

# Original Article

## Availability and use of noninvasive ventilation in the intensive care units of public, private and teaching hospitals in the greater metropolitan area of São Paulo, Brazil\*

LARA MARIS NÁPOLIS<sup>1</sup>, LEILA MARA JERONIMO<sup>2</sup>, DANILA VIEIRA BALDINI<sup>3</sup>,  
MICHELLE PINHEIRO MACHADO<sup>3</sup>, VIRGÍNIA APARECIDA DE SOUZA<sup>3</sup>, PEDRO CARUSO<sup>4</sup>

### ABSTRACT

**Objective:** To determine the availability of noninvasive positive-pressure ventilation equipment, as well as the level of expertise and familiarity of physicians, nurses and physiotherapists with noninvasive positive-pressure ventilation in the intensive care units of public, private and teaching hospitals in the greater metropolitan area of São Paulo, Brazil. **Methods:** On-site administration of questionnaires. **Results:** Noninvasive positive-pressure ventilation equipment was widely available and was more commonly found in private hospitals than in teaching hospitals. Such equipment was least available in public hospitals, in which the predominant method was the use of mechanical ventilators designed for invasive ventilation and adapted to noninvasive positive-pressure ventilation. In private hospitals, continuous flow ventilators were more common, whereas, in teaching hospitals, ventilators specifically designed for noninvasive ventilation were typically employed. All physiotherapists felt themselves capable of initiating noninvasive positive pressure ventilation, compared with 72.6% of physicians and 33.3% of nurses. Physicians and physiotherapists presented high percentages of correct answers when asked about the indications and contraindications for the use of noninvasive positive-pressure ventilation. Over a one year period, more physiotherapists read articles about noninvasive positive-pressure ventilation and participated in related classes than did physicians, who in turn did so more than did nurses. **Conclusion:** Noninvasive positive-pressure ventilation equipment is widely available in the greater metropolitan area of São Paulo, although differences exist among public, private and teaching hospitals in terms of the type of equipment used. Physicians and physiotherapists exhibited considerable knowledge regarding the indications and contraindications for the use of noninvasive positive-pressure ventilation. More physiotherapists felt themselves able to initiate noninvasive positive-pressure ventilation, and their knowledge of the subject was more current than was that of physicians or nurses.

**Keywords:** Ventilators, mechanical; Positive-pressure respiration/methods; Respiratory insufficiency; Intensive care units; Hospitals

---

\* Study carried out at the University of Hospital do Câncer (Cancer Hospital), São Paulo, São Paulo, Brazil  
1. Masters in Physiotherapy from the Universidade Federal de São Paulo (UNIFESP, Federal University of São Paulo) School of Medicine, São Paulo, São Paulo, Brazil  
2. Masters in Physiotherapy from the University of São Paulo (USP) School of Medicine, São Paulo, São Paulo, Brazil  
3. Physiotherapist at the University of São Paulo (USP) School of Medicine Hospital das Clínicas, São Paulo, São Paulo, Brazil  
4. Attending physician in the Respiratory ICU of the University of São Paulo (USP) School of Medicine Hospital das Clínicas, São Paulo, São Paulo, Brazil; Physician in the ICU of the Hospital do Câncer (Cancer Hospital), São Paulo, São Paulo, Brazil  
Correspondence to: Pedro Caruso. Unidade de Terapia Intensiva de Adultos. R. Prof. Antonio Prudente 211, Liberdade - CEP: 01509-010, São Paulo, SP, Brasil.  
Submitted: 20 March 2005. Accepted, after review: 1 July 2005.

## INTRODUCTION

Noninvasive ventilation (NIV) has proved efficient in the treatment of acute and chronic respiratory failure. However, its successful use depends on the experience of the team that is performing the procedure and on the right choice of patients and equipment.<sup>(1-2)</sup>

It can be performed with continuous positive airway pressure (CPAP) devices, ventilators designed for invasive ventilation and adapted to noninvasive ventilation, or ventilators specifically designed for NIV. Each type of ventilator presents advantages and disadvantages.<sup>(3)</sup> Therefore, the indication of the best NIV equipment depends on the type of patient treated and the availability of the equipment in the institution, as well as the level of expertise and training of the team treating the patient.

The level of expertise that physicians, nurses and physiotherapists have in the use of NIV is an unknown factor, as is the availability of NIV-capable equipment in the metropolitan area of the city of São Paulo (MASP), located in the state of São Paulo. This information is fundamental for the implementation of NIV and the acquisition of NIV equipment, as well as for NIV education and training.<sup>(4)</sup>

The principal objective of this study was to evaluate the availability of equipment for NIV in the intensive care units (ICUs) of public, private and teaching hospitals located within the MASP. As a secondary objective, we evaluated the level of NIV expertise, currency of knowledge regarding NIV and familiarity with NIV presented by physicians, nurses and physiotherapists in these intensive care units.

## METHODS

The study was carried out in the MASP from September to October 2002. A total of 15 hospitals were analyzed: 5 private hospitals, 5 public hospitals and 5 teaching hospitals. Private hospitals were defined as those that did not belong to the public health network, public hospitals were defined as those that treated *Sistema Único de Saúde* (Unified Health Care System) patients exclusively, and teaching hospitals were defined as those affiliated with a school of medicine or that have residency programs in all areas of medical treatment and offer programs for graduate studies. The hospitals selected were chosen because they represented typical

examples of the definitions above, allowing us to sample different regions of the MASP. All were medium-sized to large-scale hospitals, with over 100 beds, and offered emergency services and surgical centers in addition to their ICUs.

Before the study outset, the professionals and the participating hospitals were informed that the identities of the hospitals would not be made public, nor would any individual staff members be identified and that only the professional and hospital categories would be compared. Only those physicians, physiotherapists and licensed nurses who worked regularly in the ICUs evaluated were included in this study.

A team was formed consisting of five interviewers, all of them experienced in the use of NIV. In the hospitals visited, the interviewer delivered the questionnaire described below, which was then completed at the convenience of the staff member (so as to avoid interfering with the responses). The interviewer later made a follow-up visit in order to answer any questions. The questionnaire was created for the purposes of this study and consisted of two parts. The first part was aimed at characterizing the professional, whereas the second dealt with availability of the equipment, as well as the level of expertise, currency of knowledge and familiarity with NIV possessed by that professional. There were a total of eight questions. (Annex 1 is available at <http://www.jornaldepneumologia.com.br>.)

Questions 1 and 3 were related to the availability of NIV in the ICU. Questions 4, 5, 7 and 8 were related to the level of expertise in NIV. In questions 4 and 5, the expertise of the participants was evaluated according to the percentage of correct responses regarding the indications and contraindications for the use of NIV. The professionals were asked to write down three different indications and contraindications. Questions 7 and 8 evaluated the currency of knowledge regarding NIV. Questions 2 and 6 were related to practical aspects, such as the indication and initiation of NIV.

The results were expressed as means, standard deviations and frequency (absolute numbers and percentages). In order to evaluate the correlation among the categorical variables, we used the chi-square test and the SPSS 10.0 program.

## RESULTS

A total of 15 hospitals were visited, 5 public

**TABLE 1**  
**Characteristics, by professional category, of the health professionals interviewed**

	Total	Physicians	Physiotherapists	Nurses
N (%)	191	106 (55,5)	58 (30,4)	27 (14,1)
Male (%)	93 (48,7)	76	12	5
Years since graduation	8,5 ± 5,6	10,5 ± 6,0	6,4 ± 4,0	6,9 ± 5,3
Public hospital (%)	55 (28,8)	35 (63,6)	10 (18,2)	10 (18,2)
Private hospital (%)	56 (29,3)	25 (44,65)	25 (44,65)	6 (10,7)
Teaching hospital (%)	80 (41,9)	46 (57,5)	23 (28,7)	11 (13,8)

**TABLE 2**  
**Number and percentage, by category, of professionals who reported that noninvasive ventilation is available in the intensive care unit**

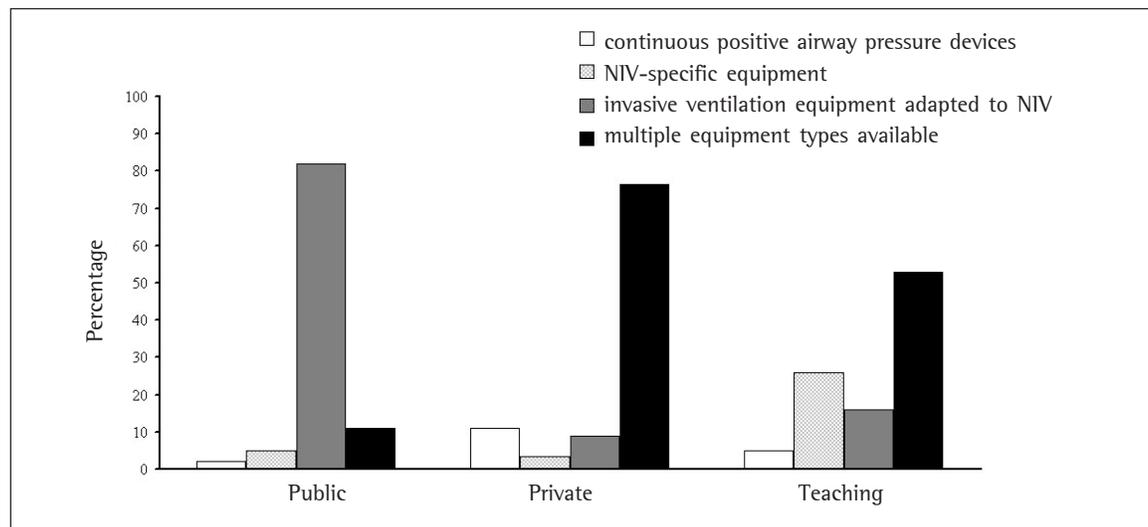
	Hospital type		
	public	private	teaching
Physicians, n (%)	29 (82,9)	25 (100)	46 (100)
Physiotherapists, n (%)	10 (100)	25 (100)	23 (100)
Nurses, n (%)	8 (80,0)	6 (100)	10 (90,9)

hospitals, 5 private hospitals and 5 teaching hospitals. In this last category, 3 were affiliated with a medical school, and 2 offered comprehensive residency and graduate studies programs. We interviewed 191 health professionals who worked in these 15 hospitals. The principal characteristics of the interviewees can be found in Table 1. Of the physicians interviewed, there were 41 intensivists (38.7%), 23 cardiologists (21.7%),

14 pulmonologists (13.2%), 8 general practitioners (7.5%), 5 nephrologists (4.7%) and 15 practitioners of other specialties (14.2%). Only 45 physicians held the title of specialist in intensive medicine (42.5%), of which 13 worked at public hospitals (37.1%), 12 worked at private hospitals (48%) and 20 worked at teaching hospitals (43.5%) (p = 0.47).

According to the interviewees, NIV is more widely available in private hospitals than in teaching hospitals, and is least available in public hospitals (85.5% in public hospitals vs. 100% in private hospitals and 98.8% in teaching hospitals; p < 0.001). Knowledge regarding availability varied according to the professional category (Table 2).

In public hospitals, the predominant method involved the use of ventilators designed for invasive ventilation and adapted to NIV. In private hospitals, CPAP devices predominated. In all the cases in which a private hospital interviewee responded that there was more than one option for NIV, one of the options



**Figure 1** - Types of noninvasive ventilation equipment available in public, private and teaching hospitals in the metropolitan area of São Paulo

TABLE 3

Most frequently cited, by professional category, indications for noninvasive ventilation

Indication cited*	Physicians	Physiotherapists	Nurses
	n (%)	n (%)	n (%)
Chronic obstructive pulmonary disease	75 (70.8)	33 (56.9)	10 (37.0)
Acute pulmonary edema	86 (81.1)	48 (82.8)	9 (33.3)
Acute respiratory failure	29 (27.4)	25 (43.1)	7 (25.9)
Postextubation	48 (45.3)	21 (36.2)	7 (25.9)
Atelectasis	18 (17.0)	18 (31.0)	3 (11.1)
Increased respiratory rate	7 (6.6)	7 (12.1)	4 (14.8)
Other**	36 (40.0)	19 (32.8)	9 (33.3)
No response	0 (0)	0 (0)	8 (29.6)

\*Up to three indications could be cited.

\*\*In the "Other" category, there were correct and incorrect citations, but they were all cited by less than 5% of the professionals.

was the CPAP device, further confirming that this is the type of equipment most commonly used in private hospitals. In teaching hospitals, NIV-specific equipment was predominant. Nearly 90% of teaching hospital interviewees who responded that there was more than one type of NIV equipment available mentioned the CPAP device and the NIV-specific equipment (Figure 1). The proportional difference among the hospital categories in the type of NIV equipment available was statistically significant ( $p < 0.01$ ). The perception of the type of NIV available did not vary among the professional categories.

All of the physicians and physiotherapists interviewed recommend the use of NIV, compared with only 61.5% of the nurses ( $p < 0.001$ ). Regarding the perception of being capable of initiating NIV, only 72.6% of the physicians and

33.3% of the nurses considered themselves capable, compared with 100% of physiotherapists ( $p < 0.001$ ).

The responses to questions 4 and 5, which were formulated to evaluate the level of expertise of each professional class regarding NIV indications and contraindications, can be found in Tables 3 and 4. A significantly higher number of nurses provided no responses to these questions ( $p < 0.001$ ). The percentage of physicians and physiotherapists citing indications and contraindications that were in accordance with the Brazilian consensus on mechanical ventilation<sup>(5)</sup> was higher than that found for the nurses.

Questions 7 and 8 evaluated the currency of knowledge regarding NIV. Analysis of the responses obtained revealed that 65.9% of the physicians, 93.8% of the physiotherapists and 28.6% of the nurses had read at least one scientific article on NIV

TABLE 4

Most frequently cited, by professional category, contraindications for noninvasive ventilation

Contraindication cited*	Physicians	Physiotherapists	Nurses
	n (%)	n (%)	n (%)
Decreased consciousness	72 (67.9)	40 (69.0)	3 (11.1)
Uncooperative patient	31 (29.2)	18 (31.0)	1 (3.7)
Hemodynamic instability	28 (26.4)	12 (20.7)	1 (3.7)
Post-esophageal/-stomach surgery	35 (33.0)	12 (20.7)	1 (3.7)
Aspiration/vomiting/secretion	19 (17.9)	10 (17.2)	2 (7.4)
Pneumothorax without drainage	8 (7.5)	18 (31.0)	1 (3.7)
Facial trauma	6 (5.6)	15 (25.9)	0 (0)
Other**	47 (44.3)	38 (65.5)	30 (55.5)
No response	3 (2.8)	0 (0)	10 (37.0)

\* até três contra-indicações poderiam ser anotadas.

\*\* na categoria "outras" havia citações corretas e incorretas, porém todas foram citadas por menos de 5% dos profissionais. VNI: ventilação não invasiva

within the preceding year ( $p < 0.001$ ). In the year preceding the study period, NIV classes had been attended by 58.9% of the physicians, 80.0% of the physiotherapists and 25.7% of the nurses ( $p < 0.001$ ).

## DISCUSSION

For various common causes of respiratory failure, such as pulmonary cardiogenic edema and uncompensated chronic obstructive pulmonary disease, NIV has proven to be an efficient treatment.<sup>(1)</sup> However, the use of NIV with masks is more recent than that of invasive ventilation. To the best of our knowledge, there have been no studies evaluating the availability of NIV in the MASP. Nor have there been any studies assessing the level of NIV training and expertise possessed by health professionals working in the MASP. Knowledge regarding the availability of NIV is fundamental for planning the acquisition of new equipment by public, private and teaching hospitals. It is also fundamental that physicians, physiotherapists and nurses who work in the ICU have expertise in and familiarity with the use of NIV.<sup>(4)</sup>

We opted to quantify the availability of NIV through interviews, rather than through performing inventories of the hospitals. We did so because, although it is important for the ICU to have NIV equipment, we feel that it is even more important for the ICU team to know that it is available. Even though question 1 of the questionnaire could reveal a situation in which the equipment was available, but the NIV procedures were not (lack of personnel capable of initiating it), we do not believe this situation is common. Another potential limitation of this method is that the professionals might have assumed that there was NIV equipment available when in fact there was not. However, due to the high level of expertise and currency of knowledge that the physicians and physiotherapists demonstrated, it is quite unlikely that this problem occurred among these professional categories. Among the nurses, the opposite situation is more likely, in that there might be available equipment of which they are not aware (Table 2).

Fortunately, NIV was found to be widely available in the MASP, even in public hospitals. This high availability was surprising if compared with the results of a study of NIV availability in British hospitals, in which NIV equipment was found to be available in

48% of the hospitals.<sup>(6)</sup> The authors of that study reported that NIV availability was higher among the large-scale hospitals and that there was wide regional variation. It is also surprising that, in the present study, NIV availability varied according to the professional category interviewed. If we consider only the responses of the physiotherapists, NIV availability was 100%, regardless of the type of hospital. Although they were found to be more aware of the availability of NIV equipment than were nurses, physicians were still less knowledgeable about NIV availability than were physiotherapists. These differences probably reflect inequalities in levels of familiarity with and instruction in the use of NIV.

All hospital categories presented high or full NIV availability. Nevertheless, the type of NIV available varied among the hospital categories. In public hospitals, ventilators designed for invasive ventilation and adapted to NIV were found to be the most common. This result is similar to that obtained in a recent study on the use of NIV.<sup>(7)</sup> The authors of that study evaluated 42 ICUs and demonstrated that 76% of them performed NIV using invasive ventilation equipment. We can suppose that this predominance is due to the lower availability of NIV-specific equipment in these hospitals. In private hospitals, CPAP devices prevailed. Finally, in teaching hospitals, the predominance of NIV-specific ventilators might be due to the higher availability of equipment and resources in teaching hospitals, as well as to higher pressure applied by the clinical staff regarding its acquisition.

In our study, regarding the indications and contraindications of NIV, the number of correct responses given by physiotherapists was equal to that of those given by physicians and higher than that of those given by nurses. In addition, the physiotherapists demonstrated that their knowledge of the subject was more current than was that of the physicians or nurses. Furthermore, the percentage of physiotherapists who felt that they were capable of initiating NIV was higher than that found for physicians or nurses. The high percentage of correct responses regarding the indications and contraindications for NIV, as well the greater confidence in their capacity to initiate an NIV, demonstrated by physiotherapists is probably due to the fact that, in the division of labor in the ICU, the task of initiation and monitoring NIV falls to the physiotherapists. More emphasis must be given

to NIV instruction during the training of these professionals. In contrast to the situation observed among physiotherapists, few nurses felt that they were capable of initiating NIV. In addition, nurses demonstrated less currency of knowledge regarding the subject, gave fewer correct responses regarding NIV indications and contraindications and left a higher percentage of questions unanswered. These findings are likely related to the fact that nurses are not responsible for initiating or monitoring NIV.

The fact that we interviewed a higher number of physicians is not surprising since, in daily practice, these professionals are present in greater numbers. Surprisingly, the number of physiotherapists interviewed was higher than the number of nurses interviewed, even though there are more nurses in the ICUs. This fact can be explained by the number of nurses who declined to participate in the study, which could be yet another indication that nurses are less familiar with NIV.

A limitation of this study is the small number of hospitals chosen to represent the MASP. In the teaching hospital category, our sample represents a great portion of the hospitals in the area. However, in the other two categories, the sample is small in relation to the total number of hospitals. Since public hospitals are more homogeneous, the private hospital category is more prone to a sample bias. We tried to avoid this bias by choosing hospitals from different areas and of different sizes.

In our opinion, this study indicates that nurses need more theoretical and practical training in the use of NIV and that physicians need more practical training. We also feel that public and private hospitals should acquire more NIV-specific ventilators, which offer advantages over the adapted ventilators. Such advantages include more precise monitoring, compensation for leaks and better patient-ventilator synchrony.<sup>(3,8)</sup> Ventilators designed specifically for NIV are also superior to CPAP devices in that NIV-specific ventilators offer the possibility of providing ventilation at two pressure levels.

The availability of NIV is high in the hospitals of the MASP, regardless of the type of hospital. In public hospitals, the predominant NIV method involves the adaptation of invasive ventilation equipment, whereas CPAP devices predominate in private hospitals, and NIV-specific ventilators are the most common type of devices used in teaching hospitals.

Physicians and physiotherapists present a high level of knowledge regarding the indications and contraindications for NIV. Physiotherapists demonstrate knowledge of the subject that is more current than that demonstrated by physicians or nurses. More physiotherapists than physicians or nurses feel that they are capable of initiating NIV.

## REFERENCES

1. Mehta S, Hill NS. Noninvasive ventilation. *Am J Respir Crit Care Med.* 2001;163(2):540-77.
2. Holanda MA, Oliveira CH, Rocha EM, Bandeira RM, Aguiar IS, Leal W, et al. Ventilação não-invasiva com pressão positiva em pacientes com insuficiência respiratória aguda: fatores associados à falha ou sucesso. *J Pneumol.* 2001;27(6):301-9.
3. Schonhofer B, Sortor-Leger S. Equipment needs for noninvasive mechanical ventilation. *Eur Respir J.* 2002;20(4):1029-36.
4. Leger P, Laier-Groeneveld G. Infrastructure, funding and follow-up in a programme of noninvasive ventilation. *Eur Respir J.* 2002;20(6):1573-8.
5. Duarte ACM, Oliveira PHE, Schettino GP. II Consenso Brasileiro de Ventilação. *J Pneumol.* 2000;26:S60-3.
6. 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):863-6.
7. Carlucci A, Richard JC, Wysocki M, Lepage E, Brochard L; SRLF Collaborative Group on Mechanical Ventilation. Noninvasive versus conventional mechanical ventilation. An epidemiologic survey. *Am J Respir Crit Care Med.* 2001;163(4):874-80.
8. Bunburaphong T, Imanaka H, Nishimura M, Hess D, Kacmarek RM. Performance characteristics of bilevel pressure ventilators: a lung model study. *Chest.* 1997;111(4):1050-60.