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# Approach of pulmonologists in Turkey to noninvasive mechanical ventilation use in acute respiratory failure

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## SUMMARY

### Approach of pulmonologists in turkey to noninvasive mechanical ventilation use in acute respiratory failure

**Introduction:** Noninvasive mechanical ventilation (NIV) has been increasingly used worldwide for acute respiratory failure (ARF), especially in patients with chronic lung disorders. We aimed to define the approach of pulmonologists in Turkey to NIV use for ARF management.

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**Materials and Methods:** A 38-question survey, developed and tested by authors, was distributed by e-mail to a total of 2.205 pulmonologists in Turkey.

**Results:** Response rate was 27% (n= 596). Seventy-one percent of responders were practicing NIV in clinic. NIV use was found to be associated with responder's academic title, age, duration of medical license, type of physician's hospital and its region, patient load, NIV experience during residency, and duration of NIV and intensive care unit (ICU) experience (p< 0.001). Based on sub-group analysis of responders using NIV, median number of NIV patients followed-up per week was 4 [interquartile range (IQR): 2-6]. Most of the NIV users reported employment of wards (90%) and/or ICUs (86%) to follow-up patients, while 8.4% of the responders were applying NIV only in ICU's. Chronic obstructive lung disease (COPD) (99.5%), obesity hypoventilation syndrome (93.7%) and restrictive lung disease (89.4%) were the most common indications. Majority of NIV users (87%) were applying NIV to > 60% of patients with COPD, and success rate in COPD was reported as over 60% by 93% of users. Oronasal mask (median and IQR 90, 80-100%, respectively) and home care NIV ventilators (median and IQR 50, 10-85%, respectively) were the most commonly utilized equipment.

**Conclusion:** NIV use in ARF varies based on hospital type, region and, especially, experience of the physician. Although consistent with guidelines and general practice, NIV use can still be improved and increased.

**Key words:** Noninvasive ventilation, acute respiratory failure, survey, chronic obstructive pulmonary disease, intensive care unit, general wards

## ÖZET

### Türkiye'de akut solunum yetmezliğinde noninvaziv mekanik ventilasyon kullanımına göğüs hastalıkları doktorlarının yaklaşımı

**Giriş:** Noninvaziv mekanik ventilasyon (NIV) akut solunum yetmezliğinin (ASY) tedavisinde, özellikle de kronik akciğer hastalığı olan hastalarda, dünya çapında giderek artan oranlarda kullanılmaktadır. Bu çalışmada Türkiye'deki göğüs hastalıkları doktorlarının ASY tedavisinde NIV kullanımına yönelik yaklaşımını belirlemeyi amaçladık.

**Materyal ve Metod:** Yazarlarca geliştirilen ve test edilen 38 soruluk anket, e-posta yoluyla Türkiye genelinde toplam 2205 göğüs hastalıkları doktoruna iletildi.

**Bulgular:** Katılım oranı %27 (n= 596) idi. Katılanların %71'i klinikte NIV uygulaması yapıyordu. NIV kullanımı ile katılımcıların ünvanı, yaşı, doktorluk süresi, çalıştıkları hastane ve bulunduğu bölge, hasta yükü, asistanlık eğitimi esnasındaki NIV deneyimi ve miktarı, NIV ve yoğun bakım ünitesi (YBÜ) deneyim süreleri ilişkili bulundu (Tablo 1, p= 0.000). ASY'de NIV kullanan 420 katılımcının alt grup analizinde, haftalık takip edilen ortalama hasta sayısı 4 (25 ve 75 persentil: 2.6) idi. Kullananların çoğunluğu servis (%90) ve/veya YBÜ (%86)'de hastalarını takip ederken; %8.4 hasta takibi için sadece YBÜ'yü kullanıyordu. En sık üç endikasyonu kronik obstrüktif akciğer hastalığı (%99.5), obezite hypoventilasyon sendromu (%93.7) ve restriktif akciğer hastalığına (%89.4) bağlı gelişen ASY idi. Kullanıcıların çoğunluğu (%87) NIV'ı KOAH'lı hastaların %60'ından fazlasında kullanmaktaydı ve kullananların %93'ü KOAH'lılarda NIV başarı oranını %60'ın üzerinde olarak bildirmekteydi. Oronasal maske (ortalama, 25 ve 75 persentil: %90, 80, 100) ile ev tipi NIV ventilatörler (%50, 10, 85) en sık kullanılan ekipmanlardı.

**Sonuç:** ASY'de NIV kullanımında bölgesel ve hastane kaynaklı, özellikle doktorun deneyimi ile ilişkili değişkenlik mevcuttur. Kılavuzlara ve genel pratiğe uygun olmakla birlikte, mevcut klinik NIV uygulamaları halen artırılabilir ve geliştirilebilir.

**Anahtar kelimeler:** Noninvaziv ventilasyon, akut solunum yetmezliği, anket, kronik obstrüktif akciğer hastalığı, yoğun bakım ünitesi, genel servis

## INTRODUCTION

Noninvasive mechanical ventilation (NIV) has been recommended as a first-line treatment for acute respiratory failure (ARF) in patients with chronic obstructive pulmonary disease (COPD) during exacerbations or weaning/extubation, cardiogenic pulmonary edema (CPE) or immunosuppression (1-5). It has been increasingly used worldwide in ARF due to acute-on- chronic lung disorders (ACLD) and even non-COPD causes, with decreased mortality (6-9). Predictors of NIV success can be listed as the cause and type of ARF, the severity of the underlying

disease, the experience and skills of the NIV-applying team, the equipment used or the location of the application (10,11). Surveys done in Europe, America and India reflected the physicians and respiratory therapists' variable attitudes to NIV use (12-19).

NIV has also been used for ARF management in Turkey since the beginning of the 1990s, and case series and randomized controlled trials about the utilization of NIV have been published since then (20-25). These studies were mainly about the efficiency of NIV use in hypercapnic or hypoxic ARF at intensive care units (ICU) or intermediate care units

(IMCU). There has been no epidemiologic data published about NIV use for ARF with different etiologies, treated not only in ICUs but also general wards or emergency departments (ED) in Turkey. In the present survey study, we aimed to define the approach of pulmonologists in Turkey to NIV use in ARF by using a questionnaire.

## MATERIALS and METHODS

The questionnaire was developed by the authors (AOU and ZK) based on the review of previously published surveys about NIV, personal experiences and perceived areas of interest. Clarity and reliability of the questions were evaluated by pilot testing done by 10 physicians and all of the authors. Based on the feedback, the final version of the 38-question, self-administered survey was formed. The study protocol was approved by the Ethics Committee at Baskent University Faculty of Medicine.

An e-mail asking for participation in the survey, with the questionnaire attached, was sent to the target population, 2.205 pulmonologists in Turkey, in November 2013. To improve the response rate, e-mail, telephone or face-to-face follow-ups were conducted for non-responders.

The questions were related to the profile of the participant (including NIV and ICU experience), characteristics of his/her current hospital (type and region) and current use of NIV in clinical practice. Hospitals were sub-grouped as teaching (including university, pulmonary/general research and training hospitals) and non-teaching (state, pulmonary branch and private hospitals). NIV users were further questioned about indications of NIV for ARF, location of NIV application and estimated NIV success rates, equipment used and related complications. The data about NIV use for chronic respiratory failure was evaluated in another study.

## Statistical Analysis

Statistical analysis was performed using SPSS statistical analysis software, version 12.0 (SPSS Inc., Chicago, IL, USA). Since the distribution of most of the continuous variables was not normal, data was expressed as the median [interquartile range (IQR)] unless otherwise specified. The chi-square test was used for categorical data, whereas the Mann-Whitney U test was used for continuous data when appropriate. Spearman's rank correlation coefficient was used to compare continuous variables, such as the rela-

tionship between the age of the physician or duration of NIV experience and the estimated frequency of NIV use for causal diagnosis. A p value of less than 0.05 was considered statistically significant.

## RESULTS

### Response Rate NIV Utilization

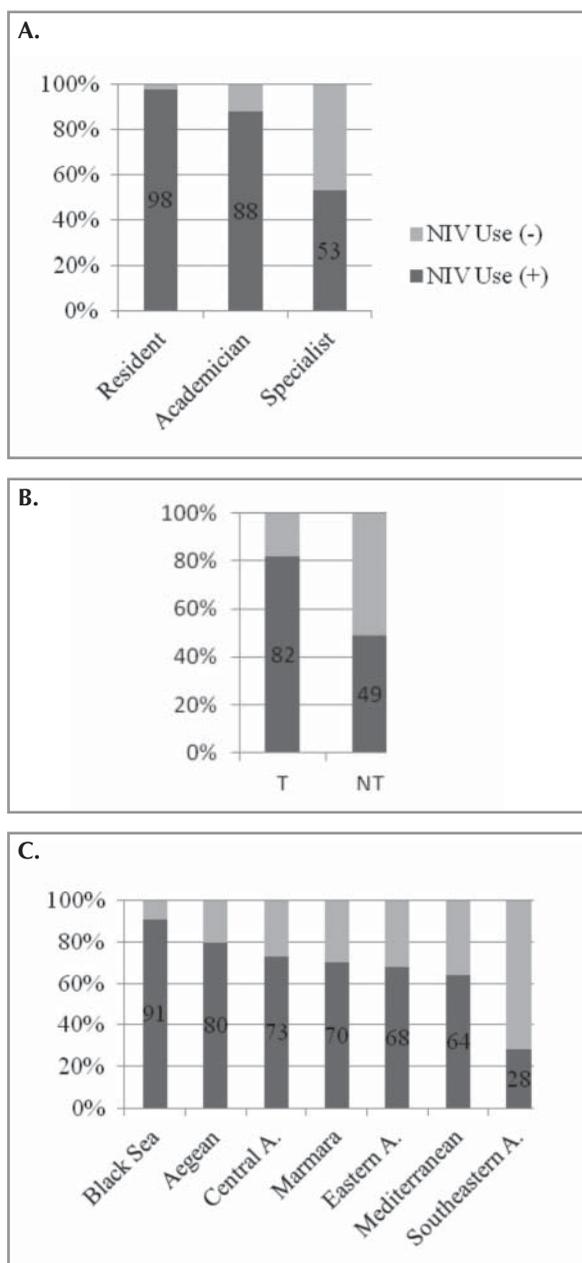
Survey responses were completed between November 2013 and February 2014, with a response rate of 27.1% (n= 596). Participation was mainly from specialists [(55.7%) vs. academicians (24.2%) and residents (20.1%)], teaching hospitals (64.6%) vs. non-teaching (35.4%) and the Marmara region (30.9%).

Most of the responders (n= 420, 70.5%) reported use of NIV in their routine clinical practice. The factors found to be associated with NIV use are listed in Figure 1 A-C and Table 1. The teaching status of the centers differed regionally (Table 2).

### Indications for NIV

The median number of patients treated by NIV per week was reported as 4 (2-6) by the NIV users. The three most frequent indications for NIV use in ARF were exacerbation of COPD (99.5%), decompensation of obesity hypoventilation syndrome (OHS) (93.7%) and restrictive lung disease (RLD) (89.4%) (Figure 2). Although there was no association between hospital profile (region and type) and NIV use in COPD, OHS, asthma or postoperative ARF, there was an association for the rest of the indications with hospital type and/or region ( $p < 0.05$ ) (Table 3).

Among physicians using NIV, the estimated frequency of NIV use for specific conditions varied, with the majority of the physicians using NIV for greater than 60% of cases with COPD exacerbation (Table 4). The association between estimated frequency of NIV for relatively uncommon indications (CPE, pneumonia, post-extubation, weaning, ARDS) and age of the physician ( $r = -0.120, -0.100, -0.132, -0.116$  and  $-0.210$  and  $p = 0.017, 0.047, 0.009, 0.022$  and  $0.000$ , respectively) was negative; however, the association was positive for those indications and the number of patients treated with NIV during residency ( $r = 0.125, 0.145, 0.145, 0.117$  and  $0.163$  and  $p = 0.016, 0.005, 0.005, 0.025$  and  $0.002$ , respectively). The association was also positive between more common indications (COPD, RLD, OHS) and the duration of NIV experience ( $r = 0.124, 0.187$  and  $0.127$ , and  $p = 0.013, 0.000$  and  $0.013$ , respectively).



**Figure 1.** Use of noninvasive ventilation based on: (A) Title of the physician, (B) Type of the hospital, (C) Region of the hospital\*.

A: Anatolia, NIV: Noninvasive ventilation, NT: Non-teaching, T: Teaching.

\*  $p < 0.001$  for all variables.

### Site of NIV Application

The majority of the NIV users was applying it on general wards (90.0%) or in ICUs (86.0%), followed by IMCUs (67.4%) and EDs (57.4%). NIV use was

**Table 1.** The comparative characteristics of physicians using vs. not using NIV in practice\*

	NIV users (n= 420)	NIV nonusers (n= 176)
Age, years	36.5 (31-42)	42.0 (35-48)
Duration of working in pulmonary field, years	10.0 (4-16)	14.0 (9-20)
Daily outpatient number	30.0 (20-50)	40.0 (30-50)
NIV experience during training, n (%)	314 (75)	87 (49)
Number of patients treated with NIV during training	100.0 (0-300)	10.0 (0-100)
Duration of NIV experience, years	6.0 (3-10)	3.5 (0-7)
ICU experience, n (%)	265 (64)	57 (33)
Duration of ICU experience, months	3.0 (0-24)	0 (0-3)

NIV: Noninvasive mechanical ventilation, ICU: Intensive care unit.  
\*  $p < 0.001$  for all variables.  
Categorical variables were shown as n (%), whereas continuous variables as median (interquartile range).

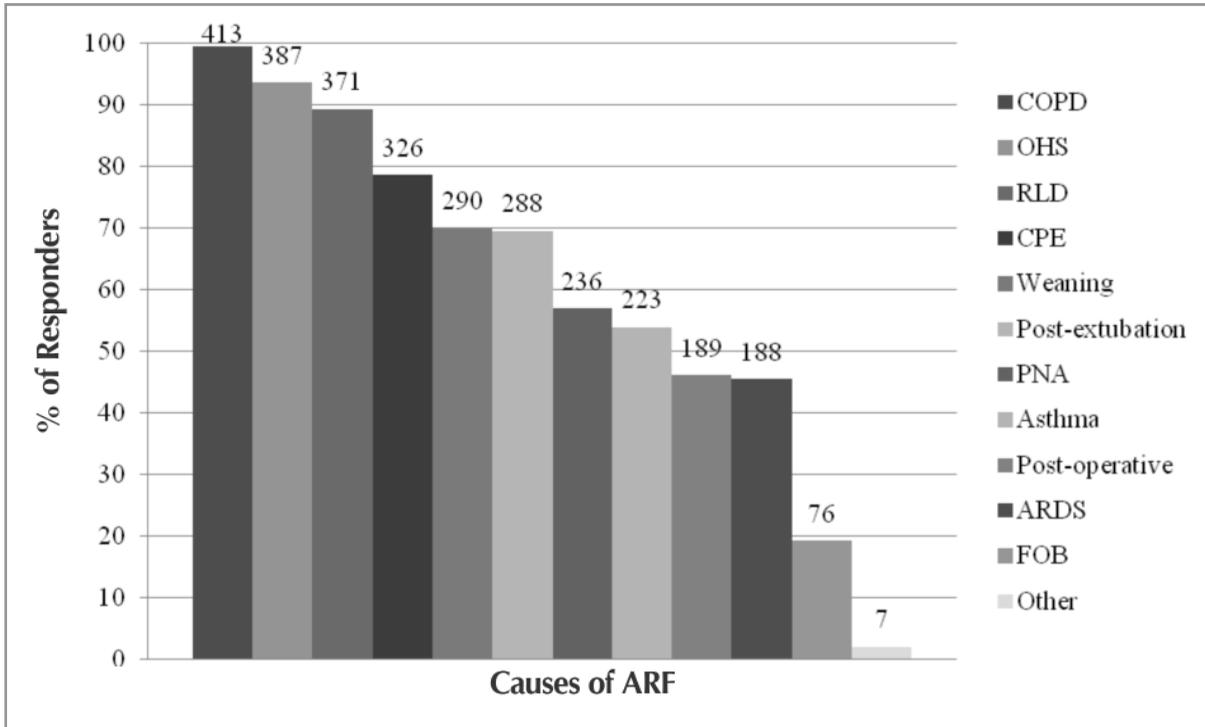
**Table 2.** Regional distribution of participating pulmonologists using NIV based on teaching status of their hospital\*

	Teaching	Non-teaching
Aegean	64 (74.4)	22 (25.6)
Black sea	26 (66.7)	13 (33.3)
Central anatolia	59 (93.7)	4 (6.3)
Eastern anatolia	26 (63.4)	15 (36.6)
Marmara	109 (85.2)	19 (14.8)
Mediterranean	20 (40)	30 (60)
South-eastern anatolia	13 (100)	0
Total	317 (75.5)	103 (24.5)

\* Numbers were shown as n (% within region),  $p < 0.001$ .

more common in all units in teaching than non-teaching hospitals, especially being more significant outside-of-ICU (70.7 vs. 17.5% in EDs, 96.2 vs. 70.9% on wards, 74.1 vs. 46.6% in IMCUs, respectively ( $p < 0.001$ ) and 89.3 vs. 75.7% in ICUs, respectively ( $p < 0.005$ )).

Only a small fraction of physicians (8.4%), most of whom were specialists (94.1%) and from non-teaching hospitals (88.2%) ( $p < 0.001$ ), were using NIV only in ICU and/or IMCU. The main reasons for this were reported as a lack of trained staff (90%), equipment (74%) or training (55%). Responders using NIV



**Figure 2.** Causes of ARF treated with noninvasive ventilation<sup>1</sup>.

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, FOB: Fiberoptic bronchoscopy, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease.

<sup>1</sup>Numbers given on the bars are the absolute numbers of physicians using NIV in that condition.

**Table 3.** Distribution of pulmonologist using NIV for different etiologies among (A) regions and (B) hospitals (teaching vs. non-teaching)<sup>(1-3)</sup>

A.	South-eastern anatolia							p
	Aegean	Black sea	Central anatolia	Eastern anatolia	Marmara	Mediterranean	South-eastern anatolia	
COPD	100	100	100	100	99.2	98.0	100	0.70
OHS	95.3	94.9	90.3	90.2	95.1	92.0	100	0.70
RLD	91.9	94.9	93.5	75.6	90.3	84.0	92.3	0.07
CPE	78.8	89.7	83.9	61.0	78.2	82.0	69.2	0.047
Weaning	77.6	76.9	69.4	65.9	58.1	78.0	100	0.004
Post-extubation	81.2	74.4	72.6	61.0	62.9	62.0	84.6	0.045
PNA	62.8	53.8	61.3	31.7	58.5	58.0	69.2	0.037
Asthma	50.6	61.5	51.6	34.1	57.3	62.0	61.5	0.12
Post-operative	54.2	48.7	40.3	29.3	48.8	49.0	30.8	0.14
ARDS	54.1	53.8	35.5	36.6	41.5	46.0	76.9	0.029
FOB	33.8	19.4	12.9	6.1	19.5	14.3	7.7	0.006

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, FOB: Fiberoptic bronchoscopy, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease.

<sup>1</sup>Number of responding pulmonologists for each diagnosis is as mentioned in Figure 2.

<sup>2</sup>Numbers shown are % of responding NIV users for each diagnosis within each region.

**Table 3.** Distribution of pulmonologist using NIV for different etiologies among (A) regions and (B) hospitals (teaching vs. non-teaching)<sup>(1-3)</sup> (devami).

<b>B.</b>			
	Teaching	Non-teaching	p
COPD	99.4	100	0.42
OHS	94.5	91.2	0.23
RLD	91.7	82.5	0.009
CPE	81.7	69.6	0.009
Weaning	70.4	68.9	0.78
Post-extubation	73.4	57.8	0.003
PNA	61.1	44.7	0.004
Asthma	54.0	53.4	0.91
Post-operative	47.1	43.0	0.48
ARDS	45.5	45.6	0.33
FOB	22.1	10.3	0.011

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, FOB: Fiberoptic bronchoscopy, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease.

outside-of-ICU listed a shortage of ICU beds (77%), managing less severe cases of ARF in other units (64%), increased experience (63%) and evidence (53%) for NIV use as main reasons for it.

Physicians using NIV for COPD exacerbations, RLD, CPE or decompensation of OHS reported mostly general wards as the site of application (Figure 3). On the contrary, most of the physicians stated an ICU as the only location of NIV use for weaning (61.3%), ARDS (55.9%), post-extubation (50.4%)/post-operative (61.0%) ARF and during application of FOB (31.8%).

### Perceived NIV Success Rates

Most of the responders estimated the success rate of NIV to be “high” for most of the causal diagnoses, except for pneumonia and ARDS (Figure 4). These rates were generally found to be higher in academicians or residents than specialists and in teaching hospitals than non-teaching ones (except for OHS, weaning, pneumonia, ARDS and post-operative ARF) ( $p < 0.05$ ) (Table 5). The association between perceived NIV success rate for relatively uncommon indications (CPE, pneumonia, post-extubation, ARDS) and age of the physician ( $r = -0.110, -0.147, -0.138$  and  $-0.146$  and  $p = 0.038, 0.005, 0.009$  and  $0.008$ , respectively) was negative, as was also shown for estimated frequency of indications.

### Equipment Used for NIV and Related Complications

Oronasal mask and home care noninvasive ventilators were the most commonly preferred equipment for most of the cases (Table 6). The mask and ventilator type was found to be associated with the title of the physician, hospital type, cause of ARF or site of application ( $p < 0.05$ ) (Table 7).

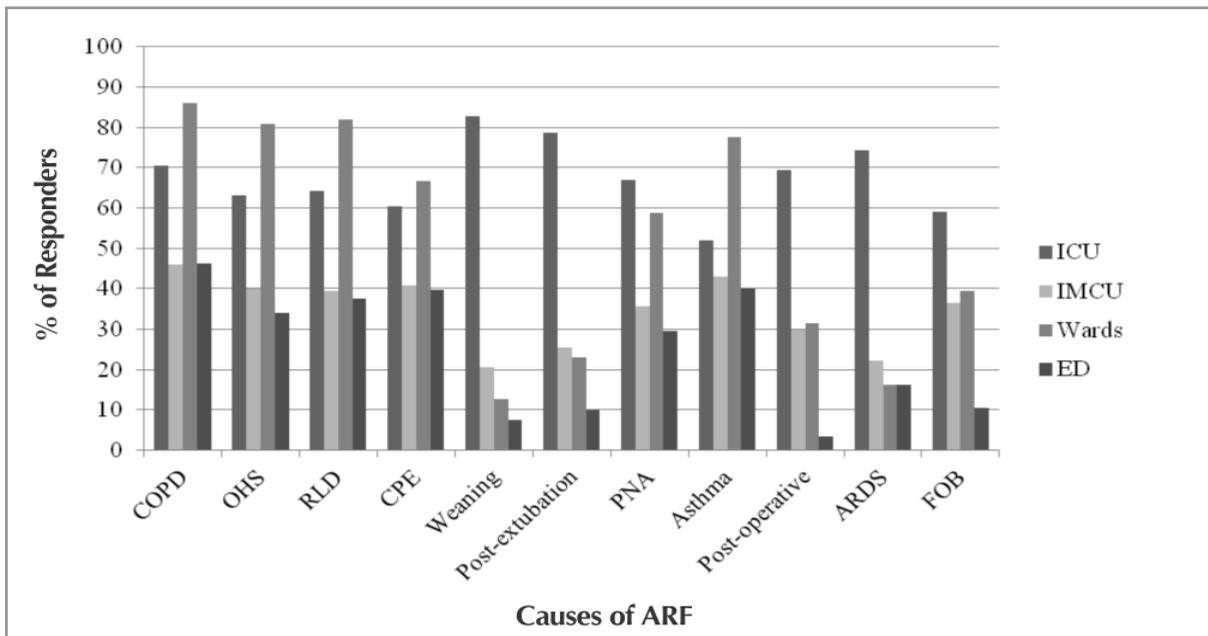
Humidification during NIV was used by only 53% of the responders.

Intolerance of the mask (86.9% of the responders), gastric distension (80%) and skin lesions (77.4%) were the most commonly reported NIV related complications. Other complications were listed as mouth

**Table 4.** Perceived frequency of NIV utilization for each causal diagnosis<sup>1</sup>

	Never (0%)	Rare (1-20%)	Few (21-40%)	Moderate (41-60%)	Often (61-80%)	Most often (81-100%)
COPD	0.5	0.5	1.4	9.7	25.6	62.3
OHS	6.0	8.0	5.0	14.1	29.2	37.7
RLD	10.8	5.1	15.2	22.8	26.7	19.4
CPE	21.9	5.0	15.2	24.6	20.6	12.7
Weaning	30.7	5.8	5.1	16.2	23.9	18.3
Post-extubation	31.5	8.5	4.3	13.2	24.5	18.0
PNA	44.1	7.9	11.1	18.6	12.4	5.9
Asthma	46.0	13.1	9.0	13.6	10.2	8.1
Post-operative	55.7	9.1	10.8	10.8	9.6	4.0
ARDS	55.8	7.4	6.5	11.7	10.2	8.4
FOB	81.2	4.6	6.3	4.6	1.3	2.0

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, FOB: Fiberoptic bronchoscopy, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease.  
<sup>1</sup>Number of responders for COPD= 414, OHS= 401, RLD= 408, CPE= 402, Weaning= 394, Post-extubation= 400, PNA= 404, Asthma= 411, Post-operative= 397, ARDS= 403, FOB= 394.

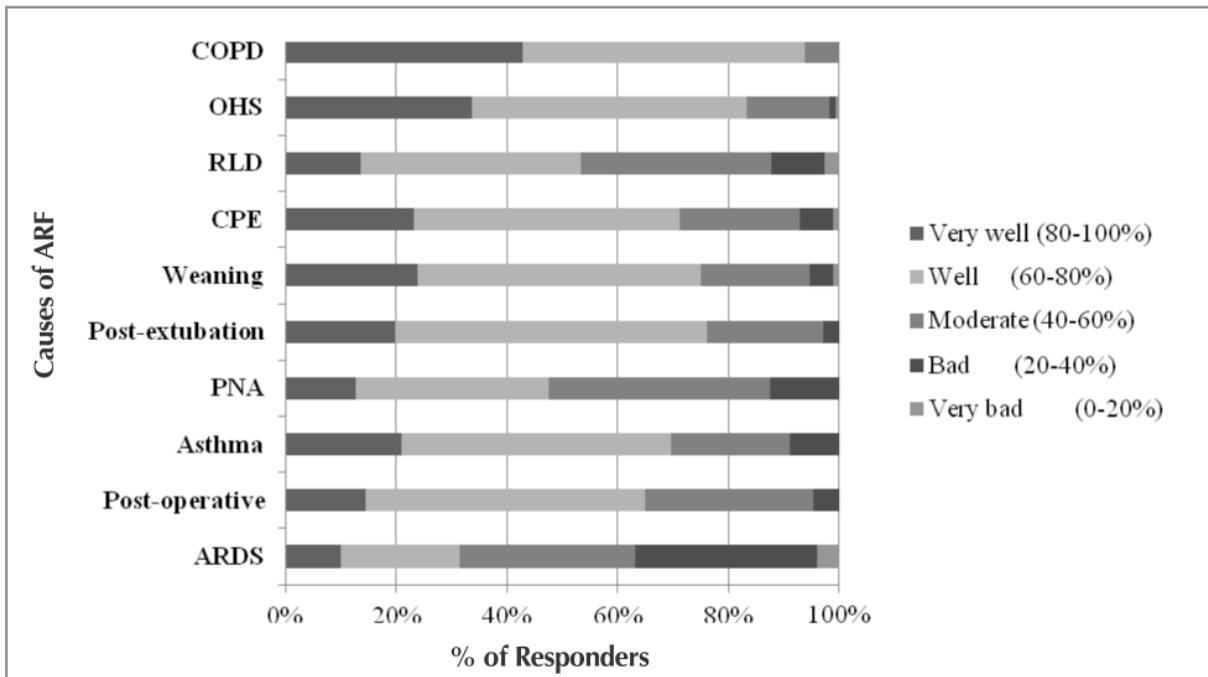


**Figure 3.** Preference of physicians for sites of noninvasive ventilation use<sup>1,2</sup>.

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, FOB: Fiberoptic bronchoscopy, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease, ED: Emergency department, ICU: Intensive care unit, IMCU: Intermediate care unit.

<sup>1</sup>More than one site could be stated for each specific condition by a physician.

<sup>2</sup>Number of responders for COPD= 408, OHS= 378, RLD= 358, CPE= 314, Weaning= 277, Post-extubation= 274, PNA=224, Asthma= 165, Post-operative= 174, ARDS= 179, FOB= 66.



**Figure 4.** Estimated success rate of noninvasive ventilation for each causal diagnosis<sup>1</sup>.

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease.

<sup>1</sup>Number of responders for COPD= 394, OHS= 351, RLD= 341, CPE= 281, Weaning= 239, Post-extubation= 242, PNA= 198, Asthma= 191, Post-operative= 131, ARDS= 149.



**Table 6.** Equipments used for NIV management<sup>1</sup>

	n (%) of responders	Estimated frequency of prescription (%)
<b>Masks</b>		
Oronasal mask	402 (95.7)	90 (80-100)
Nasal mask	232 (55.2)	5 (0-15)
Total face mask	138 (32.9)	0 (0-5)
Helmet	40 (9.5)	0 (0-0)
<b>Ventilators</b>		
Home care noninvasive ventilators	311 (74.0)	50 (10-85)
Hospital type specific noninvasive ventilators	195 (46.4)	4 (0-33.8)
ICU ventilators with NIV module	255 (60.7)	10 (0-50)
ICU ventilators without a NIV module	75 (17.9)	0 (0-0)

<sup>1</sup> More than one type of mask/ventilator could be stated by a physician. Categorical variables were shown as n (%), whereas continuous variables as median (interquartile range).

dryness (73%), nasal congestion (53.5%), claustrophobia (44%), epistaxis (31.9%), allergic reactions (26%), sinus pressure (11.6%) and others (1.6%).

## DISCUSSION

In this first national survey, we demonstrated that:

- 1) There is great variability in NIV use for ARF, depending mainly on experience and knowledge of the physician, but NIV use is also related to the type and the region of the hospital;
- 2) NIV use is more common and is perceived to be more successful in acute-on-chronic lung disorders (ACLD); and
- 3) The site of NIV application is not limited to the ICU for the majority of the physicians, and its limitation is mainly due to inadequacy of equipment, training or trained staff.

In our survey, the proportion of the pulmonologists using NIV in ARF was nearly 70%. The pulmonologists not using NIV in practice were older specialists, generally from non-teaching hospitals of different regions of Turkey, with a higher patient load and longer experience in the pulmonary field but lower experience in NIV use and ICU. The rate and the associations were reported similarly in Ontario and India surveys (16,18). However, it is important to underline that half of our NIV non-users had NIV training during fellowship, with a median of 3.5 years of experience, and some of them cited a lack of adequate equipment, trained medical staff and appropriate facilities for follow-up of NIV patients rather than poor previous experience in NIV use (oral

communication). Therefore, these rates might still be increased with post-training educational courses and new medical policies (including an increase in equipment and medical staff).

Utilization of NIV has been increasing worldwide, probably due to increased evidence and experience, as well as published guidelines favoring increased NIV use, especially for diagnoses like COPD and CPE (5-9,26-29). COPD was shown to be the most frequent indication in most of the previous surveys, and NIV utilization rate for ACLD is shown to be mid-70s in real-life studies (7,8,12,16-19). Our findings were consistent with these, as ACLD were the most common indications for NIV use. Nearly 90% of responders were using NIV for exacerbation of COPD for more than 60% of the cases. OHS, which for NIV was shown to be equally effective with better outcomes than COPD by Carrillo et al., was the second most common indication after COPD (30). We found the rate of physicians using NIV for CPE to be similar or quite lower than rates in prior surveys, which could be due to the application of NIV by cardiologists without consulting pulmonologists in their units (14,16-18). Probably based on the growing evidence on the use of NIV during weaning or for post-extubation ARF, more than 60% of our responders noted quite frequent NIV use in these conditions (28). It is still controversial to use NIV in patients with de novo ARF (including pneumonia and ARDS), whereas application of NIV during FOB is recommended to be reserved for experienced centers; our lower rates of NIV use in these conditions were consistent with these suggestions (4).

**Table 7. Association of mask type and ventilators with responder's title, hospital type, cause of ARF and site of application**

	ONM		NM		TFM		Helmet		ICU ventilator (NIV module +)		ICU ventilator (NIV module -)		Hospital type NIV		Home care NIV	
		P		P		P		P		P		P		P		P
<b>Title<sup>1</sup></b>		1.00		0.32		<b>0.018</b>		<b>0.006</b>		0.24		<b>0.010</b>		<b>0.033</b>		0.09
Academician	98.3		62.0		42.1		16.5		72.0		27.1		54.2		83.9	
Resident	99.1		57.0		36.0		9.6		63.9		21.3		58.3		84.3	
Specialist	98.3		53.2		26.6		5.3		62.7		12.7		43.0		75.2	
<b>Hospital type<sup>2</sup></b>		0.65		0.64		<b>0.040</b>		<b>0.000</b>		0.15		<b>0.031</b>		<b>0.002</b>		<b>0.007</b>
Teaching	98.7		57.5		36.6		12.7		63.9		22.0		55.3		83.5	
Non-teaching	98.0		54.9		25.5		1.0		71.9		11.8		36.6		70.8	
<b>NIV indication<sup>3</sup></b>		1.00		1.00		1.00		1.00		1.00		0.36		1.00		1.00
COPD	98.5		57.3		33.7		10.0		66.1		19.5		50.5		80.4	
OHS	98.7	0.33	59.0	<b>0.015</b>	33.6	0.61	10.1	1.00	66.1	0.61	20.2	0.59	49.9	0.31	81.9	<b>0.006</b>
RLD	98.3	1.00	58.4	0.18	35.2	0.10	10.6	0.29	67.2	0.08	20.8	0.11	52.2	0.05	82.0	<b>0.037</b>
CPE	98.1	0.35	57.2	0.88	37.1	<b>0.009</b>	11.3	0.07	68.1	0.07	19.9	0.45	54.7	<b>0.001</b>	80.8	0.76
Weaning	98.2	0.67	57.7	0.72	37.7	<b>0.014</b>	11.7	0.07	74.5	<b>0.000</b>	22.4	<b>0.034</b>	53.5	0.08	80.4	0.93
Post-extubation	98.9	0.37	59.1	0.31	38.1	<b>0.007</b>	12.1	<b>0.028</b>	73.1	<b>0.000</b>	22.1	0.06	54.6	<b>0.015</b>	80.8	0.79
PNA	98.3	0.70	54.3	0.15	37.8	0.06	10.4	0.71	67.7	0.44	21.2	0.36	55.3	<b>0.020</b>	78.3	0.20
Asthma	98.2	0.69	60.1	0.20	31.7	0.61	9.6	0.82	66.0	0.94	17.0	0.14	55.2	<b>0.047</b>	79.2	0.50
Post-operative	97.8	0.42	58.7	0.59	40.2	0.30	14.1	<b>0.012</b>	71.3	<b>0.041</b>	19.8	0.95	58.4	<b>0.004</b>	83.7	0.14
ARDS	97.8	0.43	58.1	0.60	35.5	0.32	12.4	0.27	67.6	0.73	24.2	0.08	54.4	0.17	76.4	<b>0.019</b>
FOB	98.6	1.00	47.3	0.08	56.8	<b>0.000</b>	24.3	<b>0.000</b>	82.2	<b>0.001</b>	27.4	0.08	65.8	<b>0.003</b>	80.8	0.98
<b>Site of application<sup>4</sup></b>		0.86		0.78		0.85		0.80		<b>0.026</b>		0.10		0.19		0.94
ICU	98.6		57.1		34.0		10.0		68.1		20.8		52.1		80.4	
IMCU	98.6	1.00	59.4	0.14	35.3	0.37	13.3	<b>0.001</b>	60.8	<b>0.002</b>	23.1	<b>0.009</b>	49.1	0.31	81.9	0.27
Wards	98.4	0.40	58.7	<b>0.024</b>	34.2	0.68	10.7	0.10	64.4	0.06	20.0	0.49	53.0	<b>0.008</b>	83.6	<b>0.000</b>
ED	98.7	0.70	58.1	0.57	39.4	<b>0.005</b>	15.8	<b>0.000</b>	60.1	<b>0.005</b>	21.7	0.21	55.0	0.06	83.9	<b>0.044</b>

ARDS: Acute respiratory distress syndrome, COPD: Chronic obstructive pulmonary disease, CPE: Cardiogenic pulmonary edema, FOB: Fiberoptic bronchoscopy, OHS: Obesity hypoventilation syndrome, PNA: Pneumonia, RLD: Restrictive lung disease, ED: Emergency department, ICU: Intensive care unit, IMCU: Intermediate care unit.  
 Numbers shown are % of responding NIV users within each <sup>1</sup>Title and <sup>2</sup>Hospital type using each mask or ventilator type; and % of responding NIV users stating NIV use for each <sup>3</sup>Causal diagnosis of ARF and at each <sup>4</sup>Site of application using each mask or ventilator type.

We found some consistency among stated practices independent of the physician's age, title, hospital type or region, especially for indications of COPD and OHS. However, we noted some differences in indications based on one or more of these variables. Younger physicians with higher NIV patient load during residency estimated more frequent NIV use with higher perceived NIV success rates in relatively uncommon indications (such as ARDS, pneumonia, post-extubation, etc.), whereas physicians with a longer duration of NIV experience estimated more frequent use in ACLD. Management of especially hypoxic conditions with NIV had some regional differences as well, which could be due to different numbers and profiles of physicians participating from different regions. So, there are many confounding factors, however, we can at least claim that the approach for ACLD mostly does not change throughout Turkey.

In this study, the application of NIV was shown to be generally not limited to ICU. The majority of the responders (90%) reported applying NIV in general wards, which is quite higher than reported by previous surveys (11-65%) (13,16,17,19). This could be in accordance with the literature supporting NIV use outside-of-ICU or due to the lower socioeconomic status of Turkey compared to the U.S. or Canada (13,31-33). Additionally, physician's title, hospital type and region were found to be associated with the site of NIV application, such as higher rates of application in non-ICU units in teaching hospitals compared to non-teaching ones. On the contrary, EDs were less preferred by the physicians compared to prior surveys (13,16). We can increase the awareness, availability and frequency of NIV use in EDs by providing equipment and training courses emphasizing the importance of not delaying NIV for transfer of sicker patients, with the possibility of increased mortality otherwise (33-35). Although very infrequent, the restriction of NIV use for IMCU and/or ICU was more prominent for specialists from non-teaching hospitals. Provision of trained staff, technical equipment and in-service training can further decrease this rate.

Perceived success rates for different causal diagnoses of ARF were reported between 60-80% by generally half of the responders using NIV for that condition, except for lower success rates by a higher proportion of responders for pneumonia and ARDS. Not surprisingly, for most of the diagnoses, these rates

were found to be associated with the physician's title and the hospital type (generally improving with higher specialization in the pulmonary field). There is no other survey study providing estimated success rates per diagnosis. In the study of Bierer et al., most of the responders rated it as 26-50%, and less than 10% felt it was greater than 75% of the time (17). Three-quarters of the responders in Cabrini et al.'s study also thought that NIV was successful only in less than half of the patients (13). The authors claimed that these low rates could be due to inappropriate use of NIV or could be a misperception. Our success rates were consistent with the actual success rates, shown as 73.9% in general, 75.8% for ACLD, 79.4% for CPE and 45.9% for de novo ARF (8).

The most commonly preferred mask type for NIV was oronasal, similar to the surveys from Europe and the U.S. and consistent with literature stating that an oronasal mask is more effective or better tolerated by patients in ARF (12,15,36,37). Helmets were perceived to be used very rarely in Turkey, in contrast to Europe, especially Italy (13). Physician's academic degree, hospital type or cause of ARF were found to be associated with preferred mask type, such as a more frequent preference of TFM or helmet masks mostly by the academicians, teaching hospitals or pulmonologists using NIV in hypoxemic ARF. This variation is probably due to increased experience in NIV use by these particular physicians or specialized hospitals.

"Home care" ventilators were the most commonly preferred ventilators. "Bilevel" ventilators were similarly the choice of ventilator in the U.S. and Europe surveys; however, the rate of hospital-type dedicated NIV ventilators was higher than our rates (12,15,17). This could be due to the unavailability of these specialized NIV ventilators in most of the hospitals in Turkey because of their higher cost. Preference for ICU ventilators or hospital-type NIV ventilators by physicians utilizing NIV for hypoxemic conditions can be because of the necessity of the provision of a higher fraction of inspired oxygen by oxygen blenders in these ones, whereas home care ventilators were most often preferred by physicians using NIV for ACLD, like shown in the Europe survey (12). Humidification can protect the airways from dryness, therefore it might increase the tolerance of the patient; however, it was stated to be used by only half of our physicians, as also shown by Crimi et al. (4,12).

Several limitations of this survey deserve mentioning, the most important of which is our response rate of 27%. Questionnaires were sent by e-mail, however, it is not certain how many of the physicians received the e-mail. A selection bias, favoring physicians who use NIV to respond, might have occurred. Therefore, it is difficult to extrapolate the results of this survey to the whole country; however, similar surveys done in the U.S. and India reported comparable results, at even lower response rates (17,18,38). For logistical reasons, we surveyed only pulmonary physicians, but other branches, such as anesthesiologists or cardiologists, may also use NIV for ARF. All data was self-reported, and no attempts were made to verify them. Since stated practice may differ from actual practice, our results may under or overestimate actual practice variation. The survey instrument did not undergo formalized reliability testing, and some of the questions relied on opinion and recall.

Despite these limitations, we think that the survey provides the first extensive view of NIV practices of Turkish pulmonologists in patients with ARF, and our results are generally consistent with other surveys (12,15,17,18). The variation in NIV practice can be multi-factorial, including physician (such as experience, knowledge or opportunities for these technologies), center (such as teaching status, region of the hospital, availability for a facility/staff/equipment to provide NIV) and patient-related factors (such as the cause or type of ARF). These differences might be decreased by increasing clinical experience, the provision of training to caretakers involved in NIV use and improving conditions of facilities for NIV use (39,40).

## CONCLUSION

The findings of this survey characterize the current approach of pulmonologists in Turkey to NIV use in ARF. Our survey suggests that, despite widespread evidence about the utilization of NIV in ARF in selected patients, nearly 30% of our pulmonologists still do not use NIV in clinical practice. A lack of equipment, facilities, trained medical staff or experience in NIV might lead to these, which can be improved by support of medical policies favoring NIV use. For NIV users, the major indications, sites and technical equipment were similar within the survey population and consistent with the guidelines and prior surveys. However, there was a variation in practices for specific issues, which can be decreased by in-service training programs across Turkey.

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