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A European survey of Non- Invasive Ventilation (NIV) Practices

ABSTRACT

Although non-invasive ventilation (NIV) is becoming very popular, little is known about its pattern of clinical and technical utilization in the different environments.

We conducted a web-based survey in Europe to identify the perceived pattern of NIV utilization and the reason for choosing a specific ventilator and interface type in 4 common clinical scenarios: Acute Hypercapnic Respiratory Failure (AHRF), Cardiogenic Pulmonary Edema (CPE), *de novo* hypoxic respiratory failure, Weaning/Post-extubation failure (W/PE).

A response was obtained from 272/530 (51.3%) selected European physicians involved in NIV practice. NIV utilization rate was higher for Pulmonologists than Intensivists/Anesthesiologists ($p<0.05$). The most common indication was AHRF (48%) for all the physicians. Physicians were more likely to use NIV dedicated ventilator in AHRF and CPE and ICU ventilator with NIV module in *de novo* hypoxic respiratory failure and W/PE, mainly because of the possibility of using the double circuit and FiO2 control. Oro-nasal mask was overall the most frequently used interface, irrespecteve of clinical scenarios.

The use of NIV in Europe is generally relatively high, especially among Pulmonologists, and in AHRF. Dedicated NIV ventilators and ICU ventilators with NIV modules are preferably used in AHRF and in *de-novo* hypoxic respiratory failure, respectively, together with oro-nasal masks.

Introduction

Non-Invasive Ventilation (NIV) is well recognized as a valid strategy to avoid endotracheal intubation and its complications in selected patients with respiratory failure [1, 2].

Some surveys have shown that the utilization of NIV may greatly vary depending on the geographical location and the types of environment. Between 1997 and 2002, NIV use in the French Intensive Care Units (ICUs) increased from 16% to 24% of the total ventilated patients and from 35% to 52% of the patients starting ventilation in ICU [3], while in other European countries and North America the utilization rate is much lower [4, 5].

In certain areas, this low rate is related to lack of knowledge or experience concerning the technique, insufficient technical equipment such as specific ventilators and ad-hoc interfaces, and lack of funding [4]. Despite these difficulties, NIV use has also increased outside the ICU setting, including high-dependency units, respiratory wards, emergency rooms and post-surgical recovery rooms [6-8].

Nowadays, considerable technological advances have been made by manufactures both in the development of new ventilatory modes and more sophisticated machines and interfaces, enabling physicians to choose the appropriate device for each patient.

In the present study we used an ad-hoc designed web questionnaire to assess current NIV practices in various environments in Europe and in different case-scenarios, placing emphasis on the technical aspects of NIV use.

Methods

We conducted a web survey of physicians dealing with NIV in 25 European countries between January and March 2008.

The survey was sent to all members of the European Respiratory Society Assembly of Critical Care, members of the European Society of Intensive Care Medicine Group of Acute Respiratory Failure and physicians working in the Emergency Department (ED), known to be involved in NIV practice or to have published on the topic. Only a few members (n=12) of extra-European Countries (mainly from the Middle-East), were also included in the survey as they were members of one of the two Societies.

A survey instrument [9] was developed to examine physicians' knowledge, attitudes and practice about NIV use in 4 common clinical scenarios.

We performed individual semi-structured interviews to identify content areas and items of interest, with a group of local pulmonologists and intensivists, in order to generate items and formulate questions.

A pilot testing was also performed to test content validity, reliability and relevance of the questionnaire and the ability to discriminate among respondents. Pre-testing and pilot testing were used to improve the questionnaire wording. The questionnaire showed good internal consistency and reliability with Cronbach's $\alpha \geq 0.78$. Clinical sensibility testing through personal interviews with four intensivists and four pulmonologists from Europe were conducted in order to evaluate the comprehensiveness, clarity and validity. The questionnaire had adequate content validity showing a Content Validity Index ≥ 0.78.

We developed survey questions with a structured response format, using multiple choice responses and Likert scales and afterwards we created a user-friendly web-based questionnaire.

Questions were presented on a series of linked pages (multiple-item screens) with progress indicators. Radio buttons and list box were used obliging users to choose only one option from a predefined set of alternatives. Questions were ordered on the basis of content: a) broad questions on respondents' demographics and professional data; b) specific questions, addressing physicians' experience and confidence with NIV and c) scenario-based questions, asking physicians about their own clinical experience with NIV in 4 common case scenarios:1) Acute Hypercapnic Respiratory Failure (AHRF), 2) Cardiogenic Pulmonary Edema (CPE), 3) ALI/ARDS/CAP/post-surgical (*de novo* respiratory failure), 4) Weaning/Post-extubation failure (W/PE).

Respondents were linked to a specific scenario-based section in which they were asked to select the type of ventilator and interface they preferably choose when using NIV. We identified some variables considered to be potentially important in their choice of a specific ventilator or interface type for each clinical scenario, and asked respondents to rate their importance in the decision making process using a 5-point Likert scale ranging from 1 (irrelevant) to 5 (very important).

Each physician was provided with a personal username and password that gave access to a secure internet-based questionnaire.

The final surveys were emailed to a total of 530 physicians. Reminders were sent to clinicians who did not respond to the first mailing within 8 weeks.

Statistical Analysis

The countries were divided into three geographic areas prior to data analysis: Northern Europe, Central Europe, Southern Europe and the Middle-East (Table 1).

Descriptive statistics (means, medians and proportions) was used to report responses to survey items and to summarize respondents' characteristics.

The Kruskal-Wallis test for non parametric data was used to evaluate the variability in NIV utilization among different clinical scenarios and physician groups (Intensivists vs. Pulmonologists vs. Others).
Cochran's Q-test was used to test for the variability in the attitudes toward the use of different ventilator and mask types for each scenario.
Multivariate analysis
We conducted multivariate analysis using the "supervised learning" technique that allowed us to generate models, assuming *a priori* the presence of categories.
The data on ventilators were processed, generating the following model:
Ventilator types as category index (ICU ventilator with NIV module, ICU ventilator without NIV module, Dedicated ventilator for acute NIV, Home care ventilator for chronic NIV, Stand Alone CPAP generator), and the reasons for ventilator choice, plus the Geographic area, physician types and clinical scenarios, as variables.
In a similar way, mask data were processed, generating the following model:
Mask Types as category index (Nasal, Oro-Nasal, Total Face, Helmet, Others), and the reasons for interface choice, plus the Geographic area, physician types and clinical scenarios, as variables.
Each model was processed using Stepwise Linear Discriminant Analysis (STEPLDA) to determine the variables that enhance discrimination among the respective categories. New dataset created on every STEPLDA run, contained the original category index and objects but only the most discriminant variables. K-nearest neighbor's (kNN) algorithm was applied for each new dataset to estimate models accuracy and discrimination capability.
Statistical analysis was performed using SPSS version 15 (SPSS Inc. Chicago IL USA) and PARVUS 2008 [10]. A probability value of $p<0.05$ was considered to be statistically significant.

Results

272 of 530 (51.3%) physicians (133 Pulmonologists, 109 Intensivists/Anesthesiologists, 30 Others) responded to the survey. Respondents' characteristics are shown in table 1 and 2. Scenario, ventilator and mask distribution in countries with the highest number of respondents are shown in table 3.

Rate of NIV utilization

NIV utilization rate was significantly higher for Pulmonologists (52.9% reported >20% of patients treated with NIV a year) vs. Intensivists/Anesthesiologists (34.3%) vs. Others (12.6%), [$p<0.05$].

Among the scenarios, physicians rated AHRF as the most common indication for the use of NIV.

Overall, attitudes toward the use of NIV in clinical settings differed significantly among the groups of physician respondents [Fig.1]. Pulmonologists were more likely to use NIV in the treatment of AHRF compared to Intensivists (58.9% vs. 35.2%), conversely the latter were more likely to use NIV in patients with CPE (18.7% vs. 7.2%), *de novo* respiratory failure (19.1% vs. 6.2%) and in W/PE (14.4% vs. 8.5%), [$p<0.05$].

Ventilator choice

Fig.2a shows ventilator distribution among the 4 clinical scenarios.

In AHRF patients, physicians were more likely to use NIV dedicated ventilator, compared to ICU ventilator with NIV module or the others [$p<0.01$].

In CPE, NIV dedicated ventilator and ICU ventilator with NIV module were mostly used, with stand-alone CPAP generator employed by ~23% of the respondents (NS).

In *de novo* respiratory failure and W/PE scenarios we found similar distribution rates: ICU ventilator with NIV module significantly more widely used than NIV dedicated ventilator ($p=0.02$ and 0.01 for *de-novo* respiratory failure and W/PE, respectively). Considering the distribution of ventilators based on physician qualification and regardless of the scenario, the most frequent ventilator type used during NIV by the Anesthesiologists/Intensivists was ICU ventilator with NIV module, conversely NIV dedicated ventilator was the preferred choice of pulmonologists [Fig.2b].

Reasons for choosing a specific ventilator, as assessed using the discriminant analysis, are shown in Fig.3a. In decreasing order of power: double circuit, FiO_2 control, ease of transport, monitoring capability, possibility of setting alarms and delivering drugs , were the significant parameters which provided distinction among the ventilator types. The ability of each parameter in discriminating among ventilators was investigated using a k-nearest neighbor (kNN) classifier: the above mentioned parameters together with physician types (F= 36.3) had a kNN of 76.4% for ICU ventilator with NIV module and 65.8% for NIV dedicated ventilator [Fig.3b].

Interface choice

Interface preferences were not influenced by clinical scenarios and the oronasal-mask was overall the most frequently used ($p<0.01$), [Fig. 4a] irrespectively of the type of physician [Fig.4b].

Geographic area (i.e. greater use of the helmet and total face mask in Southern Europe), patient comfort, multiple patient use, leaks and costs were factors significantly associated with mask choice [Fig.5a]. The ability of each parameter in discriminating among interfaces, investigated using a k-nearest neighbor (kNN) classifier showed that the above mentioned parameters together with the physician type (F=4.5) had a kNN of 88.9% for the oro-nasal mask [Fig. 5b].

Humidification

As shown in Fig.6 the humidification use, assessed by a dichotomic response (yes/no) was >50% in all the clinical scenarios except for CPE.

Discussion

Despite the increased amount of scientific evidence in the last 10-15 years, the "real life" application of NIV is only partially known and an international survey conducted in 2004 demonstrated that the use of NIV in the ICUs around the world is ~12% of the ventilated patients [5]. On the other hand, 5 years previously the same Authors showed a much lower rate of NIV utilization in the same units, so that it was speculated that the increasing scientific evidence, may have influenced this trend.

Geographical differences were also highlighted: the rate of NIV utilization in certain European countries is quite high [3], while in others [11, 12] and in North America [4], NIV use rate is lower.

From 1997 to 2002 an increased NIV use was observed in French ICUs: from 16% to 24% of total ventilated patients and from 35 to 52% of patients starting ventilation in ICU [3], while in 1997, 48% of the respiratory wards in UK were using NIV for the treatment of AHRF [12]. In German ICUs NIV use is <10% in most of the units [11], while in the New England acute care hospitals, the "real life" utilization of NIV is around 20% [4]. Very recently it has also been shown that in the EDs across the US, the perceived use of

NIV is < 30% considering the most "popular" indications (AHRF, CPE and Asthma) [13]. Most of these data were collected in specific surveys concentrated in a single country/geographical area and in a single environment. Indeed, with very few exceptions [4] they were not focused on technological issues, such as ventilators and interfaces, which have very often been considered as one of the barriers that limit the use of NIV in real life.

In this large European web- based survey we have demonstrated that the use of NIV, as perceived by the physicians, is relatively homogeneously spread throughout the different geographical regions and considerably high especially among pulmonologists, and the indications for its application are those recommended by the literature. The oro-nasal interfaces are thought to be by far the most widely used interfaces in all the clinical scenarios, while dedicated NIV ventilators or ICU ventilators with NIV module are largely utilized.

Use of NIV and its indications

Overall, we have found that the perceived NIV use among pulmonologists is higher in Europe than among intensivists and emergency medicine physicians. It is to be noted that contrariwise to North America, pulmonologists very rarely work in ICU and their main work facilities are either the pulmonary ward or the so-called Respiratory Intensive Care Unit (RICU), which act as a step-up unit for the ward or step down unit for the ICU. Therefore the presumed larger use of NIV among pulmonologists may depend on various reasons, including different timing of application (i.e. preventive vs. alternative to intubation use) [14], severity of patients and diseases , and the fact that many patients admitted to the ER or ICU are already intubated.

In keeping with the scientific evidence, clinicians reported AHRF as the most common indication, following by CPE, *de-novo* respiratory failure and W/PE. Not surprisingly, pulmonologists were more likely to apply NIV in AHRF patients than intensivists, and the latter used it more often on hypoxemic patients and during weaning, probably because those patients require closer monitoring and higher Nurse to Patient ratio, and therefore need to stay in ICU.

Use and reason for choosing a particular ventilator

ICU ventilators without NIV module and home care ventilators were perceived to be very seldom used during an episode of acute respiratory failure. The most frequently used machines were dedicated NIV platforms especially for AHRF, and therefore mainly by pulmonologists, while ICU ventilators with NIV module were used for other forms of acute hypoxia, mainly by intensivists. The reason for choosing a ventilator with a module able to compensate for air leaks is self-explanatory, as NIV is a semi-open ventilatory circuit, where avoidance of air leaks is almost impossible and therefore by far the most reported side effect [1, 2]. Despite the fact that a large variation in the ability for compensating leaks among the most common ICU ventilators was demonstrated in vitro [15, 16], there is agreement that, given the same setting, machine software for NIV is able to perform extremely well.

For CPE, >20% of the respondents reported a preference for using CPAP, probably for its ease of use outside the protected environment and the possible short period of ventilation in this clinical situation.

The problem of CO2 rebreathing has always been a major concern of clinicians, especially among those dealing with hypercapnic respiratory failure, so that the use of a

double tubings ventilator was a preferred option, despite the fact that many studies show that the "intentional leak" single circuit, when appropriately set, is able to minimize but not eliminate rebreathing [17, 18].
The possibility of applying a fixed and known FiO2 has also been considered a safe feature especially in those patients with *de-novo* hypoxia. The measure of a correct FiO2/PaO2 ratio is also important as a monitoring measure, since it may better guide clinicians' decisions, than when using a low flow system. In particular it has been shown that the FiO2 actually delivered using a low flow oxygen port in the circuit varies dramatically according to the ventilator settings, the amount of oxygen and the position of the probe, and that it may not always deliver the same value [19].
The possibility of having a good monitoring system, together with more sophisticated alarms, highlights the problem of assessing directly patient-ventilator synchronies, especially during the very first phases of NIV. The presence of patient-ventilator asynchronies, especially in intubated patients, is associated with a prolonged duration of ventilation and higher incidence of tracheotomy [20].
When NIV or any other form of mechanical ventilation is applied, medical therapy should be continued, therefore respondents considered the possibility of bronchodilators' delivery during NIV to be important. This holds particularly true in COPD patients where administration of bronchodilators and steroids is a paramount intervention in an attempt to reduce elastic and resistive loads. Few studies assessed the possibility of delivering this therapy during NIV, and in vivo mainly with the double tubing system, using the same "model" adopted during invasive ventilation [21, 22]

Use and reason for choosing a particular interface

There was almost unanimous agreement about the perceived use of oro-nasal masks in every clinical scenario, irrespective of the type of physician involved. This is in keeping with the literature where the large majority of studies employed this type of interface [23]. It is likely that the other masks were considered mainly as a part of the "rotation strategy" when the patient shows poor tolerance to the full-face or in order to avoid some side-effects. In certain European countries (i.e. Italy), the helmet has been extensively used especially in ICU, mainly for hypoxic respiratory failure and CPE [24], but overall in Europe the percentage of use is relatively small.
The main reasons for choosing a particular interface were the patient's comfort, the avoidance of leaks and the costs. The tolerance of patients to NIV is strongly related to the presence of air leaks, since it has been demonstrated that more leaks corresponds to a worse compliance [25] and the full-face mask is in this respect much more efficient than the nasal mask [26]. Cost reduction is a major goal for clinicians; therefore it is not surprising that the economical issue was pointed out as one of the main determinants of choice. Nowadays, improvements in technology and materials employed in assembling the interfaces enable us to use rather inexpensive masks in most of the patients. However, the most severe cases may still require sophisticated and costly interfaces.

Humidification

Humidification and warming of the inspired gas by specific devices may be needed to prevent the effects due to cool, dry gases on the trachea-bronchial epithelium during NIV [27, 28];it is therefore rather surprising that humidification is employed in a relatively small percentage of patients (~55%).The dichotomic nature of the question (yes/no), did

not allow us to discriminate between the use of the Heated Humidifiers (HH) vs. Heat and Moisture Exchangers (HME).

Strengths and limitations

The questionnaire was based, as in most of the medical surveys, on the perception of NIV use rather than on collection of data, that may have given a more detailed and real rate of NIV use in Europe. Another limitation is the selection of respondents, mainly based on their membership to a particular group or assembly of an international Society. This may have biased the results, since the members of a scientific Society may be more exposed and eventually prone to apply the innovations in medicine [29] as NIV may be considered. In keeping with the previous point, the majority of the respondents were from a University-hospital, despite the fact that the number of non-University hospitals in Europe is higher. Therefore the data obtained in the present survey may be not generalized.

Major strengths of this study are the relatively high response rate for a web-survey, and the possibility of having a complete response to all the questions by every respondent, since otherwise the questionnaire could not be submitted. This was not the case for other surveys where partially completed questionnaire might affect the response rate. Indeed, in this survey only one respondent per centre was allowed, avoiding repetitive answers from the same unit.

Conclusions

This study indicates that the perceived NIV use is prettyhigh in Europe, especially among pulmonologists and less frequent among intensivists, probably because of the different timing of NIV application.

The indications of the perceived NIV use are according to those suggested by the international guidelines.

Ventilators with NIV platform are the most frequently used machines in AHRF due to COPD exacerbations, while ICU ventilators with NIV module are preferably employed in *de-novo* hypoxic respiratory failure.

Overall, the full-face interfaces are the preferred choice, irrespective of the clinical scenarios.

References

1. Ambrosino N, Vagheggini G. Noninvasive positive pressure ventilation in the acute care setting: where are we? *Eur Respir J* 2008: 31(4): 874-886.
2. Nava S, Hill N. Non-invasive ventilation in acute respiratory failure. *Lancet* 2009: 374: 250-259.
3. Demoule A, Girou E, Richard JC, Taille S, Brochard L. Increased use of noninvasive ventilation in French intensive care units. *Intensive Care Med* 2006: 32(11): 1747-1755.
4. Maheshwari V, Paioli D, Rothaar R, Hill NS. Utilization of noninvasive ventilation in acute care hospitals: a regional survey. *Chest* 2006: 129(5): 1226-1233.
5. Esteban A, Ferguson ND, Meade MO, Frutos-Vivar F, Apezteguia C, Brochard L, Raymondos K, Nin N, Hurtado J, Tomicic V, Gonzalez M, Elizalde J, Nightingale P, Abroug F, Pelosi P, Arabi Y, Moreno R, Jibaja M, D'Empaire G, Sandi F, Matamis D, Montanez AM, Anzueto A. Evolution of mechanical ventilation in response to clinical research. *Am J Respir Crit Care Med* 2008: 177(2): 170-177.
6. Nava S, Sturani C, Hartl S, Magni G, Ciontu M, Corrado A, Simonds A. End-of-life decision-making in respiratory intermediate care units: a European survey. *Eur Respir J* 2007: 30(1): 156-164.
7. Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. *Lancet* 2000: 355(9219): 1931-1935.
8. Poponick JM, Renston JP, Bennett RP, Emerman CL. Use of a ventilatory support system (BiPAP) for acute respiratory failure in the emergency department. *Chest* 1999: 116(1): 166-171.
9. Burns KE, Duffett M, Kho ME, Meade MO, Adhikari NK, Sinuff T, Cook DJ. A guide for the design and conduct of self-administered surveys of clinicians. *Cmaj* 2008: 179(3): 245-252.
10. Forina M. http://www.parvus.unige.it. 2008.
11. Kumle B, Haisch G, Suttner SW, Piper SN, Maleck W, Boldt J. [Current status of non-invasive ventilation in German ICU's -- a postal survey]. *Anasthesiol Intensivmed Notfallmed Schmerzther* 2003: 38(1): 32-37.
12. Doherty MJ, Greenstone MA. Survey of non-invasive ventilation (NIPPV) in patients with acute exacerbations of chronic obstructive pulmonary disease (COPD) in the UK. *Thorax* 1998: 53(10): 863-866.
13. Hess DR, Pang JM, Camargo CA, Jr. A survey of the use of noninvasive ventilation in academic emergency departments in the United States. *Respir Care* 2009: 54(10): 1306-1312.
14. Nava S, Navalesi P, Conti G. Time of non-invasive ventilation. *Intensive Care Med* 2006: 32(3): 361-370.
15. Vignaux L, Tassaux D, Jolliet P. Performance of noninvasive ventilation modes on ICU ventilators during pressure support: a bench model study. *Intensive Care Med* 2007: 33(8): 1444-1451.
16. Ferreira JC, Chipman DW, Hill NS, Kacmarek RM. Bilevel vs ICU ventilators providing noninvasive ventilation: effect of system leaks: a COPD lung model comparison. *Chest* 2009: 136(2): 448-456.

17. Lofaso F, Brochard L, Touchard D, Hang T, Harf A, Isabey D. Evaluation of carbon dioxide rebreathing during pressure support ventilation with airway management system (BiPAP) devices. *Chest* 1995: 108(3): 772-778.
18. Ferguson GT, Gilmartin M. CO2 rebreathing during BiPAP ventilatory assistance. *Am J Respir Crit Care Med* 1995: 151(4): 1126-1135.
19. Thys F, Liistro G, Dozin O, Marion E, Rodenstein DO. Determinants of Fi,O2 with oxygen supplementation during noninvasive two-level positive pressure ventilation. *Eur Respir J* 2002: 19(4): 653-657.
20. Thille AW, Rodriguez P, Cabello B, Lellouche F, Brochard L. Patient-ventilator asynchrony during assisted mechanical ventilation. *Intensive Care Med* 2006: 32(10): 1515-1522.
21. Nava S, Karakurt S, Rampulla C, Braschi A, Fanfulla F. Salbutamol delivery during non-invasive mechanical ventilation in patients with chronic obstructive pulmonary disease: a randomized, controlled study. *Intensive Care Med* 2001: 27(10): 1627-1635.
22. Pollack CV, Jr., Fleisch KB, Dowsey K. Treatment of acute bronchospasm with beta-adrenergic agonist aerosols delivered by a nasal bilevel positive airway pressure circuit. *Ann Emerg Med* 1995: 26(5): 552-557.
23. Kwok H, McCormack J, Cece R, Houtchens J, Hill NS. Controlled trial of oronasal versus nasal mask ventilation in the treatment of acute respiratory failure. *Crit Care Med* 2003: 31(2): 468-473.
24. Chiumello D, Pelosi P, Carlesso E, Severgnini P, Aspesi M, Gamberoni C, Antonelli M, Conti G, Chiaranda M, Gattinoni L. Noninvasive positive pressure ventilation delivered by helmet vs. standard face mask. *Intensive Care Med* 2003: 29(10): 1671-1679.
25. Prinianakis G, Delmastro M, Carlucci A, Ceriana P, Nava S. Effect of varying the pressurisation rate during noninvasive pressure support ventilation. *Eur Respir J* 2004: 23(2): 314-320.
26. Girault C, Briel A, Benichou J, Hellot MF, Dachraoui F, Tamion F, Bonmarchand G. Interface strategy during noninvasive positive pressure ventilation for hypercapnic acute respiratory failure. *Crit Care Med* 2009: 37(1): 124-131.
27. Richards GN, Cistulli PA, Ungar RG, Berthon-Jones M, Sullivan CE. Mouth leak with nasal continuous positive airway pressure increases nasal airway resistance. *Am J Respir Crit Care Med* 1996: 154(1): 182-186.
28. Hayes MJ, McGregor FB, Roberts DN, Schroter RC, Pride NB. Continuous nasal positive airway pressure with a mouth leak: effect on nasal mucosal blood flux and nasal geometry. *Thorax* 1995: 50(11): 1179-1182.
29. Berwick DM. Disseminating innovations in health care. *JAMA* 2003: 289(15): 1969-1975.

Tables

Table 1

Respondents' Geographic area*

Geographic Area	Respondents' Countries	n	%	Total n
Northern Europe	Denmark	2	0,74	38
	Estonia	1	0,37	
	Finland	3	1,10	
	United Kingdom	17	6,25	
	Netherlands	3	1,10	
	Norway	6	2,21	
	Russian Federation	1	0,37	
	Sweden	5	1,84	
Central Europe	Austria	1	0,37	71
	Belgium	9	3,31	
	Switzerland	10	3,68	
	Czech Republic	1	0,37	
	Germany	22	8,09	
	France	27	9,93	
	Poland	1	0,37	
Southern Europe & Middle East	Egypt	1	0,37	163
	Spain	48	17,65	
	Greece	7	2,57	
	Iran	1	0,37	
	Italy	91	33,46	
	Oman	2	0,74	
	Portugal	3	1,10	
	Qatar	1	0,37	
	Romania	2	0,74	
	Turkey	7	2,57	
Grand Total				272

*Data are expressed as number (n) and percentage (%) of respondents.

Table 2
Respondents' Characteristics'*

		n	%
Field of expertize	Intensive Care/ Anesthesia	104	38.24
	Pulmonary Medicine	136	50.00
	Others	32	11.77
Hospital	Community Hospital	110	40.44
	University Hospital	162	59.56
Work facility	ICU	109	40.07
	RICU / Rehab/ Pulmonary	82	30.15
	Others	81	29.78
No. of beds per unit	1-5	27	9.93
	6-10	71	26.10
	11-15	56	20.59
	16-20	52	19.12
	> 20	66	24.26
% of patients ventilated with NIV/year	0 Patients	10	3.68
	< 20%	41	15.07
	21-40%	60	22.05
	41-60%	50	18.38
	61-80%	36	13.24
	81-100%	75	27.57

*Data are expressed as number (n) and percentage (%) of respondents.

Table 3
Scenario, ventilator and mask distribution among countries with the highest number of respondents*

	Germany	Spain	France	UK	Italy
Scenarios					
Acute Hypercapnic Respiratory Failure (AHRF)	41,5	42,9	46,1	53,9	46,3
Cardiogenic Pulmonary Edema (CPE)	14,3	19,5	16,3	8,9	17,2
de novo hypoxic respiratory failure	8,0	12,1	17,1	6,1	12,3
Weaning/Post-extubation failure (W/PE)	18,8	8,7	12,7	11,2	9,4
Ventilators					
ICU ventilator with NIV module	25,0	27,1	61,1	14,7	32,1
ICU ventilator without NIV module	1,1	2,6	2,8	0,0	3,3
Dedicated ventilator for acute NIV	37,5	35,4	28,7	41,2	27,5
Home care ventilator for chronic NIV	15,9	4,7	0,9	14,7	7,4
Stand-Alone CPAP generator	1,1	8,9	0,9	5,9	10,2
Masks					
Nasal Mask	14,8	1,6	3,7	8,8	3,6
Oro-Nasal Mask (i.e. facial)	65,9	67,2	75,0	58,8	51,6
Total Face Mask	0	4,7	14,8	8,8	9,9
Helmet	0	2,1	0,9	0	13,5
Anesthesia Mask	0	3,1	0	0	1,9

*Data are expressed as a percentage of respondents.

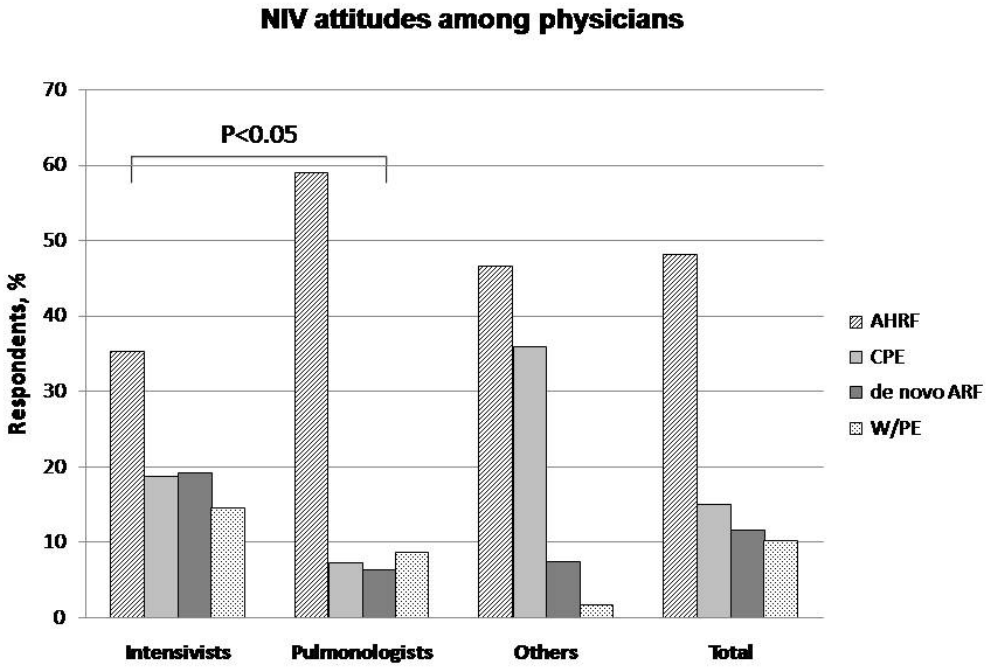
NIV attitudes among physicians
Respondents, %
70
60
50
40
30
20
10
0
P<0.05
Intensivists
Pulmonologists
Others
Total
AHRF
CPE
de novo ARF
W/PE

Fig. 1

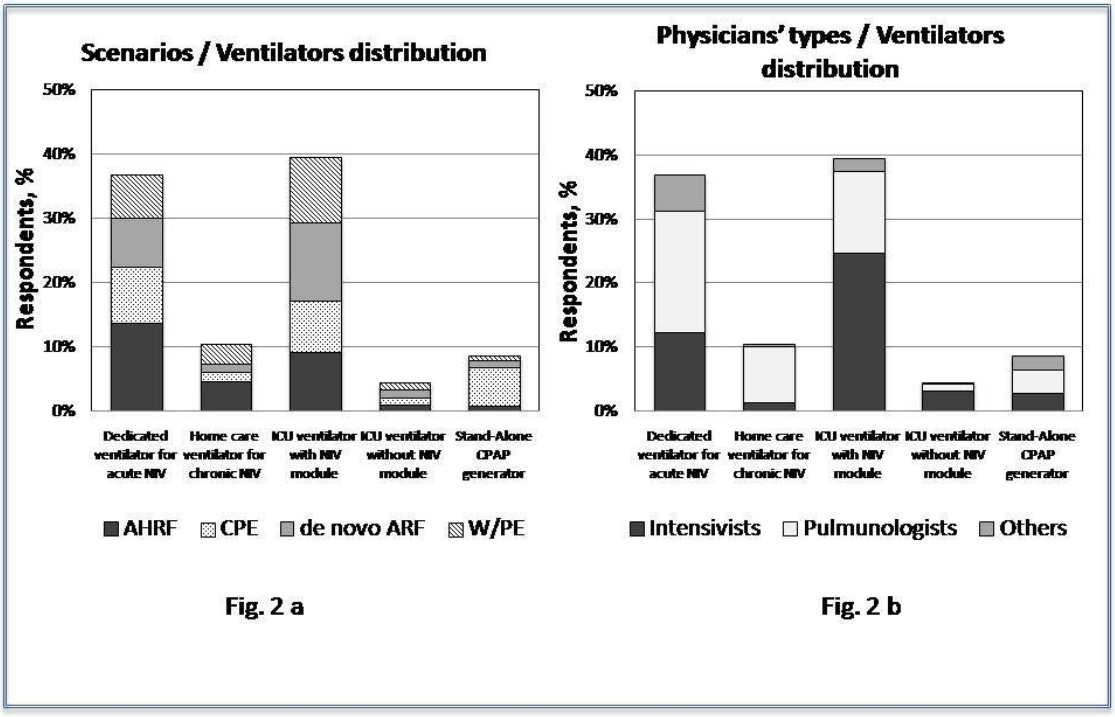

Fig. 2 a

Fig. 2 b

Fig. 2

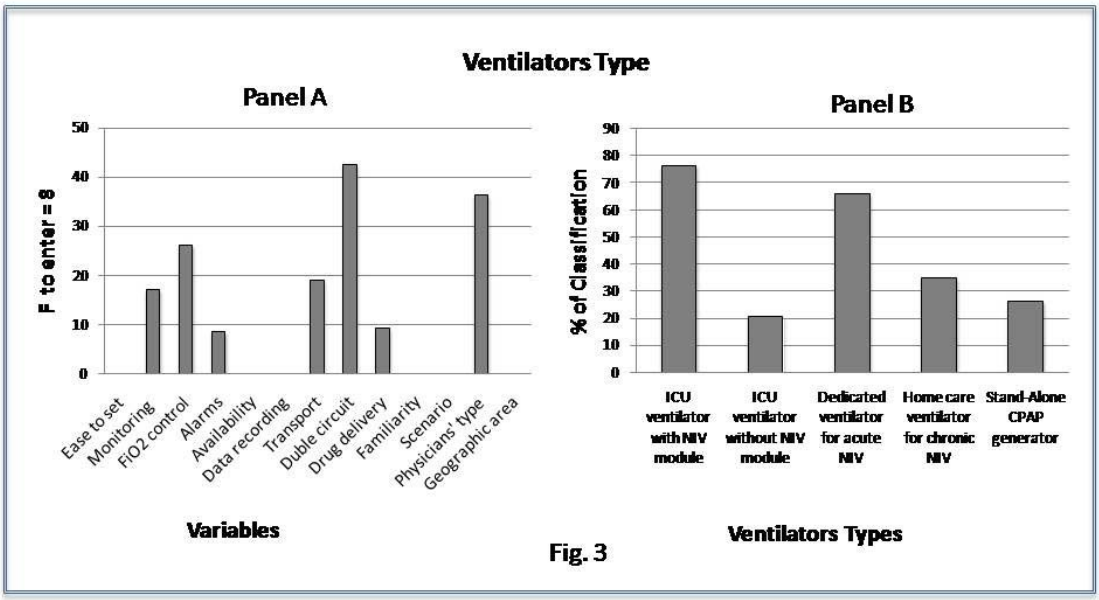
Ventilators Type
Panel A
F to enter = 8
50
40
30
20
10
0
Ease to set
Monitoring
FiO2 control
Alarms
Availability
Data recording
Transport
Duble circuit
Drug delivery
Familiarity
Scenario
Physicians' type
Geographic area
Variables
Panel B
% of Classification
90
80
70
60
50
40
30
20
10
0
ICU ventilator with NIV module
ICU ventilator without NIV module
Dedicated ventilator for acute NIV
Home care ventilator for chronic NIV
Stand-Alone CPAP generator
Ventilators Types

Fig. 3

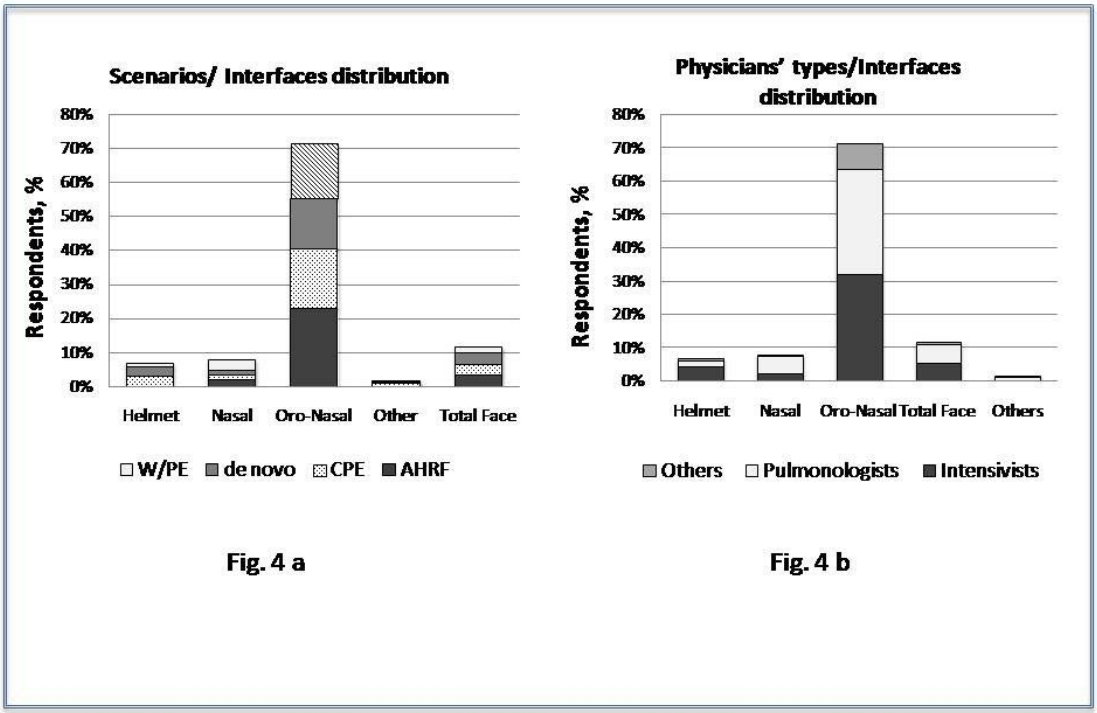

Fig. 4 a

Fig. 4 b

Fig. 4

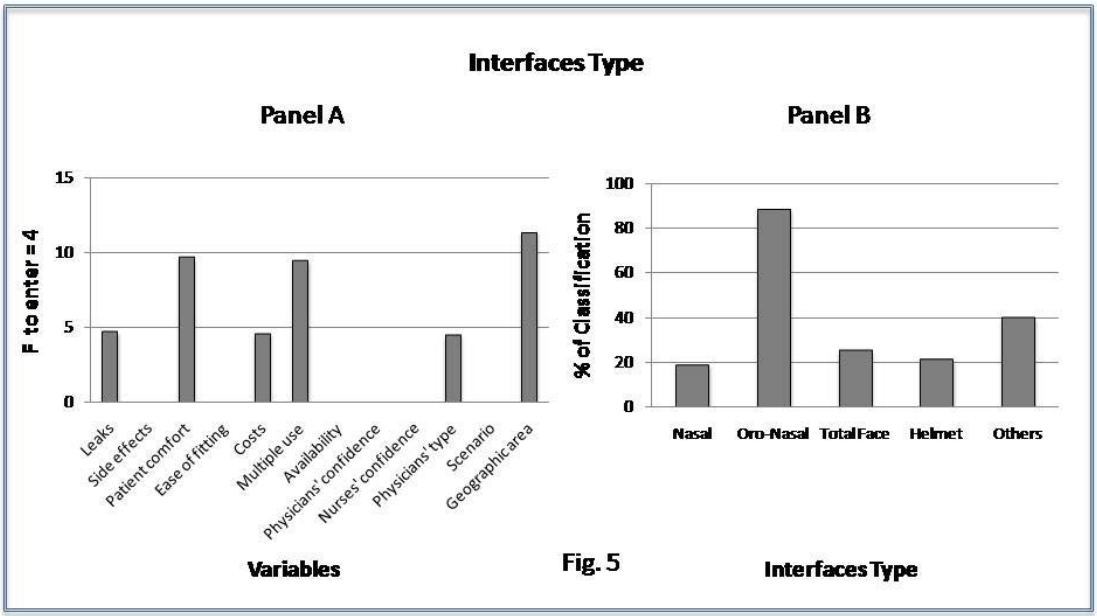

Fig. 5

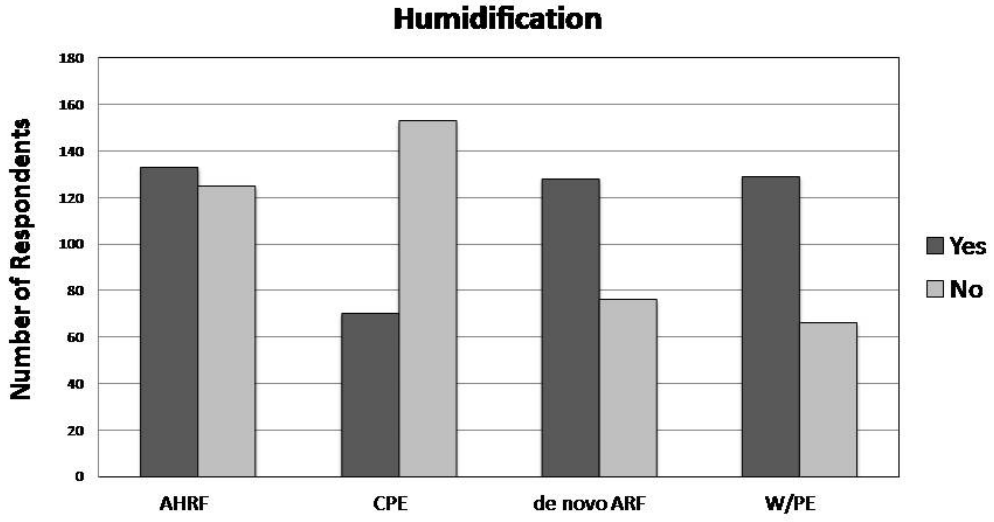
Humidification
Number of Respondents
180
160
140
120
100
80
60
40
20
0
AHRF
CPE
de novo ARF
W/PE
Yes
No

Fig. 6