the 2 h: r = −0.603, *P* = 0.005, at the 24 h: r = −0.783, *P* = 0.000, and at the 48 h r =−0.574, *P* = 0.008).

Figure 1 shows other adverse effects recorded at the 24 and 48 h after initiation of NIV. The rate of facial skin problems (erythema) based on nurse observations was found 3 (15%) at the 24 h and reached 12 (60%) at 48 h, related to the duration of NIV.

The feedbacks of patients based on their experience related to NIV treatment are shown in Figure 1 and

Table 5: Nursing workload related to NIV treatment

NIV-Related Nursing Care Practices	For 0-2 h			For 2-6 h			For 0-6 h
	Mean* entrance frequency	Mean† time spent	Mean workload§ (min) (SD; range)	Mean* entrance frequency	Mean† time spent	Mean workload§ (min) (SD; range)	Total workload
Providing mask safety	6.07	0.96	5.83 (±2.24; 2.80-9.86)	4.35	0.87	3.79 (± 2.035; 0.85-9.2)	9.62
Response to monitor/ ventilator alarms	5.25	1.28	6.75 (±3.24; 0.0-14.00)	3.55	1.03	3.67 (± 2.05: 0.0-9.06)	10.42
Detection and prevention of air leak from mask	3.12	2.16	6.73 (±4.68; 0.0-15.86)	2.2	2.24	4.74 (±3.66; 0.0-12.71)	11.47
Assessment the respiratory state	1.62	5.80	9.41 (±7.38; 5.0-36.70)	1.20	5.50	6.60 (± 4.26; 0.0-22.33)	16.01
Help to patient for maintaining the position	2.13	6.30	13.45 (±10.01;5.70-37.70)	2.4	7.74	18.65 (± 9.39; 7.45-39.16)	32.1
Preparation and assistance to obtain blood gases sample	1.26	3.20	4.06 (±2.34; 1.83-10.55)	1.5	3.07	4.60 (± 2.08; 2.88-9.35)	8.66
Preparation and assistance for the other invasive procedures	1.53	12.22	18.75 (±15.84; 0.0-64.0)	0.29	10.30	3.04 (± 4.79; 0.0-11.25)	21.79
Total workload and Ratio of nurse workload to NIV time			**65.02** (±; 30.30; 23.68-125.78) **54% (for 2 h)‖**			**45.13** (±17.35; 21.58-73.13) **18.8% (for 2-6 h)****	**110.11** **30%** **(for 0-6 h)¶**

*: Represents the mean frequency the entrance by the nursing staff to the patient's room for each practices. †: Represent mean time spending by the nursing staff for each practices (as minute). §: Represents additional nursing workload for each procedure as minute (mean frequency×the mean time spent). ‖: Represents percentage of nursing workload for the first 2-h NIV time. **: Represents percentage of nursing workload for the 2-6 h NIV time. ¶: Represents percentage of nursing workload for the 6-h NIV time

Table 4. The percentage of patients who expressed that they had a lot of problems related with "mask compliance" were 11 (55%). This rate is found to be 13 (65%) for the "pain related to the mask and ties" parameter. were 13 (65%) and 7 (35%). The results analyzed with χ^2 test among nursing observations and patients' feedback showed statistically significant relationship [Table 4].

The mean frequency of patient room entry, mean time spent, and nursing workload for each procedure at the first 2 h are presented in Table 5. To provide mask safety, the mean number of entrances was 6.02, mean time spent was 0.96 min for each entrance, and the mean nurse workload was 5.83 ± 2.24 min (range: 2.8–9.8) per patients. The most time-consuming nursing practices were to help maintaining the position (entrance frequency 2.13, time spent 6.3 min, and nurse workload 13.45 ± 10.01 min, range: 5.7–37.7) and to prepare and assist with the invasive procedures (entrance frequency 1.53; 12.22 min, workload 18.75 ± 15.84 min, range: 0–64). Additional workload of NIV-related nursing practices, collected in seven groups, was found 110 min in total for 0–6 h. The workload during in the first 2 h (65 min) was longer than in the 2–6 h (45 min) [Table 5]. In the 2, 24, and 48 h of NIV treatment, significant negative correlation was determined between mask compliance scores and nursing workload for "providing mask safety" (Spearman correlation test: 2 h r = −0.644, P = 0.002; 2–6 h r: −0,645, P: 0.002; 24 h r = −0.732, P = 0.000; 48 h r = −0.673, P = 0.001). As the mask compliance scores increase, the workload for providing mask safety decreases.

Discussion

Analyses on ABG are critically important for decision-making to initiate the NIV treatment, and also for assessing NIV success or failure. In our study, when the changes in ABG and cardio-respiratory parameters were assessed, improvements were observed in the prognosis of patients compared with the pretreatment period.

Enhanced mask compliance and patient comfort are the key factors for the patient's adaptation to this "new mode" of breathing[9] and determining successful application of NIV. Mask compliance refers to the patient's adaptation to the mask and being able to breathe through the mask.[9] Mask incompliance due to mask pressure, pain, claustrophobia, poor cooperation, agitation, etc., may lead the patient to remove the mask frequently, and to refuse ongoing NIV treatment.[10,11] Patient discomfort

is defined as a feeling related to excessive air pressure, mask incompliance, skin breakdowns (SB), air leaks, and desynchrony.[12] But, mask compliance and patient comfort are interrelated and they influence the NIV treatment success. Nurses should try to optimize patient's comfort and mask compliance by choosing appropriate interface, motivating the patient for better synchrony, taking precautions to protect tissue integrity, and encouraging the patient to report any discomfort or fears.[13,14]

In our study, the mask compliance of patients, which was 2.1 (moderate) at the beginning of treatment, increased to 2.8 at the 48 h of treatment. Although there was a partial increase tendency in the mean score, the mask incompliance problem continued during all treatment period. In addition, VAS score averages at 2 h were poor (7.0) and then improved to 3.4 at 48 h. These results indicate that patients were experiencing mask incompliance and discomfort in the early stages of NIV treatment. There was a negative correlation between mask compliance scores and discomfort scores. It was noticed that as the mask compliance increased, the patient comfort also increased. When we look at the studies that used the TFM, mask compliance score was 2.2 at the 2 h in the study by Achment *et al*.[8] similar to our study. According to another study, the effect of poor tolerance on NIV success was emphasized, and the rates of poor tolerance were found 19% in the NIV failure group vs. 7% in the NIV success group.[15] Schwabbauer *et al*.[16] found that patient comfort was 5.4 for total face mask (TFM) (1–10 point, the low numbers indicated discomfort). In addition, in the study of Sadeghi *et al*.,[17] the patient comfort score was determined as 3.13 for the TFM (1–5 point, 1: extreme discomfort). All these results indicate that patients in NIV treatment are challenged in terms of mask adaptation and they need support, especially in the first hours. Therefore, the nurses who are responsible for monitoring patients and adapting them to their masks must be prepared to fight this problem.

One of the most unpleasant and painful iatrogenic interface-related complications in NIV is the development of SB. The presence of SB may increase patient discomfort and be an aggravating factor that increases the patient's incompliance to the mask. In our study, none of the patients developed skin ulceration. But erythema was observed in only 15% of subjects in the first 24 h and this rate increased at 48 h (erythema 50%, abrasion 10%). These results indicate that the risk of developing SB is closely related to the duration of NIV. Similar to our study, Yamaguti *et al*. in their study[18] detected that the frequency of SB was increased when the NIV duration was prolonged. Likewise in another study, the rate of pressure ulcer development in TFM was 2%, and the mean time of the pressure ulcer development was 61.37 h for the TFM.[19] Since TFM distributes the pressure to a wider surface, it can reduce soft tissue damage. Some studies state that TFM is a more suitable alternative for patients due to this effect.[19-22] This may help to explain the minimal SB levels in our study as well. During NIV treatment, nurses should routinely evaluate the skin in terms of signs such as rash, erythema, abrasion, and pressure ulcers. In addition, in order to prevent these skin lesions, nurses should provide protection by changing the position of the mask, reducing mask friction and pressure, adjusting the mask ties properly, developing skin-protective strategies, and providing face hygiene.[14,19,23]

According to assessments based on nurse observation in our study, mask-related other short-term adverse effects, such as eye irritation, nasal irritation, difficulty of maintaining determined position, were observed in the nearly half of the subjects during all treatment process. As the subject's compliance increases after the first 24 h, gastric distention, sleep disturbance problems tend to decrease. However, the feeling of pain caused by the mask ties was a big problem for nearly all subjects during treatment process. When the literature is observed, the rates for "mask-related other short-term adverse effects" are similar to our study. For instance, in the study of Holanda *et al*.,[20] pain in the forehead, jaw, and cheek associated with TFM was seen in 25%–40%, dry or congested nose in 35%, skin irritation in 30%, and claustrophobia in 40%. In another study, nasal congestion/mouth dryness was seen in 32%, and eye irritation was seen in 26% of the patients using TFM on the first day. On the second day, these rates increased to 70% and 52%, respectively.[24]

In this study, we also compared the rates of problems identified by nurses with the patients' experiences, and the results showed a significant relationship in-between. These mutually supportive results reveal the must-focus areas of nursing care in the NIV treatment.

In the ICU where the current study was done, the physicians were responsible for planning and initiating treatment. A respiratory therapist or anesthetist was not available for the continuous monitoring of NIV therapy. Therefore, nurses were actively involved for monitoring the subjects, as well as running the NIV treatment. In this presented study, considering this ICU structure and the most common nursing activities, NIV-related nursing care practices were grouped into seven categories. The nursing workload associated with NIV treatment was found to be 110 min for the first 6 h per subject, which

is approximately 30% of 6-h NIV treatment. The nursing workload, which was 65 min in the first 2 h (54% of 2-h NIV session), showed marked decrease after the first 2 h (18.8%). The most frequent reasons for entry into the patient room in the first 2 h were "providing mask safety" and "response to monitor and ventilator alarms." When the mask compliance and patient comfort scores in the first 2 h are taken into consideration, this entrance frequencies seem reasonable. This is also supported by the significant negative correlation between mask safety workload and mask compliance scores of subjects. Plant and Owen[25] used a similar method to our study to calculate workload. Nearly the same as our outcomes, they found the nursing workload 105 min for the 0–8 h NIV time. Another study using a similar calculation method found the mean nurse time spent: "10 min for each 45-min NIV sessions."[26] This can be interpreted as 80 min workload for 6 h, which is a little lower than our results. Lucchini *et al*.[27] used a different methodology to measure the nursing workload (nursing activities score); they determined ideal nurse/patient ratio as 0.7 for NIV treatment in ICU. Some studies draw attention to the limited resources on the use of NIV treatment in general wards. For example, in a study respondents stated that the most common reasons for not using NIV in general ward were limited training and human resources (24.8%), safety concerns (20.4%), and lack of training (29.9%).[28] Another parallel study showed that the NIV success was lower in general wards than ICUs (58% vs. 73%).[29] They stated that these results could be explained with limited monitoring capacity and the lack of managing the interface. The study of Schmidt *et al*.[30] focused on the nurses' point of views about NIV treatment. In this survey study about perception of NIV, nurses generally reported more negative feelings and low willingness than physicians. According to nurses, the determinants of these results were related to ICU structural characteristics, excessive NIV-related workload, and the suffering of patients. Although there are differences in methodology to calculate the nursing workload and the choice of treatment-related nursing activities, all studies including our research indicate that NIV treatment will bring additional workload to nurses.

Conclusion

The important results obtained from this study can be summarized as follows: Patients' mask compliance levels, which was low at the beginning of treatment, increased with nursing support and continuous monitoring, and as the mask compliance increased, patient comfort also increased. SB incidence showed an increase related to NIV time. Mask-related short-term adverse effects were observed in almost half of the patients. NIV treatment created mean 110 min an additional nurse workload per patient in the first 6 h. The nursing workload was higher, especially in the first 2-h NIV treatment. "Providing mask safety" is the top reason for frequent entry into the patient room. Moreover, "helping patient to maintain position," and "preparation and assistance for the other invasive procedures" are the most time-consuming nursing practices. Our study was conducted in an ICU which had a nurse-patient ratio of 2/1, additionally the patients hospitalized at different times during 1 month. For these reasons, nurses were able to cope with nursing workload and adverse effects during the NIV treatment. But, it is possible that the nurse will be faced with different problems in case of NIV treatment in emergency units or general wards. NIV success and prevention of NIV failure depend on continuous monitoring of ventilatory support by medical and nursing staff with sufficient time and experience. Therefore, we think it is especially necessary to consider nurses quality and quantity in the NIV units.

Declaration of patient consent

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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