



Original Article

Noninvasive Mechanical Ventilation in Valencia, Spain: From Theory to Practice

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ABSTRACT

Objective: To obtain representative data on the type, frequency of use, and availability of resources for noninvasive mechanical ventilation (NIV) in hospitals (acute respiratory failure) and at home (chronic respiratory failure).

Method: We sent a purpose-designed questionnaire to all the hospitals in the Autonomous Community of Valencia, Spain and followed up with a telephone interview.

Results: Seventy percent of the hospitals responded to the survey. NIV was used to treat patients with acute respiratory episodes in 100% of the intensive care units and in 88% of the respiratory medicine departments. The most common diseases were chronic obstructive pulmonary disease (COPD) (mean [SD] 60% [20%]), obesity hypoventilation syndrome (22% [12%]), neuromuscular diseases (6.5% [8%]), and kyphoscoliosis (6.5% [7%]). Other diseases accounted for 4% [11%] of cases. Emergency departments used NIV in 69% of patients, internal medicine departments in 37%, hospital-based home care units in 19%, and other departments in 12%. None of the hospitals that responded to the survey had an intermediate care unit and considerable differences were found in terms of NIV systems used. Home NIV was provided by 88% of hospitals. Patients using home NIV had COPD (31% [18%]), obesity hypoventilation syndrome (30% [18%]), neuromuscular diseases (16% [23%]), kyphoscoliosis (12% [10%]), and other diseases (11% [17%]). Patient numbers varied greatly from one hospital to the next. Home NIV was delivered using a nasal interface in 65% (32%) of cases, an oral-nasal interface in 33% (33%), a tracheostomy tube in 2% (3%), and a mouthpiece in 1% (3%). Only 31.3% of hospitals has a specialized home NIV unit. Home monitoring was performed mainly by service providers. We calculated that home NIV was used in 29 individuals per 100 000 population. Only 50% of the respiratory medicine departments surveyed had written NIV protocols; the corresponding percentages for other departments were 44% for home care units, 19% for emergency departments, and 12% for internal medicine departments.

Conclusions: We observed differences in the type of equipment used, and considerable deficiencies in the availability of human and material resources and support systems. Although NIV is mostly used in hospitals to treat patients with acute respiratory failure, home NIV is also very common and is characterized by greater variability in terms of the number and type of patients. We also observed deficiencies in terms of written protocols for patients with acute and chronic disease.

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Palabras clave:

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Ventilación mecánica no invasiva en la Comunidad Valenciana: de la teoría a la práctica

RESUMEN

Objetivo: Obtener datos representativos acerca del abordaje, la prevalencia y los recursos disponibles para la práctica de la ventilación mecánica no invasiva (VMNI), tanto en pacientes agudos como en domicilio.

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Método: Mediante un cuestionario específico por vía electrónica reforzado con encuesta telefónica se recabó información de todos los hospitales de la Comunidad Valenciana.

Resultados: Se obtuvieron datos del 70% de los centros encuestados. Durante los episodios agudos la VMNI se realizaba en la unidad de cuidados intensivos en el 100% de los casos y en el servicio de neumología en el 88%; las enfermedades más frecuentes (media \pm desviación estándar) fueron las siguientes: enfermedad pulmonar obstructiva crónica (EPOC; $60 \pm 20\%$), síndrome de obesidad-hipoventilación ($22 \pm 12\%$), enfermedades neuromusculares ($6,5 \pm 8\%$), cifoescoliosis ($6,5 \pm 7\%$) y otras ($4 \pm 11\%$). La VMNI se realizaba en urgencias en el 69% de los casos, en medicina interna en el 37%, en la unidad de hospitalización domiciliaria en el 19% y en otros servicios en el 12%. Ninguno de los hospitales encuestados dispone de Unidad de Cuidados Intermedios y existió gran disparidad entre los sistemas de VMNI empleados. La VMNI en domicilio se efectuaba en el 88% de los hospitales y se aplicaba a pacientes con EPOC ($31 \pm 18\%$), síndrome de obesidad-hipoventilación ($30 \pm 18\%$), enfermedades neuromusculares ($16 \pm 23\%$), cifoescoliosis ($12 \pm 10\%$) y otras enfermedades ($11 \pm 17\%$), con amplia variabilidad en el número de pacientes por hospital. El tipo de interfaz domiciliaria fue nasal en el $65 \pm 32\%$ de los casos, oronasal en el $33 \pm 33\%$, traqueostomía en el $2 \pm 3\%$ y bucal en el $1 \pm 3\%$. Sólo disponía de consulta monográfica el 31,3% de los hospitales. El control domiciliario lo realizaban principalmente empresas suministradoras. La prevalencia calculada de VMNI domiciliaria fue 29/100.000. Sólo el 50% de los centros disponía en neumología de protocolos de VMNI para pacientes hospitalizados, un 44% para domicilio, un 19% para urgencias y un 12% para medicina interna.

Conclusiones: Se observan importantes carencias en recursos humanos y técnicos, disparidad en el material empleado y escasez en sistemas de apoyo. Aunque en la mayoría de los hospitales la VMNI se realiza en pacientes agudos, el número y el tipo de pacientes que reciben VMNI en su domicilio son más variables, pero la VMNI en domicilio presenta alta prevalencia. Además, se objetiva falta de protocolos escritos tanto para pacientes agudos como crónicos.

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Introduction

Noninvasive mechanical ventilation (NIV) has become increasingly widespread in the treatment of acute and chronic respiratory failure in the past 15 years.¹ Indeed, there is evidence that NIV reduces the need for endotracheal intubation and shortens hospital stays in both intensive care units and general wards. It has also been shown to reduce the mortality associated with respiratory failure in patients with chronic obstructive pulmonary disease (COPD) exacerbations,^{2,3} acute pulmonary edema,⁴ and compromised immune systems.⁵ Although there is less evidence supporting the effectiveness of NIV in other conditions such as severe asthma exacerbations⁶ or hypoxemic respiratory failure,⁷ consensus guidelines recommend that NIV should be administered as the treatment of choice in patients with COPD exacerbations and that it should be available in all hospitals treating such patients.⁸ Adherence to these recommendations, however, seems to be poor, as multicenter studies conducted in Europe have shown. One group of authors, for example, found that 20% of hospitals did not use NIV at all and that only 16% of patients that required mechanical ventilation actually received it in hospitals where NIV was available.⁹ A recent survey of hospitals in the United States showed that NIV was only used in 20% of patients requiring mechanical ventilation, with marked differences between hospitals.¹⁰ The Eurovent study identified wide variations between countries in terms of patterns of use of home NIV and relative proportions of users with chronic and restrictive disease.¹¹ There are limited data available for Spain, however. Although 1 Spanish study, published by de Lucas Ramos et al,¹² showed that home NIV was in widespread use in 1999, only 43 of the 200 hospitals contacted participated in the survey.

The aim of the present study was to determine the type, frequency of use, and current availability of human and material resources and infrastructures for NIV in hospitals and at home by conducting a survey among public hospitals in the Autonomous Community of Valencia, Spain.

Material and Methods

Study Design and Scope

We performed a descriptive, observational, cross-sectional study of public hospitals in the Community of Valencia between December

2006 and May 2007. On consultation of a recently updated census of public hospitals in Valencia (November 2006), we identified 29 hospitals in the 3 provinces that make up this autonomous community: 10 in Alicante, 5 in Castellón, and 14 in Valencia. Two hospitals in Castellón and 4 in Valencia were excluded from the study because they did not have a pulmonologist, because they did not serve a health district of their own, or because they were support hospitals for patients with chronic disease referred from other hospitals. One such hospital in Alicante was included because it treated hospitalized patients with acute disease and also had a pulmonology department. Twenty-three hospitals were therefore included in the study.

Survey

The survey was conducted using a questionnaire containing items asking about the practice of NIV in patients with acute and chronic disease in different hospital departments including respiratory and internal medicine departments, intensive care units, emergency departments, and short-stay units. Hospitals that used NIV were asked to supply information about the number of patients treated every month, the most common diagnoses, the number and type of ventilators used, and the availability of additional material, special-purpose rooms, trained on-call staff, and written ventilation protocols. Hospitals with home ventilation programs were asked about the number and type of patients in these programs, the type of ventilators used, and the availability of home support and monitoring services and written protocols.

The questionnaire was drawn up by the coordinator of the Working Group on Sleep Apnea and Hypopnea (SAHS) and NIV of the Pulmonology Society of Valencia (SVN) and subsequently corrected and refined in a meeting with 2 other members of the group. The intelligibility and applicability of the resulting questionnaire were tested during a telephone interview with a randomly chosen hospital.

The questionnaire was sent to all the members of the SAHS and NIV Working Group by e-mail and a single survey was obtained per hospital; when several members of the group worked in the same hospital, the questionnaire was completed by consensus. When information was found to be missing, we contacted the head of the pulmonology or NIV department at the relevant hospital by telephone.

The study was approved by the ethics committee of the coordinating hospital and good clinical practice guidelines were followed during both the design and the conduct of the study.

Statistical Analysis

A database was created to record the information collected from each hospital (1 questionnaire per hospital). We performed a descriptive analysis of quantitative variables using measures of central tendency (mean and SD). To calculate the frequency of use of NIV per 100 000 population, we used data from the Valencian Population Information System (November 2006), a database containing health-related census data, and adjusted our calculations in accordance with data for the hospitals that participated in the study.

All the data were analyzed using version 12.0 of the SPSS software package (SPSS, Inc, Chicago, Illinois, USA).

Results

Sixteen (70%) of the 23 hospitals contacted completed the questionnaire. The response rate by province was 50% for Alicante, 89% for Valencia, and 75% for Castellón.

NIV was used to treat patients with acute respiratory episodes in the respiratory medicine departments of 14 hospitals (88%); the most common diagnoses were COPD exacerbation (mean [SD], 60% [20%]), obesity hypoventilation syndrome (22% [12%]), respiratory failure associated with neuromuscular disease (6.5% [8%]), and kiphoscoliosis (6.5% [7%]); less common diagnoses included severe pneumonia and cardiac insufficiency (4% [11%]) (Figure 1). The number of patients that received ventilation per month was 1-5 in 3 hospitals (21%), 6-10 in 6 hospitals (43%), and 11-20 in 5 hospitals (36%).

Fourteen hospitals (88%) had ventilators and 44% of these used bilevel positive airway pressure (BiPAP) devices only. There were considerable differences between departments in terms of the type and number of ventilators available (range, 2-8). In most cases, the hospitals used home ventilators on loan from service providers; as

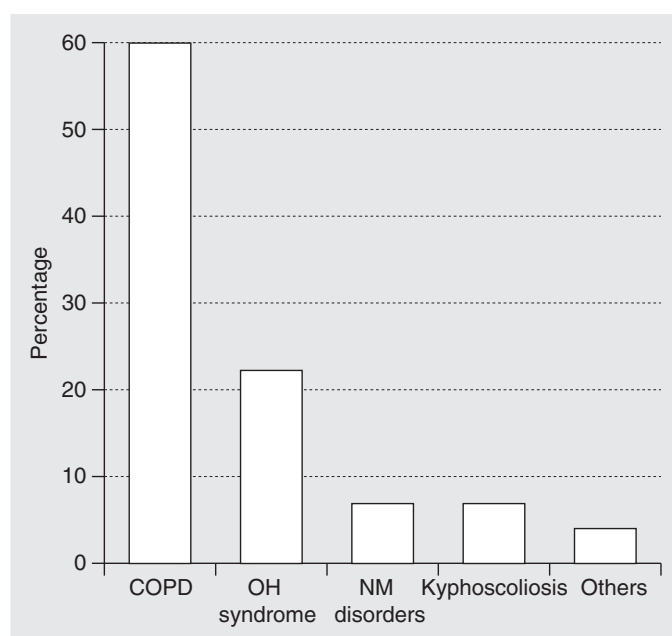


Figure 1. Distribution of diseases in patients with acute respiratory disease receiving ventilation in respiratory medicine departments. COPD indicates chronic obstructive pulmonary disease; OH, obesity hypoventilation; NM, neuromuscular

such, the technical characteristics of the equipment varied in accordance with the area served by each company.

As far as additional NIV material was concerned, only 3 hospitals (19%) used mechanical cough assist devices to control secretions in patients with neuromuscular disease and only 1 hospital had dedicated NIV rooms. NIV was mostly administered on general wards, whether in patients from the respiratory medicine department or other departments.

Fourteen hospitals (88%) did not have an on-call pulmonologist and only 1 had on-call shifts for patients on ventilation. None of the hospitals had supplemental nursing staff specialized in ventilation; indeed, NIV was administered by general ward nurses in all the hospitals.

NIV was available in the internal medicine departments of 6 hospitals. Although it was supervised by a pulmonologist in the majority of cases (83%), in 1 hospital (6%), it was performed only by internists. NIV was performed in the emergency departments of 11 hospitals (69%) and under the supervision of a pulmonologist (on demand) in 2 of these. In the other 9 hospitals, it was performed by other staff. NIV was performed in hospital-based home care units in 3 hospitals (19%), in short-stay units in just 1 hospital (6%), and in postoperative recovery rooms (on demand and under the supervision of a pulmonologist as in an emergency department) also in just 1 hospital (6%). Finally, NIV was performed in the intensive care units of all the hospitals that participated in the survey (Figure 2).

Home NIV was provided by 14 hospitals (88%). The most common diagnoses were COPD (31% [18%]), obesity hypoventilation syndrome (30% [18%]), neuromuscular disease (16% [23%]), kyphosis (12% [10%]), and others (11% [17%]) (Figure 3). There were wide variations between hospitals in terms of the type and number of patients receiving home NIV, with a median of 61 patients per hospital (range, 3-369). There were fewer than 25 patients in 5 hospitals, 25-50 in 2 hospitals, 51-100 in 4 hospitals, and over 100 in 3 hospitals.

The most common interface used to deliver home NIV was a nasal interface (65% [32%] of cases), followed by an oral-nasal interface (33% [33%]). Other devices such as a tracheostomy tube (2% [3%]) and a mouthpiece (1% [3%]) were less common. Eight hospitals (50%) used BiPAP ventilators only and the other 50% used both BiPAP and continuous positive airway pressure ventilators, although there were also major differences here in terms of the type and number of patients treated with each device.

Only 5 hospitals (31.3%), most of which treated large numbers of patients, had a specialized home care unit, and just 1 of these (6%) had a pulmonologist. In the majority of hospitals, home monitoring was performed exclusively by service providers.

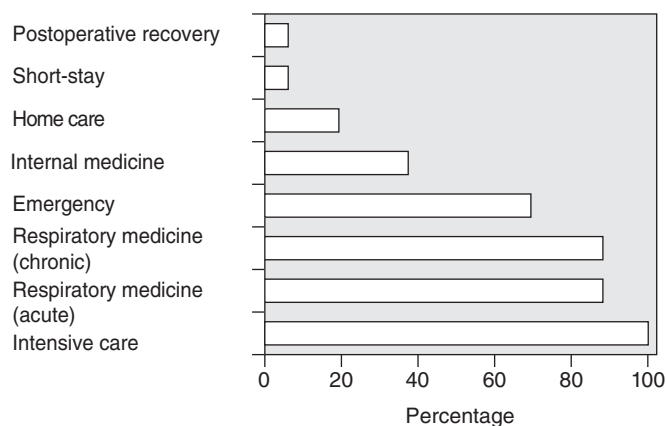


Figure 2. Use of noninvasive mechanical ventilation by specialty.

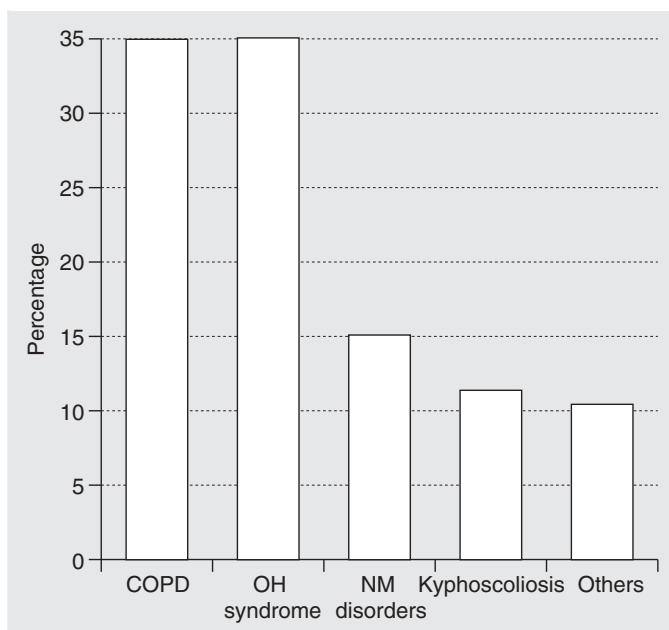


Figure 3. Distribution of diseases in patients with chronic respiratory disease receiving ventilation in respiratory medicine departments. COPD indicates chronic obstructive pulmonary disease; OH, obesity hypoventilation; NM, neuromuscular.

The pulmonology departments of just 8 hospitals (50%) had written protocols on when NIV should be initiated; the corresponding figures were 44% (n=7) for home care units, 19% for emergency departments, and 12% for internal medicine departments.

On adjusting the figure of 1067 patients receiving home NIV in our study to the population of 3 697 337 served by the 16 hospitals analyzed (77% of the 4 806 908 inhabitants in the Community of Valencia), we found that the frequency of use of home NIV was 29 per 100 000 population.

Discussion

In recent years, NIV has become increasingly used in patients with both acute and chronic respiratory disease, thanks largely to the role played by respiratory medicine and intensive care specialists. The literature, however, contains little information on aspects such as extent of use, infrastructures available, or actual usage figures. Our findings show that there is room for improvement in certain areas and we also identified serious deficiencies in the availability of human and material resources. Because 70% of the hospitals in the Community of Valencia participated in the survey, we believe that our findings are representative of the current situation.

In a study conducted in 268 hospitals in the United Kingdom, Doherty and Greenston¹³ found that 48% of the hospitals studied used NIV to treat patients with COPD exacerbations. These hospitals tended to serve larger populations and have more pulmonologists than those that did not provide NIV. The main reasons reported for not using NIV were a lack of trained personnel (53%), budget constraints (63%), and doubts about its benefits (15%). Like us, the authors found that there were wide variations between hospitals in terms of the number of patients treated each year, with only 9% of hospitals treating over 60 patients a year.

A similar study conducted by Maheshwari et al¹⁰ in 82 hospitals in the United States showed that although NIV was available in most of the hospitals, only 20% of patients who required mechanical ventilation received NIV, with considerable differences between hospitals (0%-50%). The main reasons cited for not using NIV were a lack of expertise (as in the British study) and inadequate equipment.

The authors also mentioned that previous negative experiences were significantly associated with lower use, particularly in hospitals serving smaller populations.

Our study also detected a lack of written protocols in departments providing NIV, particularly to patients with acute disease. Such protocols were more common in respiratory medicine than in other departments and very uncommon in emergency and internal medicine departments. Clinical practice guidelines are designed to optimize health care procedures, reduce resource usage, minimize variability in the routine clinical management of patients, and provide recommendations based on the results of randomized clinical trials; at times, they even anticipate the conclusions of such trials. The use of clinical practice guidelines on NIV by multidisciplinary teams has been seen to lead to changes in care delivery such as an increase in the use of NIV in intensive care units, greater consultation of pulmonologists by other specialists, and improved cardiopulmonary monitoring practices.¹⁴ The implementation of specific NIV protocols for nursing staff on general wards has also proved to be effective in improving the care provided to patients with acute respiratory acidosis.¹⁵ Nevertheless, there is a low level of adherence to clinical guidelines in the management of certain diseases; a Belgium study designed to assess adherence to the Global Initiative for Chronic Obstructive Lung Disease guidelines in the management of COPD, for example, found that just 22% of pulmonologists used NIV correctly in patients with COPD exacerbations.¹⁶

The patterns of use of NIV have changed over the years, primarily because of improvements in physician expertise and equipment availability. One study conducted between 1992 and 1999 in patients with acute respiratory failure due to COPD found no significant difference in the rate of success of NIV between the early and late study period, even though the patients in the second period had more severe respiratory failure episodes.¹⁷ They also found a significant reduction in the daily cost per patient treated with NIV in the late study period. Similar changes have also been seen in Spain, as is indirectly suggested by our study, which found that COPD exacerbations were the most common form of acute disease treated in the majority of hospitals studied.

NIV was used in the emergency departments of 69% of the hospitals that participated in our study; this figure is similar to that reported for emergency departments in the United Kingdom (67%).¹⁸ In French emergency departments, NIV was administered to just 9% of patients with moderate COPD exacerbations and 56% of those with severe exacerbations.¹⁹ The use of protocols in the emergency departments analyzed in our study was very low (19%) but similar to that reported for the United Kingdom (22%). Protocols were more common in respiratory medicine departments; we found them to be used in 50% of these departments, which is similar to the percentage estimated for hospitals in the United States.¹⁰ In general, NIV was most common in hospitals that used protocols and least common in those with a fewer number of beds or a smaller staff.

Although the benefits of creating intermediate care units in respiratory medicine departments have been described in recent years,²⁰⁻²² in this respect Spain seems to lag behind other Mediterranean countries such as Italy.²³ Our findings indicate that these units do not exist and that intermediate respiratory care is provided on general wards, with little supervision and monitoring, and no on-call pulmonologists. This problem is compounded by the fact that when NIV is used outside respiratory medicine wards, the effectiveness of the therapy and the quality of care provided can be seriously compromised. Furthermore, certain aspects of the guidelines governing NIV in Spain need to be updated as they were drafted several years ago.²⁴ The absence of supplemental nursing staff specialized in NIV administration also poses a serious risk to the quality of care provision.

In the area of home NIV, our study identified several important aspects that require further analysis, including the lack of specialized

clinics, the diversity of diseases treated and ventilation methods used, and the variations in patient numbers between hospitals. The situation in this respect is similar to that of other European countries. The Eurovent study, for example, showed wide variations in the use of home NIV between countries and considerable differences in terms of the relative proportions of patients with obstructive and restrictive disease.¹¹ The frequency of use of home NIV identified in our study region (29/100 000) contrasts with the figure reported for Spain in 1999 (4.59/100 000),¹² indicating that there has been a change in attitude and level of expertise in the management of patients requiring NIV, at least in the Community of Valencia. The Eurovent study found that home NIV was least common in Poland (0.1/100 000) and most common in France (17/100 000); the European average was 6.6/100 000.¹¹ It should be noted, however, that the data are from 2001. Our findings could probably be extrapolated to the rest of Spain as the use of NIV in patients with both acute and chronic disease has changed in the last 10 years.

Other studies have detected deficiencies in quality control procedures for monitoring home NIV systems in Spain²⁵ and Europe²⁶; the deficiencies were most evident in hospitals that did not have multidisciplinary teams and in situations in which quality control was left exclusively in the hands of technicians or service providers. Another study, conducted in 16 countries throughout Europe, and involving over 20 000 patients receiving ventilation, showed that home ventilation services were outsourced in 62% of hospitals and that the frequency of maintenance ranged from 3 to 12 months. The study also found limited interaction between service providers, little involvement by hospitals in equipment quality control procedures, an absence of monitoring systems, and considerable variations not only between countries but also within countries.²⁶ Home NIV is regulated by the state in the Community of Valencia and most other autonomous communities in Spain. Service providers are selected to provide control and monitoring services in the area of home ventilation following participation in a public tender (generally held every 4 years) in accordance with the law on the provision of home oxygen therapy, home ventilation, and similar. Although the conditions of the tender are revised periodically, companies differ in terms of equipment and control procedures, which vary between and within provinces depending on the health district in which the company operates.

In conclusion, while the use of NIV has increased considerably, we detected substantial deficiencies in the hospitals of the Community of Valencia in terms of staffing, material resources, variability of material used, and availability of support systems such as mechanical cough assist devices. Although NIV is provided to patients with acute disease in most of the hospitals studied, the number and type of patients receiving home ventilation were very varied and showed no clear relationship with the corresponding health district. The identification of a lack of written protocols in hospital departments should serve as a basis for reflection and provoke a change in attitude.

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