

An International Survey on Noninvasive Ventilation Use for Acute Respiratory Failure in General Non-Monitored Wards

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BACKGROUND: Use of noninvasive ventilation (NIV) for the treatment of patients with acute respiratory failure (ARF) has greatly increased in the last decades. In contrast, the increasing knowledge of its effectiveness and physician confidence in managing this technique have been accompanied by a declining number of available ICU beds. As a consequence, the application of NIV outside the ICU has been reported as a growing phenomenon. Previously published surveys highlighted a great heterogeneity in NIV use, clinical indications, settings, and efficacy. Moreover, they revealed a marked heterogeneity with regard to staff training and technical and organizational aspects. We performed the first worldwide web-based survey focused on NIV use in general wards for ARF. **METHODS:** A questionnaire to obtain data regarding hospital and ICU characteristics, settings and modalities of NIV application and monitoring, estimated outcomes, technical and organizational aspects, and observed complications was developed. The multiple-choice anonymous questionnaire to be filled out online was distributed worldwide by mail, LinkedIn, and Facebook professional groups. **RESULTS:** One-hundred fifty-seven questionnaires were filled out and analyzed. Respondents were from 51 countries from all 5 continents. NIV application in general wards was reported by 66% of respondents. Treatments were reported as increasing in 57% of cases. Limited training and human resources were the most common reasons for not using NIV in general wards. Overall, most respondents perceived that NIV avoids tracheal intubation in most cases; worsening of ARF, intolerance, and inability to manage secretions were the most commonly reported causes of NIV failure. **CONCLUSIONS:** Use of NIV in general wards was reported as effective, common, and gradually increasing. Improvement in staff training and introduction of protocols could help to make this technique safer and more common when applied in general wards setting. *Key words:* noninvasive ventilation; survey; general wards; acute respiratory failure. [Respir Care 2015;0(0):1-•. © 2015 Daedalus Enterprises]

Introduction

The use of noninvasive ventilation (NIV) for the treatment of patients with acute respiratory failure (ARF) has

greatly increased in the last decades.¹ Early treatment with NIV is of crucial importance to improve a patient's outcome because it has been demonstrated to reduce the need for tracheal intubation, ICU stay, and re-intubation rates in different patient groups.²⁻⁴ However, the increasing aware-

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ness of the effectiveness of NIV has been accompanied, worldwide, by a declining number of available ICU beds over the years. This shortage, together with an increased confidence of physicians in managing this technique, has resulted in the increased use of NIV outside the ICU. Preliminary reports confirmed NIV efficacy even in a general ward setting.⁵ Previously published surveys performed on this topic highlighted a great heterogeneity in NIV use, clinical indications, settings, and efficacy in general wards.⁶⁻¹⁶ Moreover, they revealed a marked heterogeneity even with regard to staff training and technical and organizational aspects of NIV use. We therefore performed the first worldwide web-based international survey focused on NIV use in general wards for ARF.

Methods

We developed a questionnaire to obtain data regarding hospital, general ward (outside ICU, non-monitored ward) or respiratory intermediate unit (characterized by a nurse/patient ratio of 1:3–1:4, multivariable monitors, NIV or invasive ventilation allowed, immediate availability of a physician)¹⁷; ICU characteristics, settings, and modalities of NIV application and monitoring; perceived outcomes; technical and organizational aspects; and observed complications. The questionnaire was evaluated for clarity and relevance by an international panel of NIV experts (see the supplementary materials at <http://www.rcjournal.com>). In October 2013, the multiple-choice questionnaire was sent by mail (using all the pertinent mailing lists available to us), LinkedIn, and Facebook professional groups via a link to Maian Survey, a free online survey system. The questionnaire was anonymous, and the collected answers were automatically tabulated in a web Excel worksheet.

Results

One-hundred fifty-seven questionnaires were filled out online and analyzed. Respondents were from 51 countries (Table 1).

The characteristics of the respondents' hospitals are listed in Table 2. In 66% of the hospitals, NIV was applied in general wards. Limited training and limited human resources were the most common reported reasons from centers not using NIV in general wards; very few respondents reported doubts of its efficacy.

In 57% of cases, NIV treatment in general wards was reported as increasing. Training had been performed before NIV introduction in general wards in 49% of cases; periodic education was available in 58% of the centers. In

QUICK LOOK

Current knowledge

The use of noninvasive ventilation (NIV) for the treatment of exacerbations of COPD has increased markedly over the last decade owing to growing evidence demonstrating improved outcomes. Growth of NIV outside of intensive care has been variable based on indication and geography.

What this paper contributes to our knowledge

A worldwide survey of NIV suggests that use outside the ICU is increasing. The survey identified lack of training and protocols as impediments to safe and effective use on the general floor.

61% of the centers, once started on NIV, the patient was always or often left in the initial ward, whereas only 19% of respondents never left the patients on NIV in a general ward.

The ventilators commonly belonged to the ICU or the pulmonology ward, whereas in only 4% of cases, every ward had its own devices. A trend toward an increase in the number of CPAP/NIV devices was reported by 59% of respondents.

Treatments were often not protocolized (see Table 2). Pulmonologists and intensivists prescribed NIV in most hospitals; however, in 29% of cases, ward physicians could prescribe NIV autonomously. In 32% of hospitals, the physician authorized to prescribe NIV was not continuously present; accordingly, the nursing staff and ward physician had a relevant role in the management of NIV, as reported by two thirds of respondents.

Treated diseases and monitoring aspects are summarized in Tables 3 and 4. In Table 5, the most common complications are reported. Overall, most respondents perceived that NIV was successful in most cases (Table 6); worsening of ARF, intolerance to the interface, and inability to manage secretions were the most commonly reported causes of NIV failure (Table 7).

Discussion

This study is the first international survey focusing on NIV for ARF in general non-monitored wards. The limited number of respondents compared with the huge number of hospitals in the world makes our data preliminary: our results should not be generalized or considered representative of all hospitals worldwide. This bias limits also the

NIV USE FOR ARF IN GENERAL WARDS

Table 1. Location of Respondents' Hospitals

Region and Country	No. of Hospitals	Percentage Overall	Percentage of Region
Total	157		
Europe	84	53.5	
Italy	19	12.1	22.6
France	10	6.4	11.9
Germany	10	6.4	11.9
Portugal	9	5.7	10.7
Spain	7	4.5	8.3
United Kingdom	4	2.5	4.8
Finland	2	1.3	2.4
Ireland	2	1.3	2.4
Norway	2	1.3	2.4
Romania	2	1.3	2.4
Russia	2	1.3	2.4
Slovakia	2	1.3	2.4
The Netherlands	2	1.3	2.4
Austria	1	0.6	1.2
Belgium	1	0.6	1.2
Bulgaria	1	0.6	1.2
Croatia	1	0.6	1.2
Denmark	1	0.6	1.2
Hungary	1	0.6	1.2
Iceland	1	0.6	1.2
Macedonia	1	0.6	1.2
Monaco	1	0.6	1.2
Poland	1	0.6	1.2
Serbia	1	0.6	1.2
Asia	31	19.8	
India	10	6.4	32.3
Turkey	5	3.2	16.1
Pakistan	3	1.9	9.7
Saudi Arabia	2	1.3	6.5
Taiwan	2	1.3	6.5
United Arab Emirates	2	1.3	6.5
China	1	0.6	3.2
Iraq	1	0.6	3.2
Japan	1	0.6	3.2
Jordan	1	0.6	3.2
Kuwait	1	0.6	3.2
Central and South America	13	8.3	
Brazil	5	3.2	38.5
Argentina	2	1.3	15.4
Peru	2	1.3	15.4
Colombia	1	0.6	7.7
Costa Rica	1	0.6	7.7
Ecuador	1	0.6	7.7
Venezuela	1	0.6	7.7
North America	9	5.8	
United States	5	3.2	55.6
Canada	2	1.3	22.2
Mexico	2	1.3	22.2
Oceania	5	3.2	
Australia	3	1.9	60.0
New Zealand	2	1.3	40.0
Africa	4	2.4	
Egypt	1	0.6	25.0
Lebanon	1	0.6	25.0
Morocco	1	0.6	25.0
Tunisia	1	0.6	25.0
Unidentified	11	7.0	

Table 2. Characteristics of the Respondents' Hospitals and Settings of NIV Use

Characteristics	Values, n (%)
Hospital type	
Academic	110 (69.1)
Non-academic	47 (30.9)
No. of hospital beds	
< 500	64 (40.8)
500–1,000	53 (33.8)
> 1,000	40 (25.4)
Presence of a respiratory step-down unit (also defined as a high-dependency or intermediate unit)	
Yes	76 (48.8)
No	81 (51.2)
NIV applied in the respiratory step-down unit, if present	
Yes	83 (53.1)
No	12 (7.5)
Not present	62 (39.4)
NIV applied in the ICU, if present	
Yes	146 (93.1)
No	6 (3.8)
Not present	5 (3.1)
NIV applied in the emergency department, if present	
Yes	114 (73.0)
No	25 (15.7)
Not present	18 (11.3)
NIV applied in general wards	
Yes	104 (66.0)
No	53 (34.0)
Reasons for not using NIV in general wards	
Safety concerns	32 (20.4)
Lack of training	46 (29.9)
Limited human resources (understaffed)	39 (24.8)
Limited financial resources	26 (16.6)
Doubts about NIV efficacy	6 (3.8)
Other	16 (10.2)
No. of NIV treatments in general wards increasing	
Yes	90 (57.3)
No	49 (31.2)
Unknown	18 (11.5)
Specific training provided before introducing NIV in general wards	
Yes	79 (50.6)
No	78 (49.4)
NIV use in general wards	
Every hospital ward	49 (31.5)
Only in some hospital wards	108 (68.5)
Patient left in the general ward after starting NIV	
Always	31 (19.6)
Often	71 (45.3)
Rarely	35 (22.3)
Never	20 (12.8)

(continued)

NIV USE FOR ARF IN GENERAL WARDS

Table 2. Continued

Characteristics	Values, n (%)
NIV modalities used in general wards	
CPAP	88 (56.1)
Bi-level or pressure support	119 (75.8)
Pressure control	30 (19.1)
Volume control	22 (14.0)
Other	14 (8.9)
No. of CPAP devices available in the hospital	
1	4 (2.7)
2	7 (4.7)
3	15 (9.4)
4	16 (10.1)
5	11 (6.7)
> 5	104 (66.4)
No. of ventilators available in the hospital for pressure support/BPAP/volume control ventilation	
1	1 (0.6)
2	7 (4.5)
3	5 (3.2)
4	12 (7.7)
5	8 (5.1)
> 5	124 (78.8)
Ventilator owner	
ICU	112 (71.3)
Emergency department	57 (36.3)
Pulmonology	83 (52.9)
Every ward has its own ventilators	12 (7.6)
Other	24 (15.3)
Interface used for NIV	
Oronasal masks	143 (91.1)
Nasal masks	73 (46.5)
Helmets	34 (21.7)
Other	24 (15.3)
Availability of different size and models	
Yes	148 (94.2)
No	9 (5.8)
Presence of NIV-dedicated protocol for:	
Indications	81 (51.5)
Treatment modalities	60 (38.2)
Weaning for NIV	50 (31.8)
Monitoring	69 (43.9)
Absolute and relative contraindications	65 (41.4)
No protocol is present	66 (42.0)
NIV prescriber in general wards	
Ward physician	46 (29.3)
Pulmonologist	108 (68.8)
Anesthesiologist	55 (35.0)
Emergency physician	52 (33.1)
Intensivist	83 (52.9)
Medical emergency team/rapid response team	23 (14.6)
Respiratory therapist	24 (15.3)
Other	6 (3.8)

(continued)

Table 2. Continued

Characteristics	Values, n (%)
Is the specialist authorized to prescribe NIV always present in the hospital?	
Yes	107 (68.0)
No	50 (32.0)
Protocol to manage NIV failure	
Yes	57 (36.6)
No	64 (40.5)
Depends mainly on ICU bed availability	36 (22.9)
Role of general ward physicians in days following NIV initiation	
Manage every aspect of the treatment	58 (36.6)
No role in NIV	31 (19.9)
Manage NIV in conjunction with the physician who prescribed it	68 (43.5)
Role of general ward nurses in days following NIV initiation	
Manage every aspect of the treatment	29 (18.3)
No role in NIV	39 (24.8)
Manage NIV in conjunction with the ward physician and physician who prescribed it	89 (56.9)
Presence of a respiratory therapist in general wards using NIV	
Yes, in all wards	38 (24.2)
Yes, in most wards	10 (6.7)
Yes, but only in a few wards	36 (22.8)
No	73 (46.3)

NIV = noninvasive ventilation
BPAP = bi-level positive airway pressure

value of comparisons with other surveys. Nevertheless, our original results offer a basis for future larger studies.

The results from our study, including respondents from all 5 continents, suggests that NIV use in general wards is common and growing worldwide. In a recent survey among the members of the Noninvasive Ventilatory Support Group of the European Respiratory Society, NIV use in general (mainly pulmonary) wards was reported as common.¹⁶ The percentage of hospitals using NIV in general wards is increasing: from < 10% in 2005⁹ to 66% in our survey. As reported in previous studies,^{6,7,9} in most hospitals, NIV is prescribed only in some hospital wards, and once the treatment is started, patients generally remain in their wards. The main reason for this phenomenon is likely the overall respondents' perception of NIV efficacy. In fact, > 50% of respondents believed that NIV was successful in more than half of cases. This percentage is doubled compared with the percentages reported in previous surveys.^{6,7} Nevertheless, the perceived success rate is still lower than the success rates reported in most published studies on NIV⁴: NIV efficacy in general wards should be further improved, and simple interventions to achieve this aim seem at hand.

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Table 3. Causes of ARF Treated by NIV Outside the ICU

Cause of ARF	Hospitals Using NIV Outside the ICU for This Cause of ARF (%)
COPD exacerbation	94.3
Acute pulmonary edema	85.4
Neuromuscular diseases	77.1
Postoperative ARF	72.0
Pneumonia in immunocompromised patients	63.0
Palliation	51.0
Pneumonia in non-immunocompromised patients	41.4
Asthma	34.4
Thoracic trauma	26.1

ARF = acute respiratory failure
NIV = noninvasive ventilation

Table 4. Reported Standard Monitoring for NIV Treatments Outside the ICU

Monitoring	Hospitals Routinely Using NIV (%)
Continuous pulse oximetry	80.3
Arterial blood gas analysis when clinically required	68.8
Visits by the specialist prescribing NIV more than once daily	44.6
Continuous electrocardiogram	43.9
Arterial blood gas analysis at fixed times	39.5
Continuous noninvasive arterial blood pressure	52.2
Daily visit by the specialist prescribing NIV	16.6
No standard	12.1

NIV = noninvasive ventilation

As an example, nearly 42% of respondents attributed NIV failure to poor patient compliance with the interface: a careful, better choice and management of the most comfortable interface could likely be obtained through better staff training.

In addition to well-established indications such as acute pulmonary edema and COPD exacerbation, NIV is also commonly used in conditions in which response to NIV is less clear, such as asthma. Moreover, use for indications with a known high failure rate, such as pneumonia, in non-immunocompromised patients has been reported. These results are comparable with those reported by Cabrini et al⁶ in 2011, with the exception of neuromuscular diseases, which was a much more prevalent cause for NIV use outside the ICU in our survey (77% vs 38%).

Table 5. Complications or Problems Reported in Patients Receiving NIV

Complication or Problem	Respondents Reporting a Complication or Problem (%)
Skin lesions due to mask	72.0
Excessive agitation of patient	67.5
Excessive air losses around a mask	65.6
Patient's refusal of or insufficient compliance with NIV	67.5
Insufficient ward doctor cooperation	28.0
Insufficient ward nurse cooperation	26.8
Sudden arterial desaturation	19.7
Ventilator malfunctioning	19.1
Coma	7.0
Delay in tracheal intubation in the case of NIV failure	25.5
Other	5.7
Conjunctivitis	15.9
Delay of visit by the specialist prescribing NIV when summoned	15.3

NIV = noninvasive ventilation

Table 6. Perceived NIV Success Rate in General Wards

Overall Average NIV Success Rate in General Wards (Avoidance of Tracheal Intubation and Admission to ICU)	Respondents Reporting NIV Success Rate in General Wards (%)
< 25%	11.6
25–49%	22.6
50–74%	25.3
> 75%	26.0
Unknown	14.4

NIV = noninvasive ventilation

Table 7. Causes of NIV Failure in General Wards

Most Common Cause of NIV Failure in General Wards	Respondents Reporting the Most Common Cause (%)
Worsening respiratory failure	67.5
Inability to manage secretions	38.9
Intolerance to the interface	42.0
Deteriorating level of consciousness	28.0
NIV-related complications	17.2
Other	9.6

NIV = noninvasive ventilation

In general, NIV should not be used in general wards when its efficacy is uncertain, at a minimum, and better monitored settings are preferred. However, the reported data do not necessarily imply that there is a lack of awareness about NIV failure risk; on the contrary, they could

merely demonstrate that better monitored beds are often unavailable, forcing physicians to manage ARF in suboptimal settings. Nevertheless, awareness of NIV limitations and risks should be promoted: mandatory preliminary training and the use of a protocol could be of help if NIV is to be administered in non-monitored wards.

Finally, lack of training and limited human and financial resources (not monitored wards) are the most common reported reasons for not using NIV in general. Despite the increasing data on NIV efficacy, in particular when applied early,² a relevant percentage of hospitals have not yet decided to invest in this field. It is worth noting that the cost effectiveness of NIV outside the ICU has already been demonstrated.^{18,19}

NIV use in general wards is an area of research that has been largely neglected compared with studies performed in ICUs. The fact that almost all published studies on NIV were performed in ICUs could be misleading, as the results might not accurately represent where NIV is currently used in the real world. Our study suggests that research on NIV use outside the ICU is urgently required.

Limitations

Our survey has some limitations. We (experienced in both NIV and surveys) developed the questionnaire, and it was reviewed by a larger number of international experts; however, the questionnaire did not undergo a full evaluation process. Information about the criteria used to define respiratory failure in every center and the severity of the respiratory failure was not collected: future surveys should consider these issues to better understand which patients are currently treated on general wards. Data on NIV performed in general wards on do-not-intubate patients or patients considered unfit for ICU admission (or who refused intubation or ICU admission) were not collected; these data would have been of help in better evaluating the use of NIV for controversial indications, such as asthma and pneumonia, in general wards. The hospitals that agreed to participate in the survey are not representative of all hospitals worldwide. Therefore, comparisons with previous studies should be made with caution. Moreover, the number of respondents was rather limited. Because the questionnaire was distributed by social media, we do not know how many people were contacted; for the same reason, we cannot report the responding rate among the different countries or different types of hospitals. However, the aim of the survey was to offer a first look at NIV use outside the ICU. We consider our effort successful, as hospitals from all 5 continents returned the questionnaire. We did not collect data on the profession or specialization of the respondents; respondents could report different complementary data or perceptions about NIV use. Finally, we explored a limited number of NIV aspects: future surveys

should focus on specific aspect such as protocols, organization, association between NIV use on general wards and shortage of ICU beds, and physicians' preferences.

Conclusions

Based on this first international survey, NIV is often applied in general wards, and its use is increasing. Criticalities such as lack of training and protocols are reported and should be addressed to make NIV use safer and more effective. Further research in this area is required.

REFERENCES

1. Schnell D, Timsit JF, Darmon M, Vesin A, Goldgran-Toledano D, Dumenil AS, et al. Noninvasive mechanical ventilation in acute respiratory failure: trends in use and outcomes. *Intensive Care Med* 2014;40(4):582-591.
2. Nava S, Hill N. Non-invasive ventilation in acute respiratory failure. *Lancet* 2009;374(9685):250-259.
3. Antonelli M, Conti G, Rocco M, Bufi M, De Blasi RA, Vivino G, et al. A comparison of noninvasive positive-pressure ventilation and conventional mechanical ventilation in patients with acute respiratory failure. *N Engl J Med* 1998;339(7):429-435.
4. Glossop AJ, Shephard N, Bryden DC, Mills GH. Non-invasive ventilation for weaning, avoiding reintubation after extubation and in the postoperative period: a meta-analysis. *Br J Anaesth* 2012;109(3):305-314.
5. Cabrini L, Idone C, Colombo S, Monti G, Bergonzi PC, Landoni G, et al. Medical emergency team and non-invasive ventilation outside ICU for acute respiratory failure. *Intensive Care Med* 2009;35(2):339-343.
6. Cabrini L, Antonelli M, Savoia G, Landriscina M. Non-invasive ventilation outside of the intensive care unit: an Italian survey. *Minerva Anestesiol* 2011;77(3):313-322.
7. Bierer GB, Soo Hoo GW. Noninvasive ventilation for acute respiratory failure: a national survey of Veterans Affairs Hospitals. *Respir Care* 2009;54(10):1313-1320.
8. Guarracino F, Cabrini L, Ferro B, Landoni G, Lembo R, Mucchetti M, et al. Noninvasive ventilation practice in cardiac surgery patients: insights from a European survey. *J Cardiothorac Vasc Anesth* 2013;27(5):e63-e65.
9. Burns KE, Sinuff T, Adhikari NK, Meade MO, Heels-Ansdell D, Martin CM, Cook DJ. Bilevel positive pressure ventilation for acute respiratory failure: survey of Ontario practice. *Crit Care Med* 2005;33(7):1477-1483.
10. Doherty MJ, Greenstone MA. Survey of non-invasive ventilation in patients with acute exacerbations of chronic obstructive pulmonary disease in the UK. *Thorax* 1998;53(10):863-866.
11. Kumle B, Haisch G, Suttner SW, Piper SN, Maleck B, Boldt J. [Current status of non-invasive ventilation in German ICUs: a postal survey]. *Anesthesiol Intensivmed Notfallmed Schmerzther* 2003;38(1):32-37. *Article in German.*
12. Crimi C, Noto A, Princi P, Esquinas A, Nava S. A European survey of non-invasive ventilation (NIV) practices. *Eur Respir J* 2010;36(2):362-369.
13. Demoule A, Girou E, Richard JC, Taillé S, Brochard L. Increased use of noninvasive ventilation in French intensive care units. *Intensive Care Med* 2006;32(11):1747-1755.
14. 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.

15. 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.
16. Scala R, Windisch W, Köhnlein T, Cuvelier A, Navalesi P, Pelosi P. Targeting European Respiratory Society Group activities: a survey of the Noninvasive Ventilatory Support Group. *Eur Respir Rev* 2014; 23(132):258-260.
17. Scala R, Corrado A, Confalonieri M, Marchese S, Ambrosino N. Increased number and expertise of Italian respiratory high-dependency care units: the second national survey. *Respir Care* 2011; 56(8):1100-1107.
18. Plant PK, Owen JL, Parrott S, Elliott MW. Cost effectiveness of ward based non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease: economic analysis of randomised controlled trial. *BMJ* 2003;326(7396):956.
19. Carlucci A, Delmastro M, Rubini F, Fracchia C, Nava S. Changes in the practice of non-invasive ventilation in treating COPD patients over 8 y. *Intensive Care Med* 2003;29(3):419-425.